Smart Innovation, Systems and Technologies 78

Suresh Chandra Satapathy
Vikrant Bhateja
Swagatam Das *Editors*

Smart Computing and Informatics

Proceedings of the First International Conference on SCI 2016, Volume 2

KES International

Springer

Smart Innovation, Systems and Technologies

Volume 78

About this Series

The Smart Innovation, Systems and Technologies book series encompasses the topics of knowledge, intelligence, innovation and sustainability. The aim of the series is to make available a platform for the publication of books on all aspects of single and multi-disciplinary research on these themes in order to make the latest results available in a readily-accessible form. Volumes on interdisciplinary research combining two or more of these areas is particularly sought.

The series covers systems and paradigms that employ knowledge and intelligence in a broad sense. Its scope is systems having embedded knowledge and intelligence, which may be applied to the solution of world problems in industry, the environment and the community. It also focusses on the knowledge-transfer methodologies and innovation strategies employed to make this happen effectively. The combination of intelligent systems tools and a broad range of applications introduces a need for a synergy of disciplines from science, technology, business and the humanities. The series will include conference proceedings, edited collections, monographs, handbooks, reference books, and other relevant types of book in areas of science and technology where smart systems and technologies can offer innovative solutions.

High quality content is an essential feature for all book proposals accepted for the series. It is expected that editors of all accepted volumes will ensure that contributions are subjected to an appropriate level of reviewing process and adhere to KES quality principles.

More information about this series at http://www.springer.com/series/8767

Suresh Chandra Satapathy
Vikrant Bhateja · Swagatam Das
Editors

Smart Computing and Informatics

Proceedings of the First International Conference on SCI 2016, Volume 2

Springer

Editors
Suresh Chandra Satapathy
Department of Computer Science Engineering
PVP Siddhartha Institute of Technology
Vijayawada, Andhra Pradesh
India

Swagatam Das
Electronics and Communication Sciences Unit
Indian Statistical Institute
Kolkata, West Bengal
India

Vikrant Bhateja
Department of Electronics and Communication Engineering
Shri Ramswaroop Memorial Group of Professional Colleges
Lucknow, Uttar Pradesh
India

ISSN 2190-3018 ISSN 2190-3026 (electronic)
Smart Innovation, Systems and Technologies
ISBN 978-981-10-5546-1 ISBN 978-981-10-5547-8 (eBook)
https://doi.org/10.1007/978-981-10-5547-8

Library of Congress Control Number: 2017945691

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

The 1st International Conference on Smart Computing and Informatics (SCI) was organized successfully with the excellent support of Department of CSE, ANITS, Visakhapatnam, during March 3–4, 2017. The aim of this international conference was to present a unified platform for advanced and multidisciplinary research towards design of smart computing and information systems. The theme was on a broader front focused on various innovation paradigms in system knowledge, intelligence, and sustainability that is applied to provide realistic solution to varied problems in society, environment, and industries. The scope was also extended towards deployment of emerging computational and knowledge transfer approaches, optimizing solutions in varied disciplines of science, technology, and healthcare. The conference received many high-quality submissions in direct track and special session tracks. After stringent quality check and review process only good papers were accepted with an acceptance ratio of 0.38. Several eminent researchers and academicians delivered talks addressing the participants in their respective field of proficiency. Professor Ganapati Panda, IIT Bhubaneswar; Dr. R. Logeswaran, Malaysia; Dr. C. Krishna Mohan, IIT Hyderabad; Dr. P.S. Grover, KIIT, Group of Colleges, Gurgaon; Dr. A.K. Nayak, Hon. Secretary, Computer Society of India, Director, Indian Institute of Business Management, Patna; Dr. Arunkumar Thangavelu, VIT Vellore; Dr. Ramchandra V. Pujeri, Director, MIT College of Engineering Pune; Dr. Nilanjan Dey, TICT Kolkota; and Dr. Prashant Kumar Pattnaik, KIIT Bhubaneswar were the eminent speakers and guests on the occasion.

We would like to express our appreciation to the members of the Program Committee for their support and cooperation in this publication. We are also thankful to the team from Springer for providing a meticulous service for the timely production of this volume. Our heartfelt thanks to Chairman, ANITS, for the support provided. Special thanks to all guests who have honored us with their presence in the inaugural day of the conference. Our thanks are due to all special session chairs, track managers and reviewers for their excellent support. Profound thanks to Organizing Chair Prof. Pritee Parweker, ANITS, Visakhapatnam for marvelous support. Sincere thanks to Honorary Chair, Dr. Lakhmi Jain, Australia,

for his valuable inputs and support during the conference. Last, but certainly not least, our special thanks go to all the authors who submitted papers and all the attendees for their contributions and fruitful discussions that made this conference a great success.

Vijayawada, India — Suresh Chandra Satapathy
Lucknow, India — Vikrant Bhateja
Kolkata, India — Swagatam Das
March 2017

Organizing Committee

Special Session Chairs

Dr. M. Bhanu Sridhar, GVP College of Engineering for Women, Visakhapatnam, AP, India
Dr. D.N.D. Harini, GVP College of Engineering, Visakhapatnam, AP, India
Dr. Tusar Kanti Mishra, ANITS, Visakhapatnam, AP, India
Prof. (Dr.) R. Sireesha, Professor, GITAM University, Visakhapatnam, AP, India
Prof. (Dr.) R. Sivaranjani, ANITS, Visakhapatnam, AP, India
Dr. Hari Mohan Pandey, Amity University, Delhi, India
Ankit Chaudhary, Truman State University, USA
Yudong Zhang, Nanjing Normal University, China, Research Scientist, MRI Unit, Columbia University, USA
Tanupriya Choudhury, Amity University, Uttar Pradesh, India
Praveen Kumar, Amity University, Uttar Pradesh, India
Dr. Sai Sabitha, Amity University, Uttar Pradesh, India
Dr. Suma V., Dean, Research and Industry Incubation Centre, Dayananda Sagar College of Engineering, Bangalore, India

International Advisory Committee/Program Committee

S.K. Udgata, UoH, Hyderabad, India
C.A. Murthy, ISI Calcutta, Kolkata, India
M.K. Tiwari, IIT Kharagpur, India
C. Chandra Sekhar, IIT Madras, Chennai, India
Suresh Sundaram, NTU, Singapore
Lipo Wang, NTU, Singapore
Amit Mitra, IIT Kanpur, India
Aruna Tiwari, IIT Indore, India

D. Nagesh Kumar, IISc, Bangalore, India
V. Sushila Devi, IISc, Bangalore, India
C. Hota, BITS Pilani, Hyderabad, India
Chilukuri Mohan, Syracuse University, Syracuse, USA
Debjani Chakraborty, IIT Kharagpur, India
P.K. Kalra, IIT Kanpur, India
Vasant Pandian, University Putra Malaysia, Malaysia
Oscar Castillo, Tijuana Institute of Technology, Chula Vista CA, USA
Indranil Bose, IIM Calcutta, Kolkata, India
S. Bapi Raju, IIIT Hyderabad, India
Brijesh Verma, CQ University, Brisbane, Australia
C.R. Rao, UOHYD, Hyderabad, India
B.L. Deekshatulu, IDRBT, Hyderabad, India
Arun Agarwal, UOHYD, Hyderabad, India
Arnab Laha, IIM, Ahmedabad, India
Biplav Srivastava, IBM Research, New Delhi, India
B.K. Mohanty, IIM, Lucknow, India
M. Janga Reddy, IIT Bombay, Mumbai, India
M.C. Deo, IIT Bombay, Mumbai, India
Pankaj Dutta, IIT Bombay, Mumbai, India
Usha Anantha Kumar, IIT Bombay, Mumbai, India
Faiz Hamid, IIT Kanpur, India
S. Chakraverty, NIT Rourkela, Rourkela
H. Fujita, Iwate Prefectural University, Iwate, Japan
Dries Benoit, Ghent University, Ghent, Belgium
S.A. Arul, Philips Electronics Singapore, Singapore
Pawan Lingars, Saint Mary's University, Halifax, Canada
Amuelson Hong, Oriental Institute of Technology, Taiwan
Zhihua Cui, Taiyuan University of Science and Technology, Taiyuan, China
Balasubramaniam Jayaram, IIT Hyderabad, India
K. Saman Halgamuge, The University of Melbourne, Melbourne, Australia
Nischal Verma, IIT Kanpur, India
Laxmidhar Behera, IIT Kanpur, India
Prof. Yao Chu Jin, University of Surrey, Guildford, England
Vineeth Balasubramian, IIT Hyderabad, India
Atul Negi, Professor, University of Hyderabad, India
M. Naresh Kumar, NRSC, Hyderabad, India
Maurice Clerc, Franch Roderich Gross, England
Dr. Syed Basha, India
Kalyanmoy Deb, IIT Kanpur, India
Saman Halgamuge, Australia
Jeng-Shyang Pan, Talwan
Peng Shi, UK
Javier Del Ser, Spain
Leandro Dos Santos Coelho, Brazil

S. Pattanaik, India
Gerardo Beni, USA
K. Parsopoulos, Greece
Lingfeng Wang, China
Athanasios V. Vasilakos, Athens
Pei-Chann Chang, Taiwan
Chilukuri K. Mohan, USA
Saeid Nahavandi, Australia
Abbas Khosravi, Australia
Almoataz Youssef Abdelaziz, Egypt
K.T. Chaturvedi, India
M.K. Tiwari, India
Yuhui Shi, China
Dipankar Dasgupta, USA
Lakhmi Jain, Australia
X.Z. Gao, Finland
Juan Luis Fernandez Martinez, Spain
Oscar Castillo, Mexico
Heitor Silverio Lopes, Brazil
S.K. Udgata, India
Namrata Khemka, USA
G.K. Venayagamoorty, USA
Zong Woo Geem, USA
Ying Tan, China
S.G. Ponnambalam, Malaysia
Halina Kwasnicka, Poland
M.A. Abido, Saudi Arabia
Richa Singh, India
Manjaree Pandit, India
Hai Bin Duan, China
Delin Luo, China
V. Ravi, India
S. Basker, India
M. Rammohan, South Korea
Munesh Chandra Trivedi, ABES Engineering College, Ghaziabad, India
Alok Aggarwal, Professor and Director, JP Institute of Engineering and Technology, Meerut, India
Dilip Kumar Sharma, Institute of Engineering and Technology, GLA University, Mathura, India
K. Srujan Raju, CMR Technical Campus, Hyderabad, India
B.N. Biswal, BEC, Bhubaneswar, India
Sanjay Sengupta, CSIR, New Delhi, India
Naeem Hanoon, Malaysia
Cirag Arora, India
Steven Fernades, India

Kailash C. Patidar, South Africa
K. Srujan Raju, CMR Group, Hyderabad
Ramakrishna Murthy, ANITS, Visakhapatnam, India
Ch. Suresh, ANITS, Visakhapatnam, India
S. Mishra, ANITS, Visakhapatnam, India
Prof. Chintan Bhatt, Chandubhai S. Patel Institute of Technology, Gujarat, India
V. Suma, Bangalore, India
Srinivas Sethi, IGIT, Odisha, India
H. Behera, Sambalpur, India
Sachi Dehuri, Balasore, India
Siressha Rodda, GITAM, Visakhapatnam, India
Lalitha Bhaskari, Andhra University, Visakhapatnam, India
J.V.R. Murthy, JNTU Kakinada, India
A. Govardhan, JNTU Hyderabad, India
Kuda Nageswar Rao, Andhra University, Visakhapatnam, India
P. Sanjeevi Kumar, India
Suresh Limkar, Pune, India
Suberna Kumar, MVGR, Vizayanagaram, India
B. Tirumala Rao, JNTU Vizayanagaram, India
Dr. Debabrata Samanta, Dayananda Sagar College of Arts, Science and Commerce, Bangalore, India
Dr. Divakar Yadav, Associate Professor, MMMUT, Gorakhpur, India
Dr. Anuja Arora, Jaypee Institute of Information Technology, Noida, India

Contents

About the Editors

Suresh Chandra Satapathy is currently working as Professor and Head, Department of Computer Science and Engineering at PVP Siddhartha Institute of Technology, Andhra Pradesh, India. He obtained his Ph.D. in Computer Science and Engineering from JNTU Hyderabad and M.Tech. in CSE from NIT, Rourkela, Odisha, India. He has 26 years of teaching experience. His research interests include data mining, machine intelligence and swarm intelligence. He has acted as program chair of many international conferences and edited 6 volumes of proceedings from Springer LNCS and AISC series. He is currently guiding 8 scholars for Ph.D. Dr. Satapathy is also a Senior Member of IEEE.

Vikrant Bhateja is Professor in the Department of Electronics and Communication Engineering at Shri Ramswaroop Memorial Group of Professional Colleges (SRMGPC), Lucknow, and also the Head (Academics and Quality Control) in the same college. His areas of research include digital image and video processing, computer vision, medical imaging, machine learning, pattern analysis and recognition, neural networks, soft computing, and bio-inspired computing techniques. He has more than 90 publications in various international journals and conference proceedings. Professor Bhateja has been on TPC and chaired various sessions from the above domain in international conferences of IEEE and Springer. He has been the track chair and served in the core-technical/editorial teams for international conferences: FICTA 2014, CSI 2014 and INDIA 2015 under Springer-ASIC Series and INDIACom-2015, ICACCI-2015 under IEEE. He is associate editor in International Journal of Convergence Computing (IJConvC) and also serving in the editorial board of International Journal of Image Mining (IJIM) under Inderscience Publishers. At present he is guest editor for two special issues floated in International Journal of Rough Sets and Data Analysis (IJRSDA) and International Journal of System Dynamics Applications (IJSDA) under IGI Global publications.

Swagatam Das received the B.E.Tel.E., M.E.Tel.E. (Control Engineering specialization) and Ph.D. degrees, all from Jadavpur University, India, in 2003, 2005, and 2009, respectively. Currently, he is serving as Assistant Professor at the

Electronics and Communication Sciences Unit of Indian Statistical Institute, Kolkata. His research interests include evolutionary computing, pattern recognition, multi-agent systems, and wireless communication. Dr. Das has published one research monograph, one edited volume, and more than 150 research articles in peer-reviewed journals and international conferences. He is the founding co-editor-in-chief of "Swarm and Evolutionary Computation", an international journal from Elsevier. He serves as associate editor in the IEEE Trans. on Systems, Man, and Cybernetics: Systems and Information Sciences (Elsevier). He is an editorial board member of Progress in Artificial Intelligence (Springer), Mathematical Problems in Engineering, International Journal of Artificial Intelligence and Soft Computing, and International Journal of Adaptive and Autonomous Communication Systems. He is the recipient of the 2012 Young Engineer Award from the Indian National Academy of Engineering (INAE).

High Level Verification of I^2C Protocol Using System Verilog and UVM

Lakshmi Manasa Kappaganthu, Avinash Yadlapati and Matta Durga Prakash

Abstract Present-day technology has reached a goal where an entire system can be implemented on a single chip which is nothing but called system on chip (SOC). It involves microcontrollers and various peripheral devices with each peripheral device having its own intellectual property (IP) named as IP cores. Serial communication is established between these IP cores using various protocols like RS232, RS422 and UART etc. They perform point to point communication which requires huge wiring connections, multiplexing of all the bus connections to deliver the information to the IP Cores. To overcome this I^2C protocol is developed by Philips, which is a two line communication. Here only two pins, i.e., SCL and SDA establish connection between various devices considering one as master and other as slave (Eswari et al. in Implementation of I^2C Master Bus Controller on FPGA, 2013) [1]. These two pins communicate using particular commands like start, address, read/write, acknowledgement and stop commands. These commands show a particular format in which data should transfer. Both 7-bit and 10-bit addressing formats can be used, 10-bit addressing supports more addressing lines, i.e., 1024 compared to 127 addressing lines in 7-bit mode. The advantage in this protocol is it has low wiring data transfer rate that can be improved using Ultra-Fast mode (UFm) (Bandopadhyay in Designing with Xilinx FPGAs. Springer, Switzerland, 2017) [2]. Ultra-Fast mode is a unidirectional data transfer mode, i.e., only writing data to an address can be done. In this paper they perform verification for the design of an I^2C protocol between a master and a slave using system Verilog and UVM in the tool SimVision.

L.M. Kappaganthu · M.D. Prakash (✉)
Department of Electronics and Communication Engineering, K L University, Guntur, Andhra Pradesh, India
e-mail: mdprakash82@gmail.com

L.M. Kappaganthu
e-mail: lakshmimanasa.k93@gmail.com

A. Yadlapati
CYIENT Ltd, Hydearabad, Telangana, India
e-mail: avinash.amd@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_1

1 Introduction

SDA and SCL are the two bidirectional pins employed for data transfer and clock generation [3, 4]. In this paper work, they employ a master and a slave between these pins; perform data transfer for both 7-bit and 10-bit addressing in normal and Ultra-Fast modes. A particular pattern is used to make this transfer, i.e., start bit, address bit, r/w bit, acknowledgement bit, data bit, acknowledgment bit, stop bit. Master and slave act as both transmitter and receiver [5]. In ultrahigh speed mode only unidirectional transfer occurs, i.e., data can only be written but cannot be retrieved; it has a data rate of 5 Mbits/s.

I^2C has various applications like LCD, LED displays, temperature sensors, system management bus (SMBUS), real time clocks, power supply controlling, ADC and DAC, etc. Thus it is best employed for short distance communication with less wiring and high data rates.

1.1 Overview of the Implementation

Slave is considered as the DUT with Master coding various test cases, i.e., Test Bench. DUT is coded using behavioral Verilog HDL, Test bench environment is created in S.V using UVM methodology, is tested for various test cases. S.V is based on OOPs concepts which make it advantageous to Verilog. Test Bench environment involves various subparts like transaction, generator, driver, environment, test and top. Each part of test bench related to individual blocks is separately executed and all are finally linked in the top module. Virtual interface is used for communication between DUT and Test Bench. It is represented in Fig. 1.

Results are simulated in SimVision tool, it is an integrated graphical debugging environment within Cadence which supports signal and transaction level flows across the design and the test bench. It is used for simulating for various languages like VHDL, Verilog, and System Verilog, etc. It is advantageous, i.e., DUT and Test Bench both can be analyzed anytime during the verification time.

2 Protocol Description

I^2C has two pins SDA and SCL, i.e., Serial Data transfer and Serial Clock which are bidirectional. Devices connected to these pins are Master and Slave, as shown in Fig. 2.

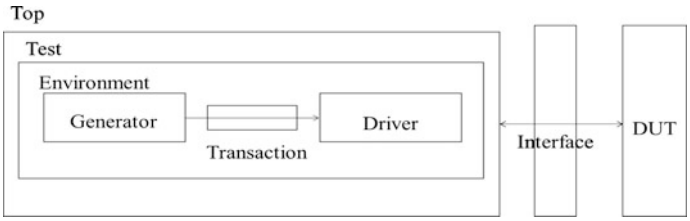


Fig. 1 System Verilog test bench architecture

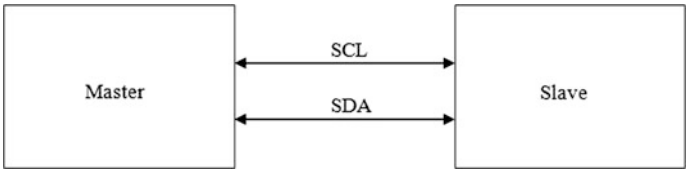


Fig. 2 Signal transmission between master and slave using the two pins SCL (serial clock) and SDA (serial data)

2.1 I²C Signal Description

SDA, Serial Data, acts as both input and output, on this pin our data is transmitted and received. When Master transmits the data slave receives it and acknowledges, similarly when slave transmits the data master receives and acknowledges after proper reception. For this reason it is a bidirectional pin.

SCL, Serial Clock, is generated by the Master; on this pin the clock signal is transmitted [6]. The signal description is as follows (Table 1).

2.2 I²C Functionality Description

Functionality of Master. It generates the clock pulse. It acts as a transmitter and a receiver. It acknowledges when it acts as a receiver. When a master also acts as a slave, its slave address is same as master address [4] (Table 2).

Table 1 Signal description

Signal name	I/O	Description
SDA	Input and output	Serial data transfers data in bidirectional format with a speed of 100 kbit/s in standard mode
SCL	Input and output	Serial clock is bidirectional, is generated by the master and controls the transfer of data
USDA	Input	UFm serial data is unidirectional, transmits data at a speed of 5 Mbit/s
USCL	Input	UFm serial clock is unidirectional and is generated by the master

Table 2 Functional description of the master

Signal name	I/O	Description
Transmitter	Input	It generates the slave address and in return waits for the acknowledgment from the slave to transfer data. After ACK is received it transfers data and the slave generates ACK till it can accept data
Receiver	Output	It generates the slave address, after receiving ACK from the slave, i.e., it is ready to transfer data. Data is accepted by the master which in return acknowledges to the slave till the extent it can receive data

Functionality of Slave. It acts as a transmitter and a receiver. It acknowledges whenever it is addressed and when it acts as a receiver. It can perform clock stretching to hold the SCL line low when it operates at low speed (Table 3).

2.3 I^2C Block Diagram Description

Block diagram for the I^2C represents the serial flow of data and clock. There is a particular pattern the protocol follows for transmitting data. Data transmission gets initiated with a start command ends with a stop command, as in [7].

In standard mode it is represented as (Fig. 3):

S (Start) It represents start command and is generated only by the master. It occurs when SCL is high and SDA makes a high to low transition.

Slave address It is a 7-bit slave address, which is the address of the slave to which the corresponding transaction has to be done.

Read/$\overline{\text{Write}}$ If a write action needs to be done, then the SDA bit value to be assigned '0'. If a read action needs to be done SDA bit value will be assigned '1'.

ACK The one which is being addressed needs to acknowledge that it is ready for data transmission, i.e., write or read by making SDA bit

Table 3 Functional description of the slave

Signal	I/O	Description
Transmitter	Input	When the slave address generated by the master matches with the slave device address. It transfers data to the master, waits for the ACK signal from the master to transfer next byte When Not ACK signal is received from master it halts transmission
Receiver	Output	When the slave address generated by the master matches with the slave device address. Slave sends an ACK signal and accepts data from the master. When it cannot handle any more data it sends a not ACK signal

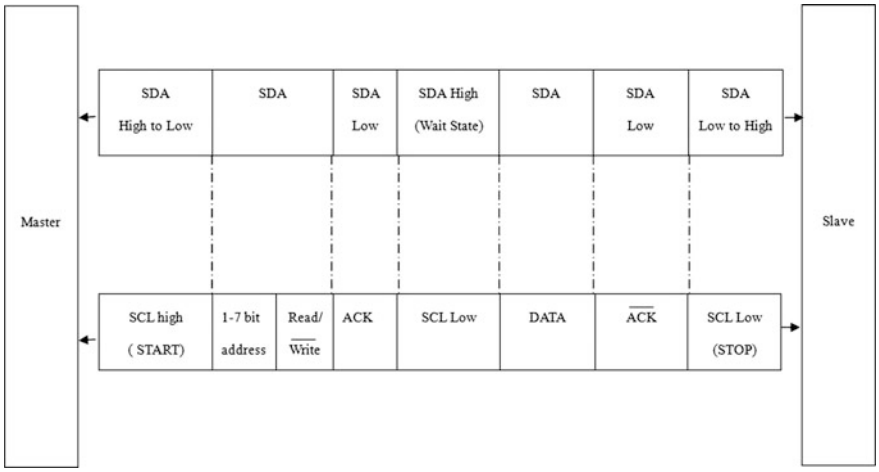


Fig. 3 Block diagram flow between master and slave with a specific data flow pattern in standard mode

	'0'. If SDA bit is '1' it means the one addressed is not ready for transmission, data does not get transmitted.
Wait	When the slave is busy, it makes SCL low so that it remains in a wait state without loss of data until slave gets free.
Data	After receiving the acknowledgment signal the one being addressed transmits 8-bit data to the slave address or reads data from the slave address based on the condition specified.
ACK/$\overline{\text{ACK}}$	If the one being addressed is ready for another data transmission it sends an ACK (active low), i.e., '0' else it generates an ACK i.e., '1'.
P (Stop)	It represents a stop command and is generated only by the master. It occurs when SCL is high and SDA makes a high to low transition. The data transmission with the slave gets terminated when this command is generated.

In Ultra-Fast mode it is represented [7] as (Fig. 4):

S (Start)	It represents start command and is generated only by the master. It occurs when USCL is high and USDA makes a high to low transition.
Slave address	It is a 7-bit slave address, which is the address of the slave to which the corresponding transaction has to be done.
$\overline{\text{Write}}$	Only write action can be done in ultra-fast mode, so the USDA bit value is assigned as '0'.

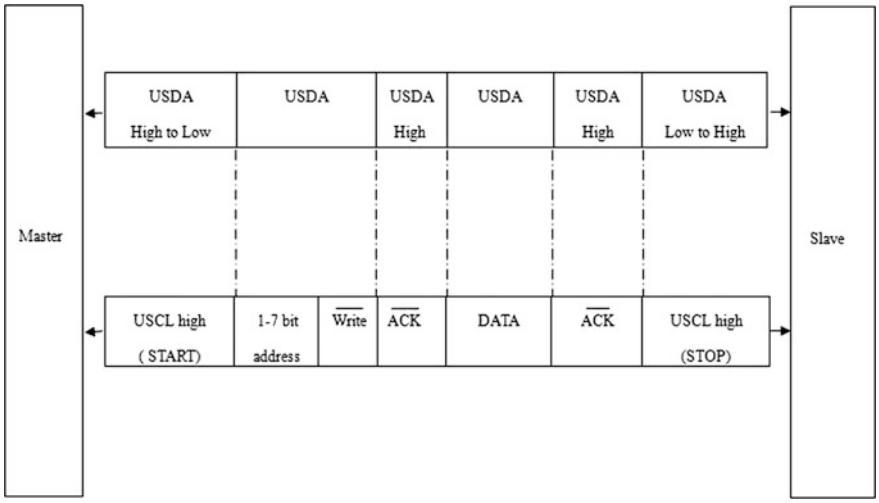


Fig. 4 Block diagram representing the data flow between Master and Slave in a specified pattern in ultra-fast mode

$\overline{\text{ACK}}$	Acknowledgment signal is not present in ultra-fast mode, but to maintain the compatibility with I^2C protocol this bit is reserved. It is always set high by the master.
Data	After receiving the acknowledgment signal the one being addressed transmits 8-bit data to the slave address or reads data from the slave address based on the condition specified.
$\overline{\text{ACK}}$	To follow the I^2C protocol pattern this bit is set to '1' by the master by default.
P (Stop)	It represents a stop command and is generated only by the master. It occurs when USCL is high and USDA makes a high to low transition. The data transmission with the slave gets terminated when this command is generated.

3 Timing Diagram

It represents basic format of the data flow with various commands. Start command which starts transmission, slave address to which transmission has to be done, write mode set to write data, acknowledgement from the slave that it will accept the data, data is written to particular address, not acknowledgment indicating slave can't accept any more data, repeated start to perform read action which is similar to start, slave address from which data to be read, read mode enabling by setting bit to '1', acknowledgment from slave that it is free to send data, data read from the particular

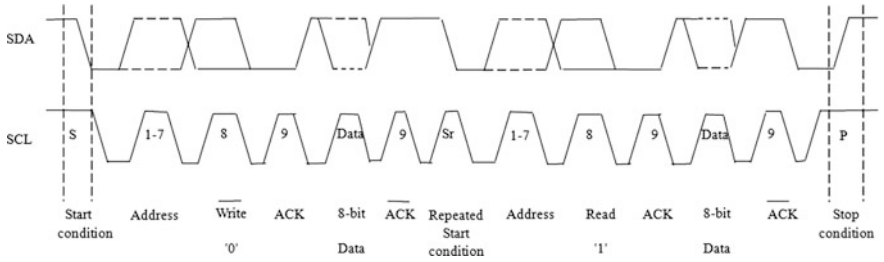


Fig. 5 Timing analysis for write and read actions in standard mode

location, not acknowledgment indicating slave is busy, stop command by the master that transmission is complete, as in [8, 9].

These steps are the minimum required for performing data transmission (Fig. 5).

4 Results

In standard mode and ultra-fast mode the results acquired for 7-bit and 10-bit addressing are as follows.

Standard mode. In this mode it has 7-bit and 10-bit addressing ways; both write and read operations are performed, as in [4].

Firstly 7-bit addressing has 128 ways of addressing; here write and read operations occur as follows (Figs. 6 and 7).

Now in 10-bit addressing it has two addresses, the first 7-bit has a fixed pattern of 7'b11110xx and the second address is a byte. The last two bits of the first address and the second byte build up our 10-bit address. Advantage of having 10-bit

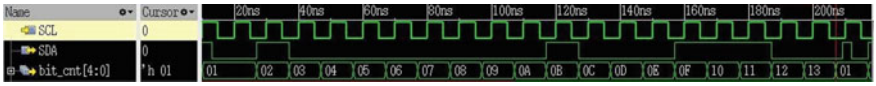


Fig. 6 Writing data into the slave using 7-bit addressing in standard mode. (01) Start bit is set, (02–08) slave address is mentioned, (09) '0' mentioning write action, (0A) acknowledgment bit as '0' i.e., slave is ready to accept data, (0B–12) data written to slave, (13) acknowledgment from slave to make repeated start i.e., performing read action from the slave

Fig. 7 Reading data from the slave using 7-bit addressing in standard mode. (01) Start bit is set, (02–08) slave address is mentioned, (09) '1' mentioning read action, (0A) acknowledgment bit as '0' i.e., slave is ready to accept data, (0A–11) data read from slave, (12) acknowledgment from slave to make repeated start

addressing is that if it has 1024 address locations instead of just 128 locations where address collisions may occur, as in [6, 7]. Write and read operations here are as follows (Figs. 8 and 9).

Ultra-Fast mode. In Ultra-Fast mode only write operation is done as the signals are unidirectional. ACK has no significance and is controlled by the master to make it compatible with I^2C protocol. Remaining is same as per mentioned in the standard mode, as in [6, 9].

7-bit and 10-bit write operations occur as follows (Figs. 10 and 11).

Fig. 8 Writing data into the slave using 10-bit addressing in Standard mode. (01) Start bit is set, (02–08) first part of slave address is mentioned, (09) '0' mentioning write action, (0A) acknowledgment bit as '0' i.e., slave is ready to accept data, (0B–12) 2nd byte address of the slave, (13) acknowledgment bit as '0' i.e., slave is ready to accept data, (14–1B) data written to slave, (1C) acknowledgment from slave to make repeated start i.e., performing read action from the slave

Fig. 9 Reading data from the slave using 10-bit addressing in Standard mode. (01) Start bit is set, (02–08) first part of slave address is mentioned, (09) '0' mentioning write action, (0A) acknowledgment bit as '0' i.e., slave is ready to accept data, (0B–12) 2nd byte address of the slave, (13) acknowledgment bit as '0' i.e., slave is ready to send data to the master, (14–1B) data read from the slave, (1C) acknowledgment from slave to make repeated start

Fig. 10 Writing data into the slave using 7-bit addressing in UFm mode. (01) Start bit is set, (02–08) slave address is mentioned, (09) '0' mentioning write action, (0A) acknowledgment bit as '1' (ack signal is not required in UFm mode but to retain protocol bit pattern the ack bit is mentioned), (0B–12) data written to slave, (13) acknowledgment from slave which is always set as high

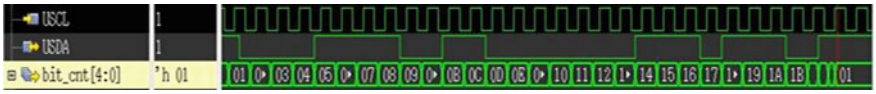


Fig. 11 Writing data into the slave using 10-bit addressing in UFm mode. (01) Start bit is set, (02–08) first part of slave address is mentioned, (09) '0' mentioning write action, (0A) acknowledgment bit as '0' i.e., slave is ready to accept data, (0B–12) 2nd byte address of the slave, (13) acknowledgment bit as '0' i.e., slave is ready to accept data, (14–1B) data written to slave, (1C) acknowledgment bit as '1' indicating stop action

5 Conclusion

In this work, implementation of I²C protocol in standard and ultra-fast modes is discussed. The operations are performed with only two signals having minimum wiring there by reducing delay and is very useful for small distance communication, i.e., making interconnections on board. Instead of the basic 7-bit address format, they have done 10-bit addressing such that it can have 1024 ways of addressing which reduces address collisions.

6 Future Work

Present work can be extended by including clock stretching case in which slave controls the clock when it is busy to handle new information from the master. The same concept can be implemented on an FPGA tool.

Acknowledgements Heartfelt thanks to the SEMICON team [CYIENT Ltd, Hyderabad] for giving me attention and their valuable time at peak times. My special gratitude and love to my parents.

References

1. Bollam Eswari, N. Ponmagal, K. Preethi, S.G. Sreejeesh.: Implementation of I²C Master Bus Controller on FPGA. International conference on Communication and Signal Processing (2013).
2. Saikat Bandopadhyay: Simulation. In: Sanjay Churiwala Nagel. (eds.) Designing with Xilinx FPGAs. LNCS, pp. 127–140. Springer, Switzerland (2017)
3. Chris Spear.: System Verilog for verification: A Guide to Learning the test bench for Language Features. Springer, Colorado (2012)
4. I²C-bus specification and user manual Rev. 6 — 4 Apr. 2014, http://www.nxp.com
5. S. Palnitkar.: Verilog HDL: A Guide to Digital Design and Synthesis. Upper Saddle River, New Jersey, Prentice Hall (1996)
6. Rashinkar, Prakash, Paterson, Peter, Singh, Leena.: System-on-a-Chip Verification: Methodology and techniques. Norwell, MA, USA (2000)
7. Zheng-wei HU.: I²C Protocol Design for Reusability. In: Third International Symposium on Information Processing, North China Electric Power University, Baoding, China (2010)
8. J. W. Bruce.: Personal Digital Assistant (PDA) Based I²C Bus Analysis. In: IEEE Transactions on Consumer Electronics, Vol. 49. pp. 83–89. No. 4, China (2003)
9. Peter Corcoran: Two Wires and 30 Years. In: U.S. Patent 4 689 750, pp. 30–36, (2013)

Pre-informed Level Set for Flower Image Segmentation

Syed Inthiyaz, P.V.V. Kishore and B.T.P. Madhav

Abstract This work proposes a pre-informed Chan–Vese (CV) based level sets algorithm. Pre-information includes objects colour, texture and shape fused features. The aim is to use this algorithm to segment flower images and extract meaningful features that will help is classification of floral content. Shape pre-information modelling is handled manually using advance image processing tools. Local binary patterns (LBP) features makeup texture pre-information and RGB colour channels of the object provide colour pre-information. All pre-defined object information is fused together to for high dimension subspace defining object characteristics. Testing of the algorithm on flower images datasets shows a jump in information content in the resulting segmentation output compared to other models in the category. Segmentation of flowers is important for recognition, classification and quality assessment to ever-increasing volumes in floral markets.

1 Introduction

Flowers induce instantaneous and elongated effects on emotions, mood, behaviours and memory of both males and females [1]. The authors studied extensively about the reactions flowers cause during their contact with humans in three different ways and concluded that human happiness is directly linked to flowers. This is the reason for a 30% increase in world floriculture market every year and a 25% in India per annum [2]. The other side of the story is the losses incurred as they do not last long

S. Inthiyaz (✉) · P.V.V. Kishore · B.T.P. Madhav
Department of Electronics and Communication Engineering, K L University, Green Fields, Vaddeswaram, Guntur, DT, Andhra Pradesh, India
e-mail: syedinthiyaz@kluniversity.in

P.V.V. Kishore
e-mail: pvvkishore@kluniversity.in

B.T.P. Madhav
e-mail: btpmadhav@kluniversity.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_2

after they are cut form the plant. The storage, temperature, sorting, packaging and transportation are some of the causes for a market loss of nearly 25% every year [3].

Computer vision based algorithms are capable of determining the quality of flower during its journey from blossoming to final consumer market. In this work we limit ourselves to the first stage of development of a complete floral quality tester using computer vision models. The first and most complicated task is to extract the flower to lower dimensional subspace for classification. The binary segmentation of the flower is performed by using a higher dimensional feature subspace comprising colour, texture and shape characteristics of the image objects. The proposed method is evaluated on flower database available at oxford [4].

In [5], the authors use an image-specific colour distribution which detects the shape of the flowers in the image automatically. The algorithm starts with colour descriptor and transforms into a foreground/background segmentation initializing a generic shape model. The generic shape model is applicable across multiple classes and viewpoints. Previously Das et al. [6] used colour of the flowers as domain knowledge for segmentation. The algorithm also learns image background model from the periphery of the image. This model works well when the flower in the image is different from background by over 50%.

But the oxford database which is being used in our work does not follow this rule and the creators of the database propose the algorithm in [7]. Here the authors develop a visual vocabulary of flowers based on colour, texture and shape information. This model overcomes the ambiguities that arise during flower classifications due to ambient lighting variations, petals shape deformations, colour changes and occlusion during image capture. Our work in this paper is also focused on pre knowledge of shape, colour and texture of the flower.

In this work we introduce a mixed feature as pre-information for the level set function. The mixed feature is made up of shape, texture and colour. For colour RGB planes are featured. Shapes are hand modelled from the original images of flowers. For texture we use Local Binary Patterns (LBP) features instead of GLCM or Gabor features. The mixed feature image of a flower from the dataset is shown in Fig. 1.

Fig. 1 Mixed feature using colour, texture and shape (CTS) images

The pre-information related to flower in CTS form is provided as constraints in the formulation of level sets. Level sets were first introduced by Osher and Fedkiw [8] and later popularized by Vese and Chan [9]. A number of versions of level sets with shape [10] and texture priors [11] were very popular with the image processing research community. A combination of colour, texture and shape features are used exclusively by computer vision researchers for complex image segmentation.

2 Multi Feature Level Set Formulation

Colour, texture and shape features form a knowledge base for the level set function to operate on the image plane. Previous algorithms used three different functions for level set formulation from these features. In this work we propose to use a single term for all these features to be incorporated in a level set. A brief review of the level sets and feature extraction models make up this section.

2.1 Colour Feature and Texture Features

Previous works extracted Red, Green and Blue (RGB) vectors from the image plane to construct a size (RGB) $\times$ 3 vector feature subspace. Other methods involve converting RGB space to Lab or HIS or HSV colour spaces and extracting them as colour features. The novel model proposed in this work saves computing power initially by avoiding this step. The idea is to use each of the R, G and B planes separately during contour propagation. The level set is formulated on these three sub-planes, which will be elaborated in the level sets section.

Nature creates different varieties of flowers based on colours and textures. Quite a few models in texture extraction were ideated for flower segmentation. They are Grey-Level Covariance Matrix (GLCM), Gabor Filters, wavelet filters and Local Binary Patterns (LBP). Results of our analysis in Figs. 1 and 2 show that LBP features in RGB plane provide us with good texture of the flower compared to the other three.

LBP compares each pixel in a pre-defined neighbourhood to summarize the local structure of the image. For an image pixel $\boldsymbol{I}(\boldsymbol{x},\boldsymbol{y}) \in \Re^{+}$, where $(\boldsymbol{x},\boldsymbol{y})$ gives the pixel position in the intensity image. The RGB image is $\boldsymbol{I}(\boldsymbol{x},\boldsymbol{y},\boldsymbol{N}) \in \Re^{+}$, where N represents RGB colour planes. The neighbourhoods of a pixel can vary from 3 pixels with radius $\boldsymbol{r} = 1$ or a neighbourhood of 12 pixels with $\boldsymbol{r} = 2.5$. The value of pixels using LBP code for a centre pixel $(\boldsymbol{x}_c,\boldsymbol{y}_c,\boldsymbol{N})$ is given by

$$\mathbf{LBP}(\boldsymbol{x}_c,\boldsymbol{y}_c,\boldsymbol{N}) = \sum_{i=1}^{N}\sum_{j=1}^{P} \boldsymbol{s}\left(\boldsymbol{g}_p - \boldsymbol{g}_c\right)2^{\boldsymbol{P}} \tag{1}$$

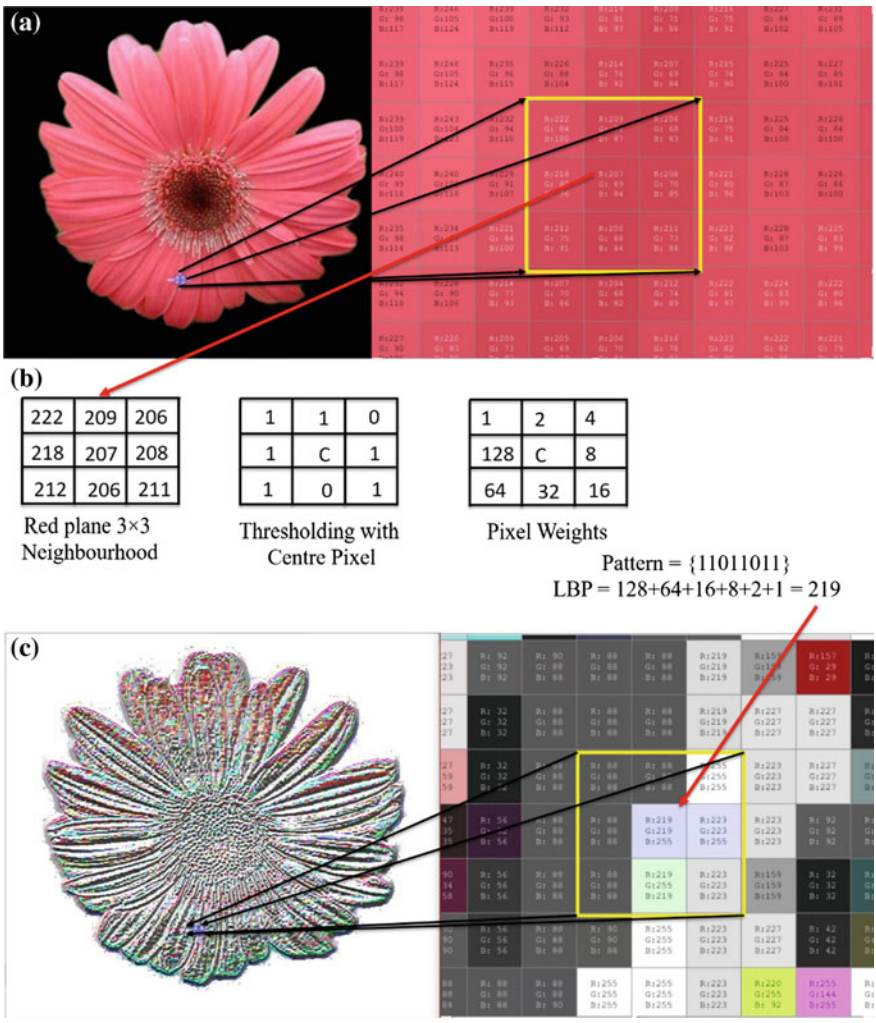


Fig. 2 **a** Original flower image. **b** LBP process for 3 × 3 window and **c** the resultant local binary patterns resulting in a colour texture image

$$s(\boldsymbol{x}) = \begin{cases} 1 & \forall \boldsymbol{x} \geq 0 \\ 0 & \textbf{Otherwise} \end{cases} \tag{2}$$

where $\boldsymbol{g_c}$ is intensity grey value of centre pixel at $(\boldsymbol{x}_c, \boldsymbol{y}_c)$ and $\boldsymbol{g}_p$ is grey value around the neighbourhood of $\boldsymbol{g_c}$. The value of $\boldsymbol{N}$ represents colour plane and $\boldsymbol{P}$ gives the number pixels in the neighbourhood of $\boldsymbol{g_c}$. Figure 2 gives the LBP calculations on the flower image in Fig. 1.

The LBP texture features are invariant to monotonic grey-level changes that are predominant in flower images. Computational simplicity makes the LBP ideal for this work as the next stage involves more computationally intensive algorithm in the form of level sets. This colour texture flower data forms the pre-information to the level set function.

2.2 Level Set Formulation

The level set model introduced by Osher and Fedkiw [8] and few others is an image segmentation model based on a closed contour spreading in the image plane adhering to object edges. An implicitly defined contour of arbitrary shape Θ in the image plane O: $\{\boldsymbol{o}(\boldsymbol{x},\boldsymbol{y}) \subset \mathbb{R}^2\}$ as the zero-level set of an embedding function $\phi : \mathrm{O} \rightarrow \mathbb{R}$:

$$\Theta = \{\boldsymbol{x},\boldsymbol{y} \in \mathrm{O} | \phi(\boldsymbol{x},\boldsymbol{y}) = 0\} \tag{3}$$

Level set function ϕ evolves instead of contour Θ itself giving advantages in the form of no marker control and immune to topological deformations of the active contour in the image plane. Here we focus on Chan Vese (CV) [9] level set functional formulated from [10] in the image plane $\boldsymbol{I} : \Theta \rightarrow \mathbb{R}^+$ as

$$\boldsymbol{E}^{\mathrm{Cv}}(\phi) = \int_{\Theta} (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^+)^2 \boldsymbol{H}(\phi(\boldsymbol{x}))\mathrm{d}\boldsymbol{x} + \int_{\Theta} (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^-)^2 (1 - \boldsymbol{H}(\phi(\boldsymbol{x})))\mathrm{d}\boldsymbol{x} + \lambda \int_{\Theta} |\nabla \boldsymbol{H}\phi(\boldsymbol{x})|\mathrm{d}\boldsymbol{x} \tag{4}$$

$\boldsymbol{I}(\boldsymbol{x},\boldsymbol{y})$ is a 2D image plane represented as $\boldsymbol{I}(\boldsymbol{x})$. Here $\boldsymbol{H}(\phi(\boldsymbol{x}))$ is a Heaviside step function. $\boldsymbol{C}^+$ represents average intensity of pixels considered constant in positive ϕ region and $\boldsymbol{C}^-$ represents negative ϕ region constant. The last term in Eq. (4) tries to keep a smoothing contour during evolution and λ is proportionality constant deciding on the minimum amount of separation needed between boundaries. The first two parts constitute external energy representing error between the image and piecewise constant approximations of the evolving level set functional. Gradient descent minimization of the level set ϕ gives a curve evolution expression

$$\frac{\partial \phi}{\partial \boldsymbol{t}} = -\frac{\partial \boldsymbol{E}^{\mathrm{Cv}}}{\partial \phi} = \delta(\phi)\left[\lambda\left(\nabla \cdot \left(\frac{\nabla \phi}{|\nabla \phi|}\right)\right) - (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^+)^2 + (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^-)^2\right] \tag{5}$$

CV model proposed the $\delta(\phi)$ term which helps level set detect even the internal edges.

A shape and texture prior model for level set as a learning basis will focus on segmenting the flower in RGB sub-planes which is useful in post processing

recognition. To establish a unique relationship between its surrounding level set ϕ and a pre-defined shape, texture, colour (STC) model $\varphi^{\mathbf{STC}}$, it will be assumed that $\phi < 0$, inside $\varphi^{\mathbf{STC}}$, $\phi > 0$, outside $\varphi^{\mathbf{STC}}$ and $|\phi| = 1$ everywhere else. The model $\varphi^{\mathbf{STC}}$ is defined as a combination of shape and texture models taken across RGB colour planes. The colour model in this case is user dependent and can be either HSV or lab colour space. The combination level set function is

$$\varphi^{\mathbf{STC}} = \sum_{N=3} \varphi^{\mathbf{S}} + \varphi^{\mathbf{T}} \tag{6}$$

There are many ways to define this signed distance functions out of which we use the most widely applied with constrains towards scaling, rotation and translational properties. In this work we propose to use initial contour ϕ and shape prior $\varphi^{\mathbf{STC}}$ contour to compute level set area difference:

$$\boldsymbol{d}^2\left(\phi, \varphi^{\mathbf{STC}}\right) = \sum_{i=1}^{N} \int_{\Theta} \left(\boldsymbol{H}(\phi(x)) - \boldsymbol{H}\left(\varphi^{\mathbf{STC}}(x)\right)\right)^{\mathbf{2}} \mathbf{d}\boldsymbol{x} \tag{7}$$

where N is the number of colour sub-planes the image is defined. The defined distance function is image size independent, nonnegative, symmetrical and satisfies the triangle inequality. Local energy minimization between $\left(\phi_0, \varphi^{\mathbf{STC}}\right)$ maximizes the possibility of finding correct shape in the cluttered backgrounds. The affine transformations are defined by current STC ϕ_0. The curve evolution expression is obtained by applying Euler–Lagrange equation on (7) as

$$\frac{\partial \phi_0}{\partial \boldsymbol{t}} = \sum_{i=1}^{N} 2\delta(\phi_0) \times \left(\boldsymbol{H}\left(\varphi^{\mathbf{STC}}\right) - \boldsymbol{H}(\phi_0)\right) \tag{8}$$

where $\delta(\cdot)$ is delta function and t is artificial time step. Finally combining STC prior energy term in (7) and CV level set function in (2), we get the total energy function of the level set as

$$\boldsymbol{E}^{\boldsymbol{T}} = \sum_{\boldsymbol{i}=1}^{\boldsymbol{N}} \zeta \boldsymbol{E}^{\boldsymbol{C}} + (1 - \zeta)\boldsymbol{E}^{\mathbf{STC}} \tag{9}$$

Here ζ controls the effect of STC prior energy on the image energy. For single shape priors the energy functional used for algorithm development is derived from evolution equations in (5) and (8) is

$$\frac{\partial \phi}{\partial \boldsymbol{t}} = \sum_{i=1}^{N} \zeta\delta(\phi)\left[\lambda\left(\nabla \cdot \left(\frac{\nabla\phi}{|\nabla\phi|}\right)\right) - (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^{+})^2 + (\boldsymbol{I}(\boldsymbol{x}) - \boldsymbol{C}^{-})^2\right] + 2(1 - \zeta) \times \left(\boldsymbol{H}\left(\varphi^{\mathbf{STC}}\right) - \boldsymbol{H}(\phi)\right) \tag{10}$$

where $\boldsymbol{C}^+$ and $\boldsymbol{C}^-$ are updated iteratively in each discrete time step using the expressions

$$\boldsymbol{C}^+ = \sum_{i=1}^{N} \frac{\int_{\Theta} \boldsymbol{I}(\boldsymbol{H}(\phi))\mathbf{d}x}{\int_{\Theta} (\boldsymbol{H}(\phi))\mathbf{d}x} \tag{11}$$

$$\boldsymbol{C}^- = \sum_{i=1}^{N} \frac{\int_{\Theta} \boldsymbol{I} \times (1 - \boldsymbol{H}(\phi))\mathbf{d}x}{\int_{\Theta} (1 - \boldsymbol{H}(\phi))\mathbf{d}x} \tag{12}$$

The following proposed level set model is tested for different flower images in the dataset [4].

3 Results and Discussion

The following parameters of the proposed level set functional needs adjustments during the simulation trials. The shape, texture, colour (STC) effect term ζ is set based on the complexity in the image planes. This term controls the contour movement distributions on the sub-planes related to shape and texture. The ζ is around 0.634 for images captured under lesser ambient lighting or with dominating backgrounds compared to flower foregrounds. For high-quality images this value is kept very low around 0.12. In this work the value of ζ ranges from 0.1 to 0.7.

The level set stopping criteria is set using the gradient descent algorithm. Contour evolution stops when the error between the current iteration and previous iteration reaches a pre-defined threshold. The error value is set 0.0001. The performance of the proposed method is estimated using Structural Similarity Index (SSIM) against the other methods such as Gabor Texture Prior (GTP) and Grey-Level Covariance Matrix Texture Priors (GLCMTP).

The segmentation results for various flower images in the dataset are presented in Fig. 3 along with their shape and texture priors. Local binary pattern based texture is used in all the simulations. Figure 3 shows initial contour in yellow and final contour in green. Both the contours are projected on to the image under IC heading. The final iteration count for each flower image is different, even though the images collected in Fig. 3 are shown for common iteration count. The last column shows the binary segmented flower image that can be used for classification process. Visual analysis of the segmented flower indicates the quality of the proposed method. A very clear picture is obtained about the flower showing internal texture and its shape. The internal stem of the flower in Anthurium is fully extracted under the cluttering influence of the flower texture. This near perfect segmentation can achieve good classification rates. Figure 4 shows more test results on flower images from the dataset in [4].

Figure 4 gives the performance of the algorithm when tested on images of different colour, shape and texture. The resulting flower images can be presented to

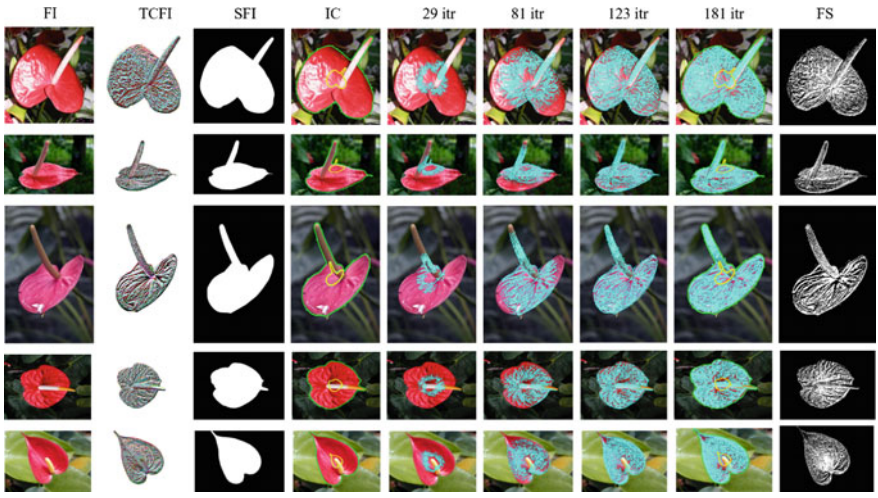


Fig. 3 Flower segmentation process, *FI* flower image, *TCFI* texture colour FI, *SFI* shape flower image, *IC* initial contour, *29 itr* 29th iteration captured, *81 itr* 81th iteration captured, *181 itr* 181th iteration captured, *FS* segmented flower

Fig. 4 Segmentation results of the proposed algorithm on flowers of different sizes, shapes, textures and colours

a classifier for classification. For qualitative performance measurement we use structural similarity index as a measure between the segmented output and the hand segmented ground truth. The ground truth is extracted using expert craftsman in Photoshop.

Superiority of the proposed Local Binary Pattern Texture (LBPT) segmentation is established by comparing its performance with Gabor Texture Prior (GTP) and Grey-Level Covariance Matrix Texture Priors (GLCMTP). The performance indicators are SSIM and number of iterations. SSIM measures the local and global similarity between pixels between images. We use reference image as the hand segmented image and the test image is represented by segmented flower.

Table 1 gives global SSIM values for flowers in the database between LBPT, GTP and GLCMTP. SSIM values are in the range of [0, 1]. Is SSIM score is '0' indicates no match and '1' indicates a perfect match.

The average SSIM value for all the images in the dataset from the proposed algorithm (LBPT–LS) is around 0.9282 and the average number of iterations is 189. The average SSIM values for GTP–LS and GLCMTP–LS are 0.7798 and 0.7801 respectively. Similarly, the average iteration count is 221 and 228 for GTP and LCMTP. Further these values can be improved using a combination of these methods and more complicated flower image structures.

Table 1 Performance indicators for the flower segmentation algorithms using level sets

Flower name	No. of images/flower	LBPT–LS		GTP–LS		GLCMTP–LS	
		Avg. SSIM	Avg. Itr.	Avg. SSIM	Avg. Itr.	Avg. SSIM	Avg. Itr.
Anthurium	10	0.923	181	0.785	220	0.786	222
Barbeton daisy	10	0.918	186	0.776	236	0.778	226
Bishopof llandaff	10	0.935	192	0.753	242	0.751	232
Californian Poppy	10	0.952	188	0.802	224	0.800	234
Frangipani	10	0.920	184	0.786	229	0.789	219
Hibiscus	10	0.872	177	0.742	211	0.748	221
Lotus	10	0.942	187	0.795	236	0.791	226
Rose	10	0.852	171	0.736	209	0.730	219
Thorn apple	10	0.892	179	0.761	219	0.760	229
Tree mallow	10	0.865	173	0.750	213	0.752	223

4 Conclusion

A novel method for flower image segmentation is attempted in this work. Flower images are the most complicated structures nature creates for humans which are difficult to understand. The task is accomplished using level sets that are pre-informed about the colour, shape and texture related to the flower. Local binary patterns make texture information related to the flower. Shape is hand segmented and the level set is evolved in the RGB colour plane using the shape and texture information. SSIM and number of iterations are used as a performance measure for comparing the proposed level set with Gabor texture filter based level set and grey covariance matrix based level sets. The proposed method using LBP textures outperforms the other two texture models for flower classification.

References

1. Jeannette Haviland-Jones, Holly Hale Rosario, Patricia Wilson, Terry R. McGuire, "An Environmental Approach to Positive Emotion: Flowers", Evolutionary Psychology, vol. 3, pp. 104–132, 2005.
2. Annamma Oommen, Floriculture Report – Flower Power, Agriculture and Processed Food Products Export Development Authority, A Government of India Enterprise, pp. 51–53, 2015.
3. U. van Meeteren, Causes of Quality Loss of Cut Flowers - a Critical Analysis of Postharvest Treatments in Proc. IXth International Symposium. on Postharvest Quality of Ornamental Plants, Acta Horticulture. 847, pp. 27–36, 2009.
4. http://www.robots.ox.ac.uk/ ~ vgg/data/flowers/.
5. Nilsback, Maria-Elena, and Andrew Zisserman. "Delving into the Whorl of Flower Segmentation." In BMVC, pp. 1–10. 2007.
6. Das, Madirakshi, R. Manmatha, and Edward M. Riseman. "Indexing flower patent images using domain knowledge." IEEE Intelligent Systems and their Applications 14, no. 5 (1999): 24–33.
7. Nilsback, M-E., and Andrew Zisserman. "A visual vocabulary for flower classification." In 2006 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'06), vol. 2, pp. 1447–1454. IEEE, 2006.
8. Osher, Stanley, and Ronald Fedkiw. Level set methods and dynamic implicit surfaces. Vol. 153. Springer Science & Business Media, 2006.
9. Vese, Luminita A., and Tony F. Chan. "A multiphase level set framework for image segmentation using the Mumford and Shah model." International journal of computer vision 50, no. 3 (2002): 271–293.
10. Saito, Atsushi, Shigeru Nawano, and Akinobu Shimizu. "Joint optimization of segmentation and shape prior from level-set-based statistical shape model, and its application to the automated segmentation of abdominal organs." Medical image analysis 28 (2016): 46–65.
11. Wu, Qinggang, Yong Gan, Bin Lin, Qiuwen Zhang, and Huawen Chang. "An active contour model based on fused texture features for image segmentation." *Neurocomputing* 151 (2015): 1133–1141.

3D Motion Capture for Indian Sign Language Recognition (SLR)

E. Kiran Kumar, P.V.V. Kishore, A.S.C.S. Sastry and D. Anil Kumar

Abstract A 3D motion capture system is being used to develop a complete 3D sign language recognition (SLR) system. This paper introduces motion capture technology and its capacity to capture human hands in 3D space. A hand template is designed with marker positions to capture different characteristics of Indian sign language. The captured 3D models of hands form a dataset for Indian sign language. We show the superiority of 3D hand motion capture over 2D video capture for sign language recognition. 3D model dataset is immune to lighting variations, motion blur, color changes, self-occlusions and external occlusions. We conclude that 3D model based sign language recognizer will provide full recognition and has a potential for development of a complete sign language recognizer.

1 Introduction

Motion analysis is the way toward capturing real life gestures and movements of a subject as arrangements of Cartesian facilitates in 3D space. A motion capture framework has applications in various domains such as surveillance [1–4], assistive interaction of human with computer technologies [5, 6], deaf sign word recognition [7–9], computational behavioral science [10, 11] and consumer behavior analysis [12], the focus is the detection, recognition and analysis of human movements and behavioral actions.

E. Kiran Kumar (✉) · P.V.V. Kishore · A.S.C.S. Sastry · D. Anil Kumar
Department of Electronics and Communication Engineering,
K L University, Green Fields, Vaddeswaram, Guntur, Andhra Pradesh, India
e-mail: kiraneepuri@kluniversity.in

P.V.V. Kishore
e-mail: pvvkishore@kluniversity.in

A.S.C.S. Sastry
e-mail: ascssastry@kluniversity.in

D. Anil Kumar
e-mail: danilmurali@kluniversity.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_3

Motion capture systems are classified into magnetic, mechanic, and optical. In magnetic system, the electromagnetic sensors connected to a computer used to produce the real-time 3D data at lower processing cost. But some of the movements are restricted due to the cabling. The mechanical motion capture system uses suits with integrated sensors which records the real-time movements as 3D data.

Optical motion capture utilizes cameras to recreate the body stance of the entertainer. One approach utilizes an arrangement of numerous synchronized cameras to catch markers set in vital areas on the body.

As introduced newly in [13], the community of computer vision describes a skeleton as a schematic model of the human body. The skeletal parameters and motion attributes can be used as an illustration of the gestures commonly known as actions and, consequently, the human frame pose is described by means of the relative joint locations in the skeleton. Application domains such as gaming and human–computer interfaces are greatly benefiting of this new innovative technology.

In recent years, the motion capture technology is introduced to capture the hand motions, which in turns greatly boost the field of sign language recognition in 3D environment. This increases the efficiency and accuracy of sign language recognition system. The biomechanical anatomy of human hand incorporates many number of degrees of freedom (DoF) which making the mapping of external measurements with functional variables complex. Hence the finest assessment of human hand kinematics is a complex task [14].

The present trends in sign language recognition technologies are on the primary basis on virtual reality, unable to produce animations on their own in which the signer associates locations in space with entities under discussion. The automatic spatial association of signs locations is closely related to the sign recognition process. Without extracting the signature of the sign word through motion analysis, the spatial location of signs cannot be modified as the change in location of entities under discussion.

Kinematic movements of a human hand are increasingly demanded in sign language recognition. The appropriateness of the finger movements is greatly prompting to identify the accurate sign. From the past few decades, the development is confined to human gait analysis in clinical research field. In clinical gait analysis, the positional changes of the markers attached to the skin greatly affect the analysis. Performing the sign, which provides small displacements in the marker positions due to skin moments will not effects our sign recognition.

The Optical motion capture of a subject flow is shown in Fig. 1.

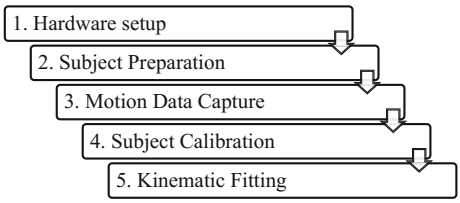


Fig. 1 3D motion capture model

Hardware Setup: As an initial stage the capture volume must be defined accordingly the camera positions to be fixed such a way that at least any two cameras to see the markers, which is known as the field of view. Using the software interface nexus, the cameras to be calibrated and a global coordinate system is set to produce reliable 3D data. A special wand is used to calibrate the cameras.

Subject Preparation: The signer is a subject attaches a passive retro reflective marker set on to the surface of the hand and a static trial captured. The skeletal structure of the subject and the marker set is described in the nexus and stored as a Vicon skeleton template (.vst) file.

Motion Data Capture: Now in the dynamic trial the cameras capture the radiated light from the markers and produces blobs at exact locations. The cameras will use the calibration information to reconstruct and locate the markers on to the 3D coordinates.

Subject Calibration: The VST file is not necessary to be 100% accurate all the times. The lengths of the fingers vary with subject to subject. In this case the subject calibration fixes the problem.

Kinematic Fitting: All captured trials are labeled and fit the kinematic model to compute the joint angles. These joint angles are treated as outputs of motion capture and necessary to operate the 3D model.

2 Motion Capture Setup

The finger movements of a signer can be recorded using motion capture setup. We conducted motion capture using a 6-camera Vicon model at 100 Hz. Each hand is represented using 22 markers of size 6.4 mm. A 14 mm sized markers were used for head. A total of 54 markers were used to represent a signer. The below Fig. 2 shows the camera arrangement on a 3D Cartesian plane.

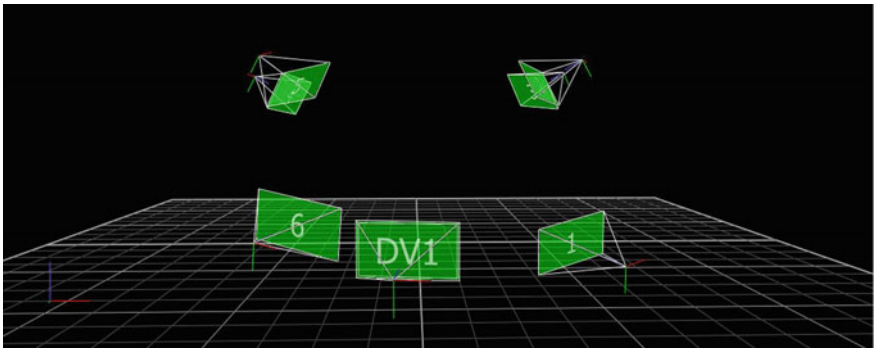


Fig. 2 Camera positions on a 3D cartesian plane

2.1 Marker Placement for Hand Motion Capture

Several methods of marker placements were proposed by many researchers. Miyata [15] have introduced a model with 25 markers for each hand to measure wrist, fingers joint angles. Carpinella [16] developed a hand model with less number of markers but wrist movements are not included. In [17], three linear markers used at metacarpal, proximal and distal interphalangeal joints for each finger.

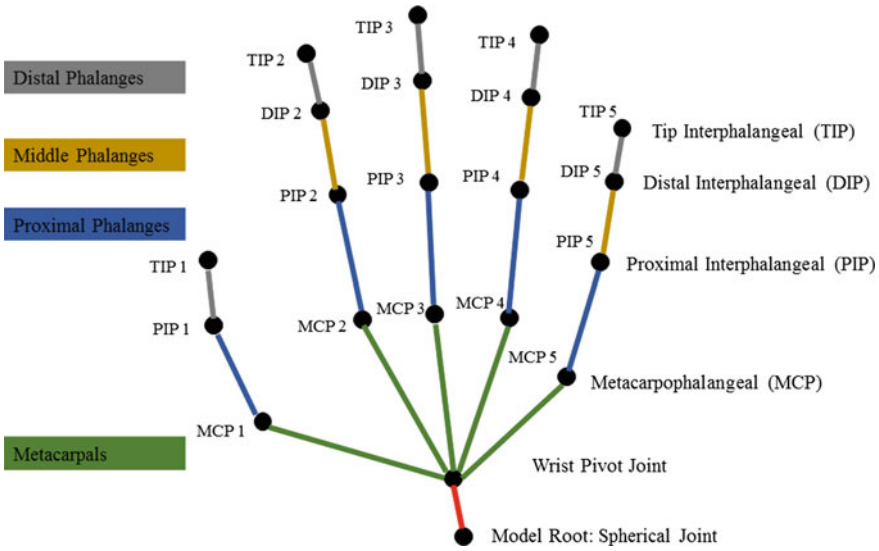


Fig. 3 The hand anatomy

Fig. 4 Maker placement design and actual markers used for capturing the sign language

Even though several models were proposed by many researchers the sign language requires a sophisticated hand model in order to produce accurate data. Figure 4 shows the proposed hand model with marker placements based on the hand anatomy as shown in Fig. 3.

The model in Fig. 4 can capture every sign language character which can be easily recognized accurately. Whereas in 2D the visualization is only in one direction and the information which can only be seen in other direction can be lost leading to inappropriate classification. As shown in Fig. 5 blurring will also affect the recognition in 2D which leads to false classification.

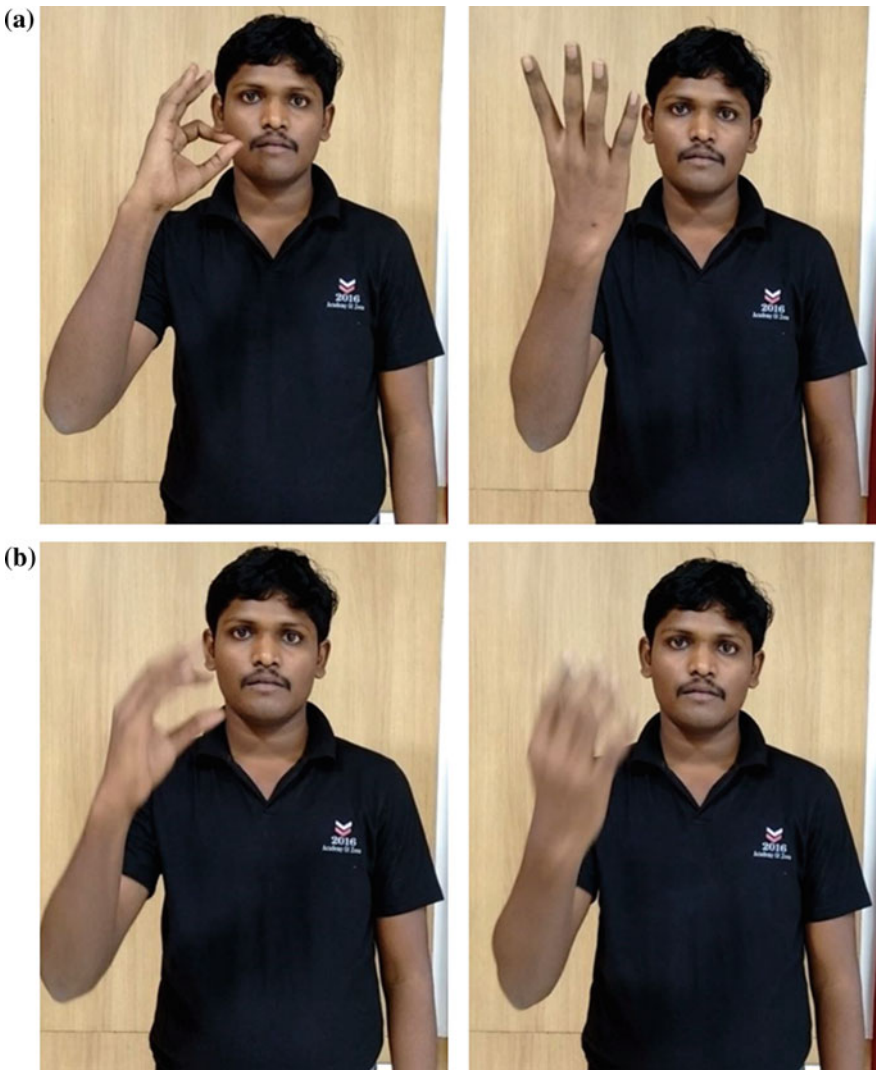


Fig. 5 **a** 2D signs with missing finger information, **b** 2D sign with blur

3 Results and Discussions

To validate our approach, we captured the Indian sign 'Good Morning' in 3D using motion capture technology and successfully obtained the sign in all the direction which shows the information that is missed in 2D. Figure 6 shows the sign in

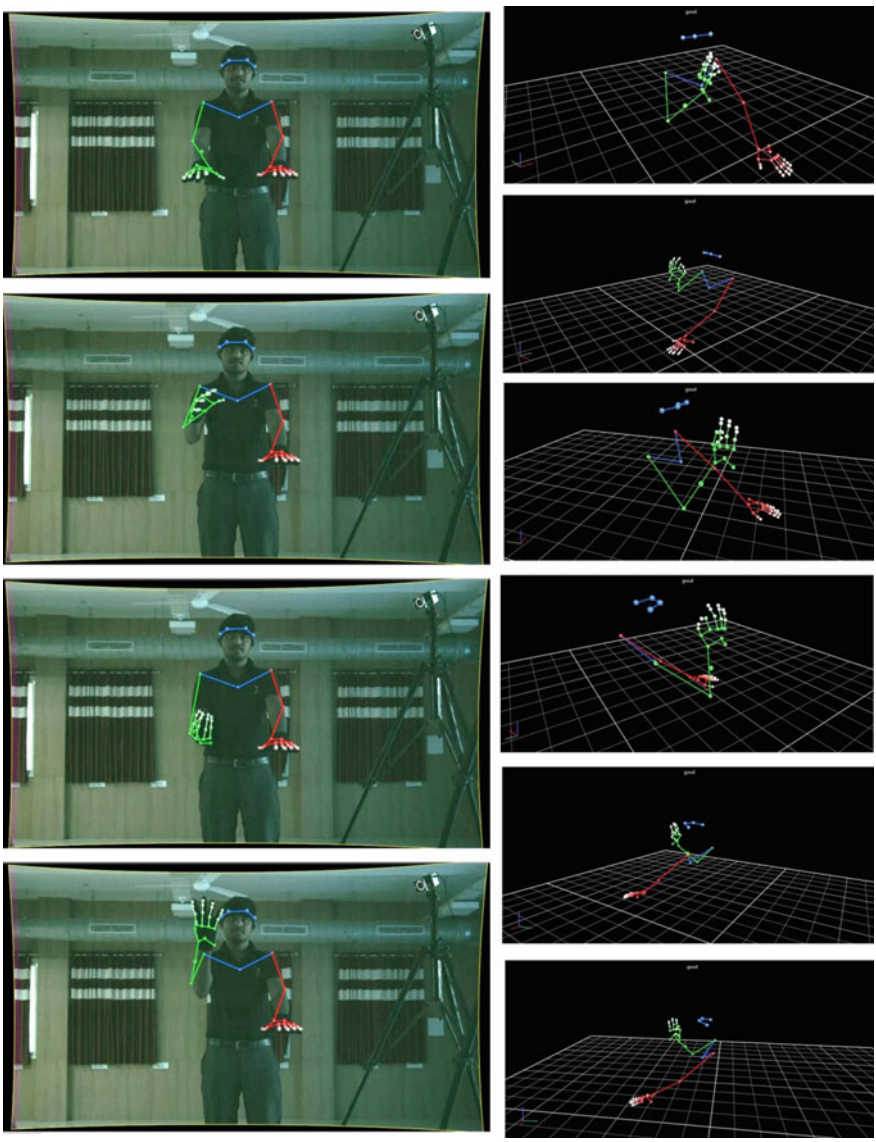


Fig. 6 3D image data captured for some signs from Indian sign language. The meaning of the sign is 'good morning'

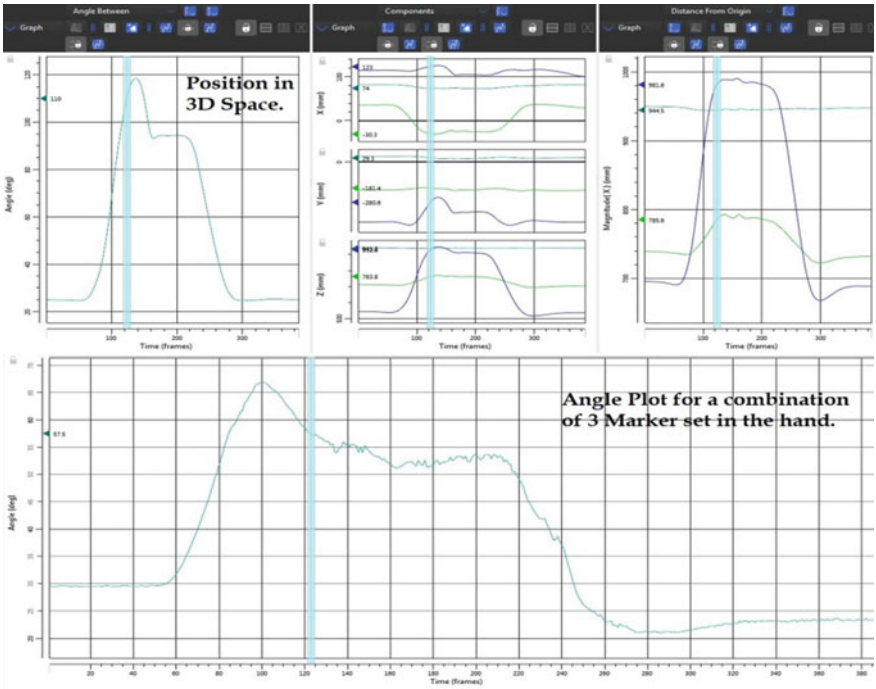


Fig. 7 3D data plots of signs during motion capture

different angle orientations. In frame 3 and 4 the finger information is missed. But the 3D frame will provide the missing information because it captured in all orientations. Angle plots and marker position plots were obtained as shown in Fig. 7, which helps in detailed study and accurate classification of sign.

4 Conclusion

The results show the advantage of 3D motion capture in sign language recognition. It captures the data on a Cartesian coordinate which provides the information in all orientations. In 2D some finger's information is missing and blurring is also affecting the recognition. Motion capture is immune to blur, lighting, color change and self- and external occlusions. A 3D hand model was designed for marker placements to capture the signs meaningfully. At this juncture, we can conclude that 3D motion capture is best suitable for Indian sign language recognition. We further working to develop best algorithms to process and classify the signs of Indian sign language.

Declaration: The images used in the work are of private image and due permission has been taken. Authors of the paper bear all responsibilities if any issues arise due to this. Publisher will not be responsible for same.

References

1. S. Kwak, B. Han, J. Han, Scenario-based video event recognition by constraint flow, in: Proceedings of Conference on Computer Vision and Pattern Recognition (CVPR), IEEE, Colorado Springs, 2011, pp. 3345–3352, http://dx.doi.org/10.1109/CVPR.2011.5995435.
2. U. Gaur, Y. Zhu, B. Song, A. Roy-Chowdhury, A string of feature graphs model for recognition of complex activities in natural videos, in: Proceedings of International Conference on Computer Vision (ICCV), IEEE, Barcelona, Spain, 2011, pp. 2595–2602, http://dx.doi.org/10.1109/ICCV.2011.6126548.
3. S. Park, J. Aggarwal, Recognition of two-person interactions using a hierarchical Bayesian network, in: First ACM SIGMM International Workshop on Video surveillance, ACM, Berkeley, California, 2003, pp. 65–76, http://dx.doi.org/10.1145/982452.982461.
4. I. Junejo, E. Dexter, I. Laptev, P. Pérez, View-independent action recognition from temporal self-similarities, IEEE Trans. Pattern Anal. Mach. Intell. 33 (1) (2011) 172–185, http://dx.doi.org/10.1109/TPAMI.2010.68.
5. Z. Duric, W. Gray, R. Heishman, F. Li, A. Rosenfeld, M. Schoelles, C. Schunn, H. Wechsler, Integrating perceptual and cognitive modeling for adaptive and intelligent human–computer interaction, Proc. IEEE 90 (2002) 1272–1289, http://dx.doi.org/10.1109/JPROC.2002.801449.
6. Y.-J. Chang, S.-F. Chen, J.-D. Huang, A Kinect-based system for physical rehabilitation: a pilot study for young adults with motor disabilities, Res. Dev. Disabil. 32 (6) (2011) 2566–2570, http://dx.doi.org/10.1016/j.ridd.2011.07.002.
7. A. Thangali, J.P. Nash, S. Sclaroff, C. Neidle, Exploiting phonological constraints for handshape inference in ASL video, in: Proceedings of Conference on Computer Vision and Pattern Recognition (CVPR), IEEE, Colorado Springs, 2011, pp. 521–528, http://dx.doi.org/10.1109/CVPR.2011.5995718.
8. A. Thangali Varadaraju, Exploiting phonological constraints for handshape recognition in sign language video (Ph.D. thesis), Boston University, MA, USA, 2013.
9. H. Cooper, R. Bowden, Large lexicon detection of sign language, in: Proceedings of International Workshop on Human–Computer Interaction (HCI), Springer, Berlin, Heidelberg, Beijing, P.R. China, 2007, pp. 88–97.
10. J.M. Rehg, G.D. Abowd, A. Rozga, M. Romero, M.A. Clements, S. Sclaroff, I. Essa, O.Y. Ousley, Y. Li, C. Kim, et al., Decoding children's social behavior, in:Proceedings of Conference on Computer Vision and Pattern Recognition (CVPR), IEEE, Portland, Oregon, 2013, pp. 3414–3421, http://dx.doi.org/10.1109/CVPR.2013.438.
11. L. Lo Presti, S. Sclaroff, A. Rozga, Joint alignment and modeling of correlated behavior streams, in: Proceedings of International Conference on Computer Vision-Workshops (ICCVW), Sydney, Australia, 2013, pp. 730–737, http://dx.doi.org/10.1109/ICCVW.2013.100.
12. H. Moon, R. Sharma, N. Jung, Method and system for measuring shopper response to products based on behavior and facial expression, US Patent 8,219,438, July 10, 2012 ⟨http://www.google.com/patents/US8219438⟩.
13. G. Johansson, Visual perception of biological motion and a model for its analysis, Percept. Psychophys. 14 (2) (1973) 201–211.
14. Cerveri, P., De Momi, E., Lopomo, N. et al., Finger kinematic modelling and real-time hand motion estimation, Ann Biomed Eng (2007) 35: 1989. doi:10.1007/s10439-007-9364-0.

15. N. Miyata, M. Kouchi, T. Kurihara, and M. Mochimaru, "Modelling of human hand link structure from optical motion capture data," in Proc. Int. Conf. Intelligent Robots Systems, Sendai, Japan, 2004, pp. 2129–2135.
16. I. Carpinella, P. Mazzoleni, M. Rabuffetti, R. Thorsen, and M. Ferrarin, "Experimental protocol for the kinematic analysis of the hand: Definition and repeatability," Gait Posture, vol. 23, pp. 445–454, 2006.
17. G. Wu, F. C. T. van der Helm, H. E. J. Veeger, M. Makhsous, P. van Roy, C. Anglin, J. Nagels, A. R. Karduna, K. McQuade, X. Wang, F. W. Werner, and B. Buchholz, "ISB recommendation on definitions of joint coordinate systems of various joints for the reporting of human joint motion—Part II: Shoulder, elbow, wrist and hand," J. Biomech., vol. 38, pp. 981–992, 2005.

SABE: Efficient and Scalable-Filtered Access Control in Distributed Cloud Data Storage

K. Kamakshaiah, K. Venkateswara Rao and M. Subrahmanyam

Abstract Distributed cloud data storage is an advanced and empirical concept in present days for outsourcing of data in cloud. A new decentralized grained access control approach is required for privacy on data storage that supports anonymous authentication. In this paper, we introduce to propose and develop an approach, i.e. Scalable Attribute-Based Encryption (SABE) to achieve grained with flexible and scalable access control in cloud computing for secure distributed cloud storage. SABE not only is scalable due to its pyramid structure, but also shares effective and flexible access control in supporting on ABE; it also assigns for user expiration time and revocation efficiently than existing schemas. Protected data transmission among users should be effective as well as flexible in order to support access control policy models with secure team communication, selective and hierarchal data transfer control in sharing. So in this paper, we propose and develop Transmitted Team Key Management (TTKM), where each client (user) in group shares a secret trust key owner with subsequent rekeying for data sharing join or departure of users requires only broadcast message between data sharing in cloud. We analyze the privacy of proposed TTKM schema and compare with existing SABE security schemas in distributed data sharing. Our experimental results show effective data access control with authorized security considerations.

K. Kamakshaiah (✉)
Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology, Bachupally, Nizampet (SO), Hyderabad, Telangana, India
e-mail: kamakshaiah.k@gmail.com

K. Venkateswara Rao
Vijayawada, AP, India
e-mail: mailtovenkibujji@gmail.com

M. Subrahmanyam
Infosys Ltd., Vijayawada, AP, India
e-mail: subbu.nagu944@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_4

1 Introduction

Cloud computing is a casual keyword for the delivery of hosted services over web service which includes computer resources. Different companies enable cloud computing to compute resources as utility to maintaining cloud infrastructures with relevant network services in network. Cloud computing promises attractive benefits for business and end users, main benefits of cloud computing are (1) Individual Data Outsourcing, (2) Elasticity, with Flexibility, (3) User Services by Pay Money. These three services can be public, private, and hybrid. Private services are outcome from business with maintain data centers to applications used users in data storage. Private cloud services achieve connivance, preserving management control, and security. In public cloud model, middle service provider achieves and outcome cloud service over web service provider. These services are sold on demand and usage on cloud computing, customers pay for CPU operations, storage, and bandwidth of clients consuming. Cloud service providers like Amazon Web Service, Microsoft, and Google Search engine. Hybrid cloud is combination of both public cloud services and on premises private cloud services with normal cloud assessment with feasible operations.

As shown in Fig. 1, distributed cloud computing refers to configure, manipulate applications on web with application processes. It offers online data storage, infrastructure, and application outsourcing in cloud. It offers development and service models for manipulate applications in distributed storage system [1, 2]. Recently cloud file storage is an emerging concept in implementation of distributed cloud computing, users concern about privacy of data storage that impacts cloud computing from different operations. These concerns are complicated from sensible data in public cloud; it is maintained by unfavorable CSP. Attribute-Based Encryption follows primitive security from untrusted users while data sharing in cloud. Still now there are two kinds of ABE approaches were proposed to provide security in cloud: Key-Policy-based ABE (KP-ABE) and Cipher Text Policy ABE (CP-ABE). In KP-ABE, access control policy is assigned in secure format in terms of private key with sequential storage of cloud data, where as CP-ABE follows security as private key in terms of cipher text [3]. By preferring these conditions ABE gives privacy and way for data user to distribute out sourced data to untrusted data storage service provider instead of described and feasible server with specified large amount of users in cloud computing.

Consider the effective disadvantage of ABE is communication with computational cost while decoding with decryption phase in data sharing. Procedure of ensuring secure file storage environment is shown in Fig. 2. ABE needs to increase efficiency, introduce outsourced anonymity ABE which provides outsourcing intensive computed task during decryption phase to CSP without producing data or primitive keys, was introduced in [4, 5]. Conventionally, Scalable Attribute-Based Encryption for access control in cloud computing used for cipher text-policy attribute-based encryption with hierarchal structure of system users and to achieve scalable flexible and fine-grained access control policy. This schema provides full

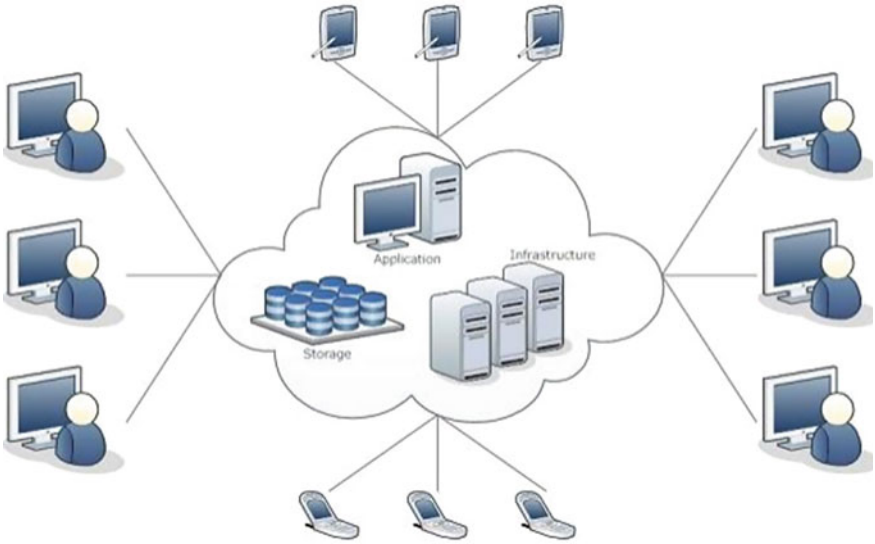


Fig. 1 Distributed cloud infrastructure framework

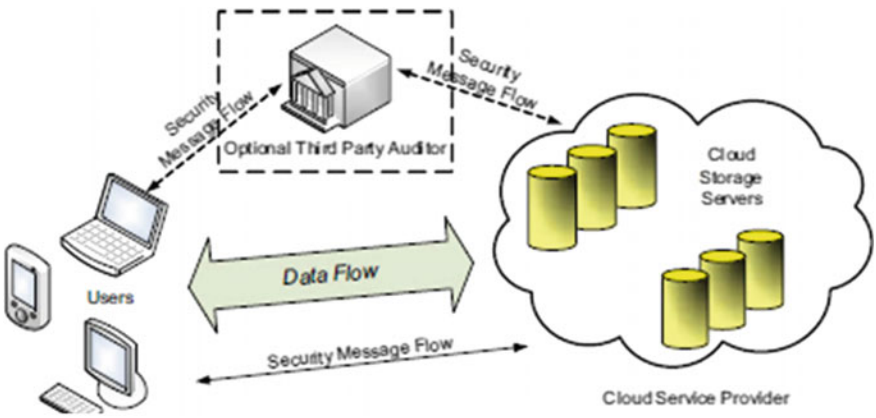


Fig. 2 Ensuring data storage security in distributed cloud computing

support for hierarchal user grant, file creation and user revocation in cloud computing. It has hierarchal structure to improve scalable and flexible fine-grained access control of hierarchal attribute-based encryption. SABE is single-key sharing process between different user's data sharing. SABE is not accessible for Group Key Management to support security between different users in cloud data sharing. There are more number of approaches proposes for group key management, those centralized approaches use single-key trust key to update and distribute share group keys in cloud data sharing. A Transmitted Team Key Management (TTKM)

addresses above problems in group data sharing. In this schema, each user in team shares a secret server-based trusted key with subsequent rekeying to communicate or relieve of different users require only one broadcast message and also no change to secret key shares with existing users. This schema is flexible, efficient, and privacy in cloud data sharing. This approach maintains use of secure private communication when rekeying takes a place either among different users between server and persisting group user. Our proposed approach is as follows:

1. Introduce TTKM using formalization methodology.
2. Analysis of TTKM.
3. Comparison of Security and Complexity of our proposed approach with existing schemas.
4. Empirical performance of our proposed approach with SABE.

Remaining sections of this paper are organized as follows: Sect. 2 describes related work with literature review on security in cloud computing. Section 3 describes the implementation of Scalable Attribute-Based Encryption implementation with design. Section 4 explains TTKM implementation and design procedure. Section 5 discusses experimental evaluation with comparative results to decrease computational overhead to provide security in cloud computing. Section 6 concludes overall conclusion of providing security using TTKM with decrease of computational overhead in cloud computing.

2 Background Related Work

Here, we review the process of feature-centered protection and also provide brief summary of the feature set-centered protection and also we analyze current accessibility management schemas depending on feature-centered protection.

Yang et al. [6] explain information accessibility management as a highly efficient approach for the details protection in the reasoning. Because of details freelancing and untrusted reasoning web servers, the details accessibility management becomes an examining problem in allocated storage frameworks.

Tzeng [3] explains the recommended efficient and protected (string) unaware transfer (OT1n) programs for any n_2. We set up our OT1n strategy from central cryptographic techniques straight. The receiver's decision is truly protected and the secret of the unclosed expert information relies upon on the solidity of the decisional Diffie–Hellman problem. Yu et al. [7] present that Personal Health Record (PHR) creates a patient-driven model of wellness data trade, which is frequently contracted to be put away at an outsider, for example, reasoning providers. However, there have been wide protection problems as individual wellness data could be provided to those outsider web servers and to unapproved events.

Shamir [8] explains a novel kind of cryptographic strategy, which encourages any pair of customers to provide securely and to validate each other's representation

without trading personal or open important factors, without keeping key indices, and without using the companies of an outsider [9]. The system performs the reliable key assurance with different users maintenance, whose only objective is to give every customer a personalized amazing card when he becomes a part of the organization.

Sahai and Waters [1] explain another sort of Identity-Based Encryption (IBE) strategy that we contact Unclear Identity-Based Encryption. In unclear IBE we see a way of life as set of informative features. A unclear IBE strategy considers a personal key for a personality, ω, to decipher a cipher text scrambled with a personality, $\omega\_$, if and only if the individualities ω and ω are near each difference as calculated by the "set cover" separating measurement [9].

Goyal et al. [2] show that as more sensitive details are shipped and put away by outsider places on the Internet, there will be a need to scribe details put away at these locations. One issue with development details is that it can be specifically allocated just at a coarse-grained level (i.e., giving another collecting your personal key). We build up another cryptosystem for fine-grained discussing of secured details that we contact Key-Policy Attribute-Based Encryption (KP-ABE) [5].

The agreement utilized the cover-up strategy and in this way led to spilling of personal details. Atallah and Li analyzed the problem of handling the modification separating two successions and showed a highly efficient conference to securely delegate collection connection with two web servers. Moreover, Ben and Atallah maintained to the point of protected freelancing for generally appropriate direct statistical computations. In fact, the suggested conferences required the expensive functions of homomorphic protection. Atallah what is more, Frikken further focused on this problem and provided improved conferences considering the expected incapable secret covering doubt [10, 11]. Recently Wang et al. provided efficient elements for protected freelancing of straight development computation. We take note of that; however, a few programs have been knowledgeable about securely delegate sorts of expensive computations and they are not appropriate considering the ABE computational expense of exponentiation at customer side. To achieve this purpose, the traditional technique is to use server-helped techniques. Be that as it may, past jobs are found to quicken the rate of exponentiation using untrusted web servers. Straightforwardly using these systems in ABE will not perform efficiently. Another technique may be to guide delayed wide freelancing process or doing computation in light of completely homomorphic protection or user-friendly proof structure. In any case, Gentry has revealed that notwithstanding for incapable protection factors on "bootstrapping" function of the homomorphic protection, it would take no less than 30 a few moments on an top-level machine [12]. In this way, regardless of the fact that the protection of the details generated can be stored using these general techniques, and the computational expense is still tremendous and unfeasible.

3 SABE Secure Implementation

Procedures of cloud computing is considered in following five steps: Cloud Service Provider, User's Data, Data Consumers based on their attributes, Domain Authorities with attributes, and Trusted Authority for users.

(a) **System Design**: As depicted in Fig. 3, CSP controls overall cloud to provide information with security and storage service. Data entrepreneurs secure their information in terms of data files and then store them into cloud for information discussing into other information customers. To access their data files information customers decrypt information submitted from information entrepreneurs. Each information owner or information consumer administrated by sector power, domain power managed by reliable sector power provider [13, 14].
(b) **SABE Schema Implementation**: The suggested SABE schema totally expands ABE to handle chart structure of the program customers as shown in Fig. 5. Remember that suggested approach program design comprises multiple sector regulators, reliable regulators with numerous customers corresponding to information consumers and information owners. Trusted regulators maintain, manage and spread program factors with master private important factors as well as approve parent sector regulators. So sector power is responsible for assigning secrets of subordinate regulators at each level of description with feasible reflection of information based on its sector.

Main operations of SABE are as follows: we are ready to develop following steps to implement scalable access control environment to share user's data into different domain authorities.

System Setup, Domain Authority, User Grant, File Creation, User Revocation, File Access and File Deletion. Procedure of developing these steps achieved as follows:

System Setup: Cloud distributed environment trusted authority achieves implementation procedure to create public key (PK) parameters and Victim Key (VK_0). PK will store data as public to visible data to all persons in same time VK_0 will be secret to data sharing. Setup $d = 2 \rightarrow (PK, VK_0)$, where d is depth measure of key structure store in procedure. Implementation procedure selects bilinear group B of

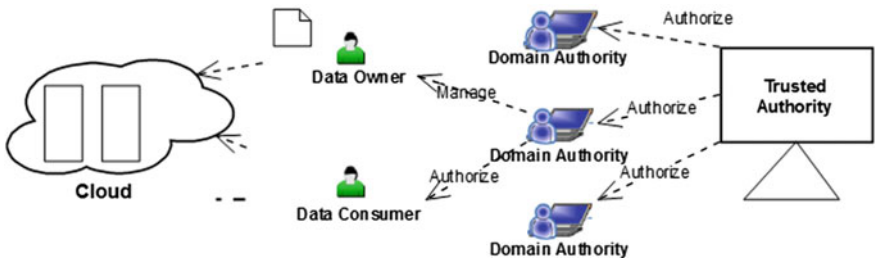


Fig. 3 Proposed approach implementation procedure

unique order p with generator g and then random exponents $\delta, \gamma_i \in Z_p, \forall_i\{1,2\}$. To support generated key design with proper structure of depth d and i is the range from 1 to d. The procedure for PK and VK_0 is as follows:

$$\mathrm{PK} = \Big(B, g, h_1 = g^{\gamma_1}, f_1 = g^{1/\gamma_1}, \\ h_2 = g^{\gamma 2}, f_2 = g^{1/\gamma 2}, e(g,g)\delta\Big)$$

$$\mathrm{VK}_0 = \left(\gamma_1, \gamma_1, g^{\delta}\right)$$

Main Level Domain permission Authority: Main attribute domain authority conceives with unique representation, i.e. ID and recursive attribute set $\mathbb{C} = \{C_0, C_1, C_2, C_3, \ldots C_m\}$ where $C_i = \{c_0, c_1, c_2, \ldots, c_m\}$ with $a_{i,j}$, it is being able to generate jth attribute in C_i and n_i being presentation of all the attributes in C_i then create Domain Authority (DA) as follows:

$$\mathrm{VK}_i = \Bigg(\mathbb{C}, D = g^{\frac{\delta + r^{\{\mu\}}}{\gamma_1}}, \quad D_{i,j} = g^{r_i^{\{\mu\}}} \cdot H(c_{i,j})^{r_{i,j}^{\{\mu\}}}, \\ D'_{i,j} = g^{r_{i,j}^{\{\mu\}}} \quad \text{for} \rightarrow (0 \le i \le m), (1 \le j \le n_i), \\ E_i = g^{\frac{(r^{\{\mu\}}) + r_i^{\{\mu\}}}{\gamma_2}} \quad \text{for} \rightarrow (1 \le i \le m)\Bigg)$$

In the above victim key reflection, E_i is for interpretation from $r^{\{\mu\}}$ of C_i at the converting components E_i and E'_i can be used in decryption process.

User Grant: When customers signify as u and new subordinate sector power denoted as DA_{i+1} wants to be a part of into system for giving authorization to other customer present immediately reasoning data discussing with possible connections created by managing the domain authority. Create User using victim key; proceed to attribute set using create domain authority procedure with secret key as follows:

$$\mathrm{VK}_{i+1} = \Bigg(\tilde{\mathbb{C}}, \tilde{D} = D \cdot f_1^{\tilde{r}^{\{\mu\}}}, \quad \tilde{D}_{i,j} = D_{i,j} \cdot g_1^{\tilde{r}^{\{\mu\}}} \cdot H(c_{i,j})^{\tilde{r}_{i,j}^{\{\mu\}}}, \\ \tilde{D}'_{i,j} = D'_{i,j} \cdot g^{\tilde{r}_{i,j}^{\{\mu\}}} \quad \text{for} \rightarrow c_{i,j} \in \tilde{\mathbb{C}}, \\ \tilde{E}_i = E_i \cdot f_2^{\tilde{r}^{\{\mu\}} + \tilde{r}_i^{\{\mu\}}} \quad \text{for} \rightarrow C_i \in \tilde{\mathbb{C}}\Bigg)$$

The newly generated secret key VK_{i+1} for key structure $\tilde{\mathbb{C}}$, it is equivalent to received key from trusted authority.

Data file Creation: To safeguard information saved on the reasoning, an information proprietor first encrypts information and then stores the secured information on the reasoning. First post file into reasoning prepared by information proprietor as follows: Pick file exclusive id, arbitrarily select symmetrical

information security using encryption and then decrypt with decryption process, and describe shrub accessibility framework [14, 15].

User Revocation: Whenever there is a person to be suspended, the system must make sure the suspended customer cannot connect to the associated information any more. One way to resolve this problem is to re-encrypt all the associated information used to be utilized by the suspended customer, but we must also ensure that the other users who still can get rights to the information can access them properly. SABE gets the advantage of ABE in efficient customer cancelation.

File Deletion: Encrypted information can be removed only at the demand of the information proprietor. To remove a secured computer file, the information proprietor delivers the file's exclusive ID and its trademark on this ID to the reasoning. Only upon successful confirmation of the information proprietor and the demand, the reasoning removes the information file.

4 System Design and Implementation

In this section, we formally express TTKM and its implementation procedure and key management schema with defined users in group which has hold Individual Subscription Token (ISP) with common group key. TTKM definition is as follows:

Transmitted Team Key Management (TTKM) Exposed with two leafs like (1) A key Server (Svr) and (2) Group Members (Usrs), a convenient broadcast from single server (Svr) to all the Usrs. Procedure of TTKM achieves as follows:

ParamGen Svr takes as input a warranty parameter k and gives outputs a fit of nation parameters.

Param includes the dwelling KS of vacant time signature values.

TkDeliv Svr sends each Usr a deserted subscription least possible (IST) on a secluded channel.

KeyGen Svr chooses a shared accumulation key K $ KS. Based on the ISTs of Usrs, Svr computes a reside of values PubInfo. Svr keeps K confidential, and broadcasts at the hand of the word channel.

PubInfo generally tells lock stock and barrel members Usr.

KeyDer Usr uses its IST and PubInfo to count one by one the shared lock stock and barrel key K.

Update when shared everyone K cut back no longer be second-hand (e.g., when there is a culmination of group dynamics one as united and cease to exist of lock stock and barrel users), Svr generates polished group key K″ and PubInfo″, before it broadcasts the dressed to the teeth PubInfo to the group. Each Usr uses its IST and the new PubInfo″ to count one by one the dressy shared group key K″. We re-gather the system after the update phase dressy "session". The update phase is further called a rekeying phase.

Svr picks randomly generated key K ∈ KS as the shared team key, then Svr chooses N random strings $a_1, a_2, \ldots, a_N \in \{0, 1\}$. Svr creates an $n \times (N+1)\mathbb{F}$-matrix.

$$Z = \begin{pmatrix} 1 & z_{1,1} & z_{1,2} & z_{1,N} \\ 1 & z_{2,1} & z_{2,2} & z_{2,N} \\ & & & \\ 1 & z_{n,1} & z_{n,2} & z_{n,N} \end{pmatrix}$$

In the above equation $a_{i,j} = H(\text{ist}_i || a_j), 1 \leq i \leq n, 1 \leq j \leq N$.

By using non-zero evaluation with solution of matrix nontrivial by construction of uniformly generated random keys by Svr for clause access control vector generation.

Based on individual subscription token, Svr constructs $(N + 1)$ dimensional matrix with vector representation. Based on above operations like KeyGen, PubInfo KeyDer update all the KeyGen then Svr runs all the phases with respect to current group users, creates new group and broadcast all the keys based on PubInfo of multiple users as shown in Fig. 4.

Suppose Svr runs an update past to serve Param for another diffuse gathering time signature K″, and a yesteryear kind of thing user is superior in no way a gathering part at the heels of the update stage. Let K be a horse and buggy day shared gathering key which can be left to the imagination by user mutually token IST. A TTKM is a head key securing if a foe mutually learning of IST, K, and the beautiful Pub Info cannot get the dressed to the teeth key K″ from an unreasonable esteem in the key-space KS by all of non-negligible happening [4, 5]. Essentially, a TTKM schedule is in dance to a different tune key securing if another bunch part User at the heels of the Update stage cannot recall anything roughly the yesterday gathering keys. Consider the entanglement in multikey disclosure sharing mid-multiusers in unsound sourced front page new TTKM was not support travail flexibility in key sharing to multiusers.

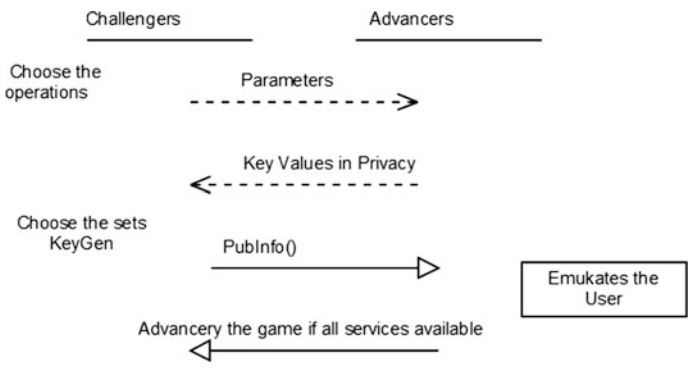


Fig. 4 TTKM procedure with group sharing in cloud

5 Experimental Setup

In this section, we analyze theoretical computation of complexity of proposed schema at each operation. Then we implement an SABE based on CP-ABE and also define a series of experiments to evaluate performance of our proposed schema in comparison to outsource Anony ABE. Theoretical implementation is already discussed in above section with feasible implementation.

Performance Evaluation: We have implemented multilevel SABE based on CP-ABE which is a pair-based cryptography. Experimental setup is conducted on laptop with I3 processor 4 GB RAM on Windows operating system successfully. Its implementation is as follows:

Comparison with respect to Existing Schemas: In this section we present to compare TTKM with SABE theoretically because of lack summaries in group data sharing in real-time cloud data sharing. SABE only performs single key distribution for uploaded files in cloud. So TTKM performs effective efficiency in generation of multiple keys with representation of multi user data sharing.

Implementation of TTKM with respect to Usrs: In this area we analyze the computational performance of TTKM. We imitate the KeyGen stage at Svr and the KeyDer stage at Usrs. In the research, we vary both the dimensions of the actual primary field Fq and the dimensions of the group of Usrs, and measure the Svr-side and Usr-side calculations time. To stress on the mathematics functions, we do not depend here on hashing functions in the research.

As shown in Fig. 5, the common calculation time improves normally as the dimensions of the best area improve. The actual operating time relies upon the best area that is selected and the way area mathematics.

Figure 5 reviews the ACV-BGKM operating time at Svr and Usr for set area measures (in bits) 64, 80, 96 and 112, with the dimensions of the team varying from

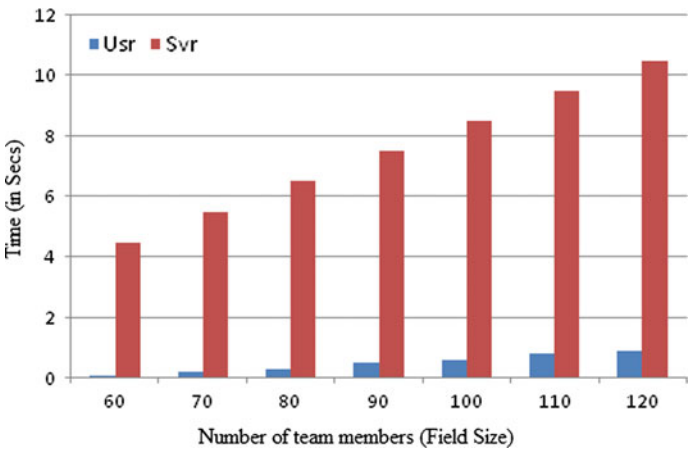


Fig. 5 Dimensionality-based data sharing in cloud with field size with group members

100 to 2000 members. The important time is averaged over 20 versions. It demonstrates the ACV-BGKM rekeying process operated fast on Svr when there are thousands of Usrs in the team. It takes less than two minutes for Svr to produce new Pub Info when there are up to 2000 Usrs and when the best area is large enough.

6 Conclusion

In this chapter, we have introduced to implement SABE approach for analyzing flexible, realizing scalable and dependable attribute access control in distributed cloud environment with computational implementation. The SABE incorporates pyramid structure of systematic user's implementation by improving outcome delegation procedure to ABE. SABE not only supports relevant attributes (features) due to flexibility attribute set combinations with data user removable revocation because of multiple analyzed attributes with newly added attributes to upload file. Finally our proposed schema conducted theoretical and practical experimental setup and evaluation, and it shows efficiency in user revocation and computational over a head with existing schemas.

References

1. Sahai and B. Waters, "Fuzzy identity-based encryption," in *Advances in Cryptology*. Berlin, Germany: Springer-Verlag, 2005, pp. 457–473.
2. V. Goyal, O. Pandey, A. Sahai, and B. Waters, "Attribute-based encryption for fine-grained access control of encrypted data," in *Proc. 13thCCS*, 2006, pp. 89–98.
3. W.-G. Tzeng, "Efficient 1-out-of-n oblivious transfer schemes with universally usable parameters," *IEEE Trans. Comput.*, vol. 53, no. 2, pp. 232–240, Feb. 2004.
4. M. Li, S. Yu, Y. Zheng, K. Ren, and W. Lou, "Scalable and secure sharing of personal health records in cloud computing using attribute based encryption," *IEEE Trans. Parallel Distrib. Syst.*, vol. 24, no. 1, pp. 131–143, Jan. 2013.
5. Jin Li, Xinyi Huang, Jingwei Li, Xiaofeng Chen, "Securely Outsourcing Attribute-Based Encryption with Check ability", proceedings in IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 25, NO. 8, AUGUST 2014.
6. K. Yang, X. Jia, K. Ren, and B. Zhang, "DAC-MACS: Effective data access control for multi-authority cloud storage systems," in *Proc. IEEE INFOCOM*, Apr. 2013, pp. 2895–2903.
7. S. Yu, C. Wang, K. Ren, and W. Lou, "Achieving secure, scalable, and fine-grained data access control in cloud computing," in *Proc. IEEE INFOCOM 2010*, 2010, pp. 534–542.
8. Shamir, "Identity-based cryptosystems and signature schemes," in *Advances in Cryptology*. Berlin, Germany: Springer-Verlag, 1985, pp. 47–53.
9. R. Bobba, H. Khurana, and M. Prabhakaran, "Attribute-sets: A practically motivated enhancement to attribute-based encryption," in *Proc. ESORICS*, Saint Malo, France, 2009.
10. Zhiguo Wan, Jun'e Liu, and Robert H. Deng," HASBE: A Hierarchical Attribute-Based Solution for Flexible and Scalable Access Control in Cloud Computing", IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 7, NO. 2, APRIL 2012.

11. B. Barbara, “Salesforce.com: Raising the level of networking,” *Inf. Today*, vol. 27, pp. 45–45, 2010.
12. J. Bell, Hosting Enterprise Data in the Cloud—Part 9: Investment Value Zetta, Tech. Rep., 2010.
13. G. Wang, Q. Liu, and J. Wu, “Hierarchical attribute-based encryption for fine-grained access control in cloud storage services,” in *Proc. ACM Conf. Computer and Communications Security (ACM CCS)*, Chicago, IL, 2010.
14. K.-M. Chung, Y. Kalai, F.-H. Liu, and R. Raz, “Memory Delegation,” in Proc. Adv. Cryptol.-CRYPTO, LNCS 6841, P. Rogaway, Ed., Berlin, 2011, pp. 151–168, Springer-Verlag.
15. C. Wang, K. Ren, and J. Wang, “Secure and Practical Outsourcing of Linear Programming in Cloud Computing,” in Proc. IEEE INFOCOM, 2011, pp. 820–828.

Automatic X-ray Image Classification System

C.M.A.K. Zeelan Basha, T. Maruthi Padmaja and G.N. Balaji

Abstract In recent days, computer-aided fracture detection system plays a role in aiding both orthopaedician and a radiologist by providing accurate and fast results. In order to detect the fracture automatically, classification of X-ray images should be automated and it becomes the initial step. Therefore, an attempt has been made and a system is presented in this paper, which involves five image processing steps namely, denoising using high boost filter, enhancement using adaptive histogram equalization, statistical feature extraction, and classification using artificial neural network. To classify the given input X-ray images into the categories head, neck, skull, foot, palm, and spine, the probabilistic neural network, backpropagation neural network, and support vector machine classifiers are employed in classifying X-ray images. The results ascertain an overall accuracy of 92.3% in classifying X-ray images and the presented system can be used as an effective tool for X-ray image classification.

1 Introduction

The automatic classification of medical X-rays plays a vital role in speeding up the process of fracture diagnosis and aids towards better treatment. However, the available X-ray images are low in contrast with noise, which makes the doctors difficult to locate the fracture. The automatic fracture detection aids in this regards.

C.M.A.K. Zeelan Basha (✉) · G.N. Balaji
K L University, Vaddeswaram, Guntur, Andhra Pradesh, India
e-mail: cmak.zeelan@gmail.com

G.N. Balaji
e-mail: balaji.gnb@gmail.com

T. Maruthi Padmaja
VFSTR University, Guntur, Andhra Pradesh, India
e-mail: padmaja.tu2002@gmail.com

G.N. Balaji
CVR College of Engineering, Mangalpalli, Hyderabad, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_5

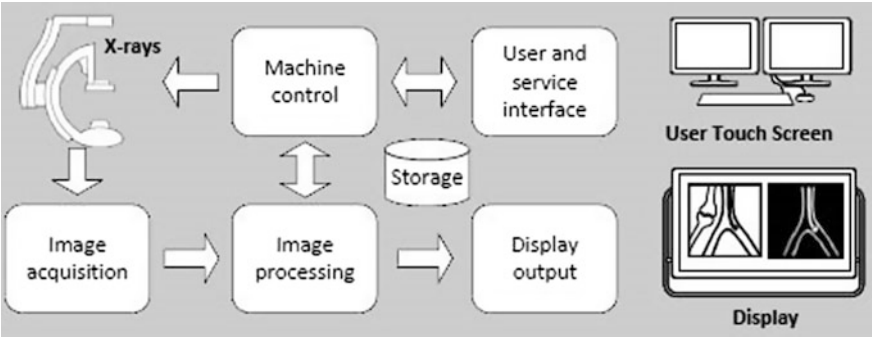


Fig. 1 Concept of medical imaging

In order to detect these fractures automatically, classification of X-ray images is to be automated, and it becomes the initial step. Therefore, this paper concentrates on the automatic classification of X-ray images.

In general, the automated systems for X-ray interventions change overtime because of both clinical trends and technical development. In order to develop automatic X-ray classification systems, the image processing techniques are adopted. Concept of medical imaging block diagram is shown in Fig. 1.

Automation of X-ray image classification is a challenging task. The challenges include the following: (1) The intensity values in the X-ray image do not solely define the structure of interest, (2) X-ray images are characterized by individual variability. The spatial relationship among different structures in X-ray images are often a priori known based on existing anatomical knowledge.

In order to address the above issues and to contribute to the required methodological knowledge, efforts have been directed towards the development of fully automated X-ray image classification system. In this work we have presented a system, to find the intensity difference between the tissue and bone in X-ray images, i.e., image segmentation is carried out. Finally, the segmented X-ray images are classified with neural networks.

Section 2 describes the literatures considered, Sect. 3 elaborates the proposed methodology while the results are discussed in Sects. 4 and 5 concludes the paper.

2 Literature Survey

Bone fractures are only the splits which happen because of mishaps. There are many sorts of bone fractures, for example, normal, transverse, comminuted, oblique, spiral, segmented, avulsed, impacted, torus, and greenstick [1, 2]. For the most part for X-ray image segmentation of bone fractures, various edge detection methods like Sobel, Prewitt, Roberts and Canny [3–6] were utilized. Kaur et al. [3] described about image segmentation of X-ray image utilizing different edge

location procedures and found that the best segmentation results were acquired utilizing Canny edge detection. The authors in [6] proposed a method to determine the image view based on the similarity of the image to reference images, but used four distance measures and *K*-nearest neighbor classifier. The classification of views in medical images will aid the radiologist in diagnosing diseases [7]. The work in [8] proposed a method to identify the frontal/lateral view using a template matching technique, the similarity measures were based on the cross-correlation coefficient. The speedup robust features are used for the classification of cardiac views in echocardiogram in [9]. Random forests with local binary patterns are used to classify the X-ray images in [10]. A segmentation algorithm based on the kernelized weighted *C*-means clustering and automatic segmentation correctness coefficients is proposed in [11]. Fuzzy-based Medical X-ray Image Classification is proposed in [12]. A novel shape texture feature extraction technique to classify medical X-ray images is proposed in [13]. Even though the above methods are used to process X-ray images, a fully automatic system which can aid doctors to detect and diagnosis fracture is not reported, the presented system aims to fill this gap.

3 Methodology

The block diagram of the presented system is shown in Fig. 2. The presented system undergoes four steps to classify the given X-ray image into some particular categories namely head, neck, skull, foot, palm, and spine. Since the X-ray images are of low contrast, the anatomical structures are difficult to view, therefore the image smoothing and enhancement are done in the preprocessing stage to remove the noise and increase the contrast of the image. The preprocessing of X-ray images not only helps in smoothing and enhancing the image, it also makes the segmentation step easier. The high boost filter and adaptive histogram equalization are used to remove the noise that are applied in order to remove the noise and enhance the contrast. The high boost filter emphasizes the high-frequency components without eliminating the low-frequency components (such as sharpening). In this paper, expectation maximization algorithm is used to segment the X-rays.

$$\text{Highboost} = (A) * (\text{original}) - \text{lowpass} \tag{1}$$

where A is the amplification factor.

Since the X-ray images are of low contrast, the bone region cannot be segmented accurately. So in order to highlight the bone region contrast, enhancement is carried out using adaptive histogram equalization. It is widely used in contrast enhancement for both natural and medical images [7]. After preprocessing, the image is segmented by the expectation maximization algorithm.

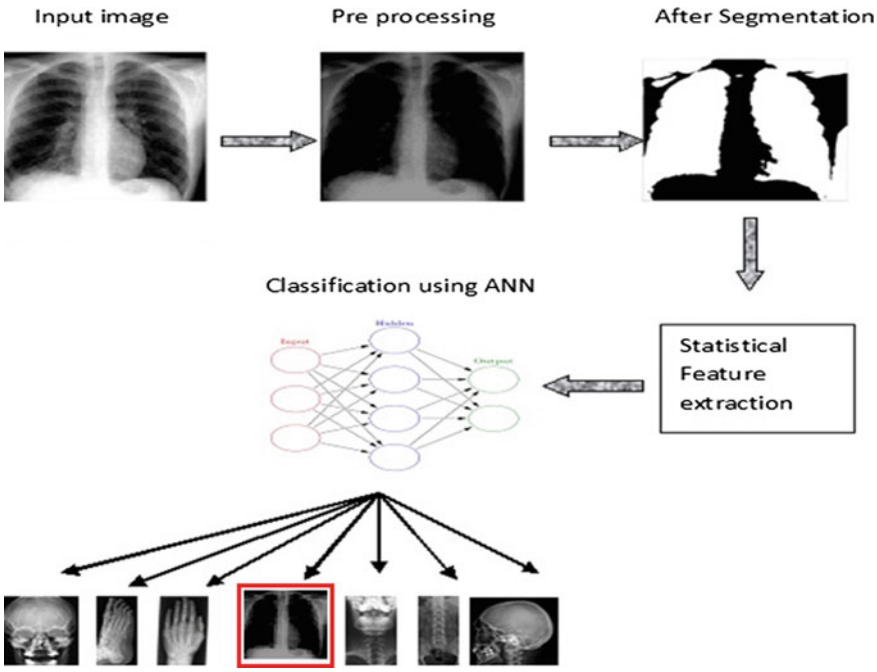


Fig. 2 The block diagram of the proposed system

3.1 Expectation Maximization (EM)

EM algorithm is used for the purpose of finding maximization likelihood function with missing data. This algorithm is a powerful tool for solving complex maximum-likelihood problems. EM algorithm is an iterative approach to calculate maximum-likelihood evaluation even when the complete observations are not done. In unsupervised setting, estimation of data points is done using EM algorithm.

The algorithm consists of two steps: (1) Computing Expectation and (2) Maximization.

The iteration of EM steps is continued till convergence occurs. The condition of this EM algorithm is to maintain lower error rate or perform maximum number of iteration to limit calculation. EM algorithm does not directly incorporate spatial modeling, and it is more sensitive to noise and intensity in homogeneities. The segmented image is superimposed on preprocessed image to obtain the bone region exactly. Figure 3a, b shows the original and segmented images.

The statistical features like mean, standard deviation, entropy, skewness, and kurtosis are extracted and fed into the classifiers BPNN, SVM, and PNN. The architecture of PNN is shown in Fig. 4.

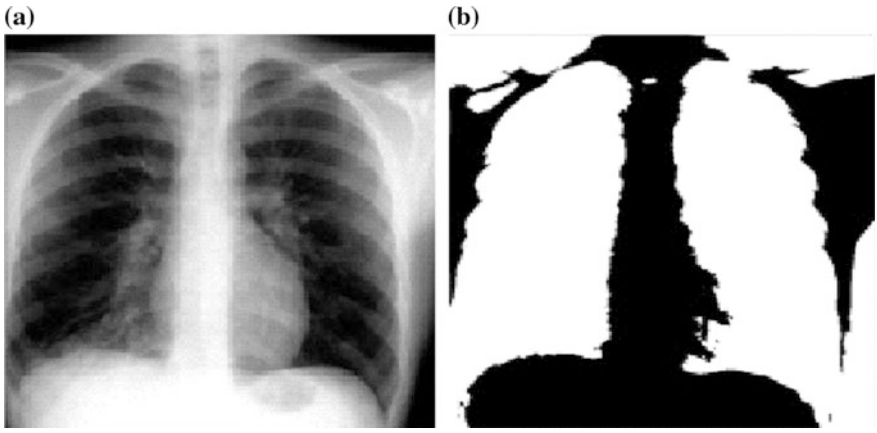


Fig. 3 **a** Preprocessed image and **b** segmented image

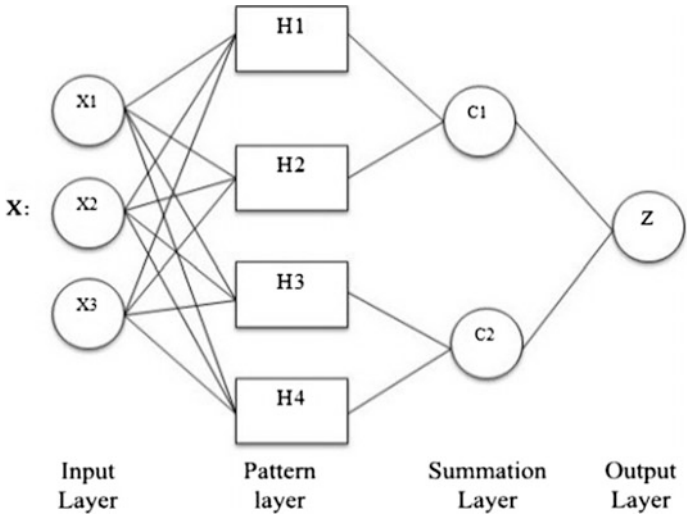


Fig. 4 Architecture of probabilistic neural network

4 Performance Measures

The performance measures sensitivity, specificity, and accuracy are calculated as follows:

$$\text{Sensitivity} = \frac{\text{tp}}{\text{tp} + \text{fn}} \tag{2}$$

$$\text{Specificity} = \frac{\text{tn}}{\text{tn} + \text{fp}} \tag{3}$$

$$\text{Accuracy} = \frac{\text{tp} + \text{tn}}{\text{tp} + \text{fp} + \text{tn} + \text{fn}} \tag{4}$$

tp, tn, fp, and fn are defined in the confusion matrix shown in Table 1.

5 Results and Discussion

A database of 300 (head-50, neck-50, skull-50, foot-50, palm-50 and spine-50) X-ray images were collected from Yashoda Hospital, Hyderabad and each image is in resolution 512 × 468. The presented work is implemented in MATLAB 2013a tool. When a digital X-ray image is given as an input to the presented system, the preprocessing step is executed first in which the noise in input X-ray image is removed using high boost filter and the contrast is enhanced using adaptive histogram equalization. The presented denoising filter is better when compared to the other filters, since the PSNR value of the presented filter is higher when compared to few traditional methods used as illustrated in Table 2.

The preprocessed image is segmented using EM algorithm in order to extract the region of interest (ROI). From the segmented image, the statistical features, viz., mean, standard deviation, entropy, skewness, and kurtosis are obtained. The classifiers BPNN, SVM, and PNN are used to classify the given input X-ray image as head, neck, skull, foot, palm, and spine. Among the 50 images in each category, 30 images are used for training purpose and the remaining images are used for testing and validation.

Table 3 shows the performance of BPNN classifier in classifying the X-rays into seven categories namely head, foot, palm, chest, neck, spine, skull. The overall performance of the BPNN classifier is 84.75%. In order to improve the performance, the PNN classifier is employed but the overall accuracy is 81.33% which is

Table 1 Confusion matrix demonstrating normal and abnormal patterns

Actual	Predicted	
	Positive	Negative
Positive	True positive (tp)	False negative (fn)
Negative	False positive (fp)	True negative (tn)

Table 2 Comparison of PSNR values of denoising filters

Denoising filter	PSNR value	Reference
Wavelet	18.51	[8]
Wiener	21.64	[14]
Median	20.25	[9]
High boost filter	23.16	Presented method

lesser than BPNN as illustrated in Table 4. Further to improve the performance, the SVM classifier is used and the overall accuracy rose to 89.03%, which is greater than the other two classifiers which are shown in Table 5. The sensitivity and specificity are also high in the case of SVM.

Figure 5 shows the performance of BPNN classifier graphically and it can be seen that the sensitivity is good and the specificity is less which impacts the overall accuracy. Even though the errors are back propagated by the algorithm the performance remains less worthy. Figures 6 and 7 show the performances of PNN and SVM classifiers graphically, and it can be seen that the SVM gives a better performance when compared to BPNN and PNN classifiers.

Table 3 Performance of BPNN in classifying X-rays

Class	Sensitivity	Specificity	Accuracy
Head	90	83.33	84.66
Foot	93.33	83.33	85.33
Palm	96.66	84.16	86.66
Chest	80	82.5	82
Neck	73.33	85	82.66
Spine	90	85	86
Skull	86.6	85.83	86
Overall	87.13	84.16	84.75

Table 4 Performance of PNN classifier in classifying X-rays

Class	Sensitivity	Specificity	Accuracy
Head	93.33	87.5	88.66
Foot	93.33	79.16	82
Palm	86.66	80.83	82
Chest	80	79.16	79.33
Neck	96.66	72.5	77.33
Spine	90	83.33	84.66
Skull	93.33	70.83	75.33
Overall	90.35	79.04	81.33

Table 5 Performance of SVM classifier in classifying X-rays

Class	Sensitivity	Specificity	Accuracy
Head	93.33	89.16	90
Foot	90	96	90
Palm	96.6	91.6	92.6
Chest	90	90	90
Neck	93.33	93.33	93.33
Spine	93.33	80.83	83.33
Skull	90	82.5	84
Overall	92.37	88.20	89.03

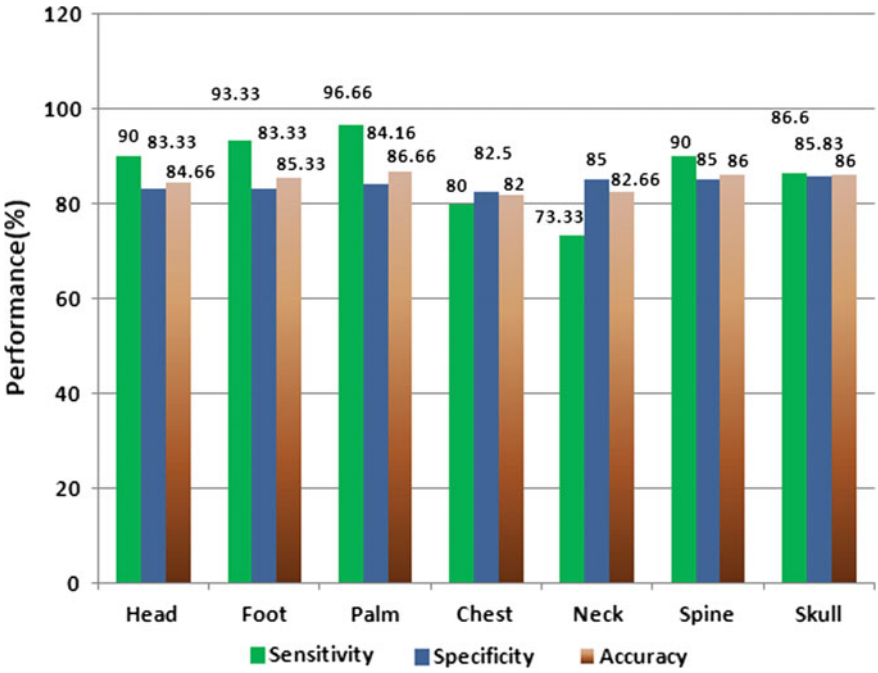


Fig. 5 Classification of X-rays using BPNN

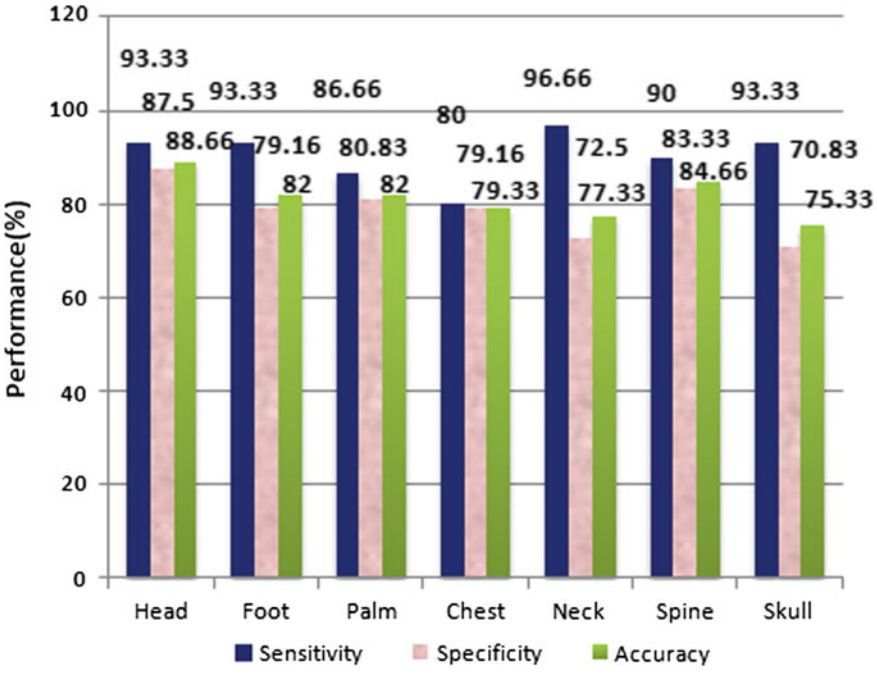


Fig. 6 Performance of PNN classifier

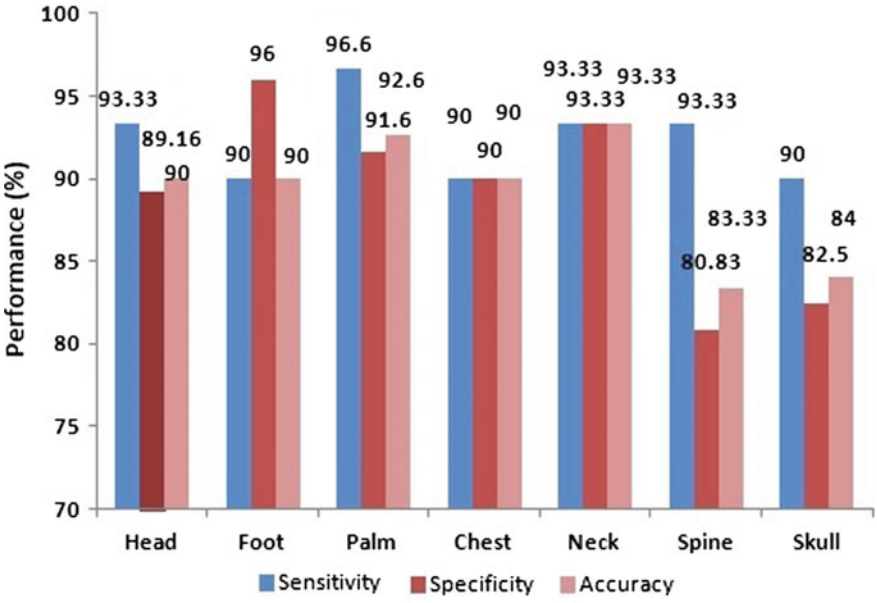


Fig. 7 Performance of SVM classifier

6 Conclusion

In this paper, a system is presented which involves denoising, contrast enhancement to improve the quality of input X-ray images, extracts statistical features, and finally classifies them into seven categories. Among the three classifiers employed, the SVM gives a better performance and the presented methods can be used as an effective tool for classifying X-ray images. Therefore, the radiologist can classify the X-rays and it will make the succeeding process like fracture detection and surgery planning easier. Further orientation of X-ray images and abnormality detections can be automated i.e., computer-aided diagnosis (CAD) can be automated as an extension. Content-based image retrieval (CBIR) systems can be developed using the presented method which will be helpful for both the radiologists and students.

References

1. Mahmoud Al-ayoub, Ismail Hmeidi, Haya Rababah, "Detecting hand bone fractures in X-ray images", Journal of multimedia processing and technologies, Vol. 4, No. 3, pp. 155–168, September 2013.

2. S. Sai Niveaditha, V. Pavithra, R. Jayashree, T. Tamilselvi, "Online diagnosis of X-ray image using FLDA image processing algorithm". IRF International Conference, March 2014, pp. 76–80.
3. Jaskirat Kaur, Sunil Agrawal, Renu Wig, "A comparative analysis of thresholding and edge detection segmentation techniques." International journal of computer applications. Vol. 39, No. 15, pp. 29–34, 2012.
4. S.K. Mahendran, "A comparative study on edge detection algorithms for computer aided fracture detection systems". International journal of engineering and innovative technology. Vol. 2, No. 5, pp. 191–193, November 2012.
5. Subodh Kumar, Prabat Pandey, "Implementation of X-ray image segmentation by using edge detection using sobel edge operator", International journal of innovative research and studies, Vol. 3, No. 2, pp. 191–202, February 2014.
6. Rafeal. C. Gonzalez & Woods, "Chapter 10: Image segmentation", Digital image processing, Pearson Education, Inc., 2005, pp. 392–439.
7. Balaji, G. N., T. S. Subashini, and N. Chidambaram. "Automatic Classification of Cardiac Views in Echocardiogram Using Histogram and Statistical Features." Procedia Computer Science 46 (2015): 1569–1576.
8. H. Arimura, S. Katsuragawa, Q. Li, T. Isguda, and K. Doi, "Development of a computerized method for identifying the posteroanterior and lateral views of chest radiographs by use of a template matching technique," Med. Phys., vol. 29, no. 7, pp. 308–315, 2002.
9. Balaji, G. N., T. S. Subashini, and N. Chidambaram. "Cardiac View Classification Using Speed Up Robust Features." Indian Journal of Science and Technology 8.S7 (2015): 1–5.
10. Kim, Seong-Hoon, et al. "X-ray image classification using random forests with local binary patterns." Machine Learning and Cybernetics (ICMLC), 2010 International Conference on. Vol. 6. IEEE, 2010.
11. M. Bugdol, J. Czajkowska, and E. Pietka, "A novel model-based approach to left ventricle segmentation," in Computing in Cardiology (CinC). Krakow, Poland: IEEE, 2012, pp. 561–564.
12. Ghofrani, Fatemeh, et al. "Fuzzy-Based Medical X-ray Image Classification." Journal of medical signals and sensors 2.2 (2012): 73.
13. Mohammadi, Seyyed Mohammad, Mohammad Sadegh Helfroush, and Kamran Kazemi. "Novel shape-texture feature extraction for medical X-ray image classification." Int J Innov Comput Inf Control 8 (2012): 659–76.
14. F. Zhang, Y. M. Yoo, K. L. Mong, Y. Kim, Nonlinear diffusion in Laplacian pyramid domain for ultrasonic speckle reduction, Medical Imaging, IEEE Transactions on 26 (2) (2007), p. 200–211.

TILLAGE DRIP: An Efficient Seed Selection and Conservative Irrigation with Crop Defective Alert by IOT

D.N.V.S.L.S. Indira, Manti Harshita, Dasari Shree Pranav and Jasti Poornima Mani Sai

Abstract Agriculture is the classical and most reliable way of growing food for many centuries. In it irrigation is the prime element for a successful cultivation. In India, seventy percent of the economy is dependent on agriculture (Ingale and Kasat in Int J Eng Res Dev 4, 2012) [1]. Tillage uses 85% of available fresh water supplies worldwide, and this percentage will maintain to be prevailing in water consumption because of the increase in population and expanded food demand (Gutiérrez et al. in IEEE transactions on instrumentation and measurement, 0018–9456) [2]. Long gone are the days of watering your plants or checking the fertility of the soil or discovering how healthy the crop is, manually all by yourself. There is also a risk of accuracy with manual work. India is a country where seventy percent of the land is under cultivation. In order to irrigate these large chunks of land, we use stupendous amount of water which might lead to loss of this valuable resource. So, in order to provide a solution for this tangled issue, we came up with TILLAGE DRIP. This paper has three segments, where in the first segment it deals with checking of fertility of the soil, provided the best suitable soil type for a particular crop. The second segment deals with automatic irrigation with the help of IOT. Whereas the third segment works with health conditions of the crop using image processing technique.

D.N.V.S.L.S. Indira (✉) · M. Harshita · D.S. Pranav · J.P.M. Sai
Department of Computer Science and Engineering, Gudlavalleru Engineering College (Affiliated to Jawaharlal Nehru Technological University Kakinada), Krishna District 521356, Andhra Pradesh, India
e-mail: indiragamini@gmail.com

M. Harshita
e-mail: harshita8179@gmail.com

D.S. Pranav
e-mail: shree.pranav007@gmail.com

J.P.M. Sai
e-mail: poornima.jasti8@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_6

1 Introduction

In agriculture, the pH level, contaminated content, minerals, etc., are tested by taking a soil sample. A soil test determines the fertility and the growth ability of the soil. This shows up all the deficiencies and toxicities. Soil type is the most predominant characteristic which affects the constraints considerate to seed selection, amount of soil erosion, and many more [3]. The process of selecting seeds according to appropriate soil needs, proper specialised knowledge which plays an essential role in detecting the accurate cause of any mislead fertilities.

When irrigation is not monitored properly, there are high possibilities of experiencing water shortage due to increasing population [4]. There is a compelling need to devise strategies based on science and technology for continual use of water resource [2]. It is easier for famers to irrigate lands if automated systems are implemented. Among the most predominant techniques, sensor irrigation finds a useful way [5]. The art or science of cultivating the land includes the harvesting of crops and the rearing and management of livestock.

The research on plant features refer to the research of visually noticeable patterns of a specific plant. In present days, crops are facing numerous diseases. Insecticides are not always seemed to be advantageous because insecticides might be noxious to some birds. It also causes havoc to food chain of natural animals. A general method followed by plant scientists is to assess the damage of plant (leaf, stem) due to the disease on a scale based on amount of disease attacked area which outcomes subjectivity and low throughput. This paper equips advanced techniques in different processes used to study plant diseases or traits using image processing and data mining techniques.

2 Existing System

Previously, there are researchers who tried for the melioration of farmers and provide the systems facilitated with technologies which support in proliferating the agronomic yield [6].

The existing systems made use of Humidity sensor, Temperature sensor. A/D converter takes the outputs of these sensors. Now, they are converted to digital domain which is given to the controller [7].

Development, testing, and integrated distributed wireless sensor network (WSN) are used which in turn use Bluetooth technology for sensor-based variable rate irrigation systems [8]. And, an area which is needed to be cultivated is divided into many subzones [9].

In another existing system, soil moisture and temperature sensors are used near the root area of the plant. The sensor information is thus transmitted to a web application. An algorithm was also developed for calculating or measuring the threshold values of sensors and thus, parameters are estimated.

In another existing system, a sensing unit such as soil moisture sensor to calculate the content of water in the soil, temperature sensor notices the temperature, humidity sensor to calculate the existence of water in air, pressure regulator sensor to maintain the recommended pressure, molecular sensor for improved crop growth [10]. Digital camera is installed to track and click photographs of the crop field in order to observe the crop growth. The output of the sensors is transformed to analog using Digital to Analog converter at the sender input side. This is again transformed back to digital form by using Analog to Digital converter at the receiver output side. Multiplexer, also called as Data selector is a combinational logic circuit which chooses any one input among the $2n$ inputs and routes it to the output.

Now, the data collected from various sensors are transfused to the Multiplexer using Wireless Sensor Network [11]. This procedure is followed by considering ZigBee or Hotspot programs for wireless data communication to control unit.

3 Proposed System

The proposal is to develop an automatic irrigation system and disease detection system which switches the pump motors of water as well as pest spray ON and OFF on sensing the amount of moisture present in the soil for irrigation and pesticide spray [12]. In agriculture, usage of proper procedures for irrigation is vital. The leverage of using this procedure is to reduce human interference and still ensure proper irrigation along with sustainable use of water resources and help the farmer to select the best yielding crop for his field based on the soil. Here, the humidity sensor reports to humidity information of each plot to Arduino in analog data range from 0 to 1023. Greater data means the pot with more moist. So we set the threshold to determine when to water.

3.1 The Components Which Are Useful for This Process Are

(a) Arduino sensor board
(b) DC motor operated valve
(c) Soil sensors
(d) Pump set
(e) Relay
(f) Servos

3.2 Major Contribution for Proposed Work

1. To accommodate farmers in identifying the appropriate soil textures suitable for the required cultivation and to designate their respective soil fertility.
2. To reduce the wastage of water due to excessive irrigation by monitoring the dripping intervals according to the soils' moisture.
3. To spot the crop diseases efficiently with accurate image processing techniques that helps the farmers with zero loss of the crop.

4 Experimentation

4.1 Phase 1: Seed Selection Based on Soil

Three different soils textures namely black clay, red clay, and sand are taken in order to study the nature of crops depending on the soil conditions in which they are grown. A test for the soil is done to check out the nutrient deficiencies, potential toxicities. The test is used to mimic the function of roots to assimilate minerals. Proper soil pH, fertility, seed bed preparation are the important factors to be considered for selecting high quality seeds of appropriate species are observed using the soil sensors. Values are tabulated and the so obtained values will help analyse the best seed for the soil (Fig. 1).

4.2 Phase 2: Automatic Irrigation

An algorithm was advanced with the threshold values of moisture present in soil and was programmed into an arduino [2]. The arduino sends the instructions to the motor pump, based on the threshold limit of the soil moisture given to the arduino. If the limit value given by soil sensor does not match with the arduino threshold,

Fig. 1 Different crops in different soils

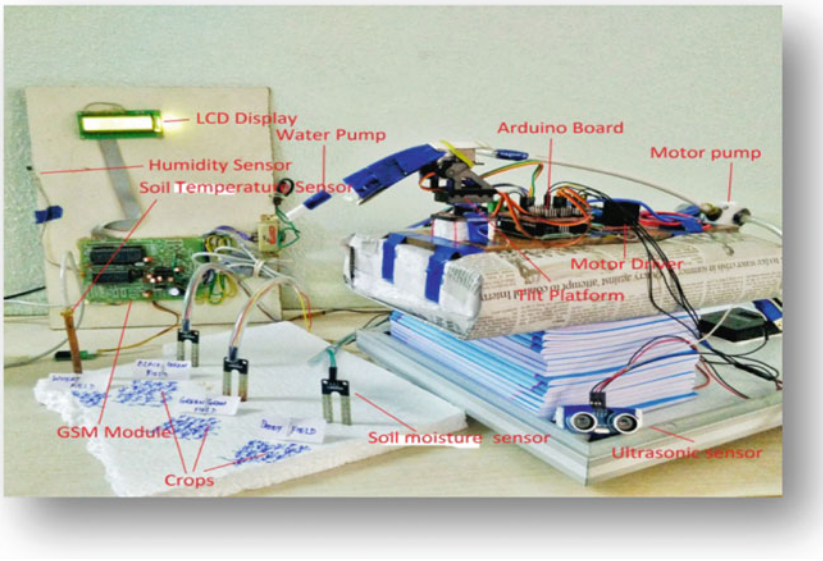


Fig. 2 Automatic watering based on soil temperature

then the motor pump activates using relays and switches the pump motor ON/OFF on sensing the moisture content of the soil. This method is implemented to reduce human intervention and still ensure proper irrigation along with sustainable use of water resources (Fig. 2).

4.3 Phase 3: Disease Detection

For conducting our experiment we consider an area of about 4–5 acres of cultivable land. In this land we place a camera that captures the images of the crop periodically and sends these to the server for further analysis. These images are analysed and will be compared with the images stored in the database for identifying the type of disease. We place two sensors out of which one will be placed beneath the ground which is used for measuring/sensing the proportion of minerals like ammonia, sodium, sulphide, etc., present in the soil and the other will be placed above the ground level that senses the external parameters like humidity, fog, temperature etc. These values also are intimated to the farmer periodically. If any of these readings from sensors are not in accordance with standard values. They result in change of the colour of the plant. These changes are captured by the camera and are analysed periodically and will be intimated to the farmer for necessary actions (Fig. 3).

4.4 Flow Diagrams

See Figs. 4 and 5.

4.5 Algorithm for Automatic Irrigation

Step 1. Start
Step 2. Initialize the trigger values of each soil texture

Fig. 3 Disease in beetle leaves

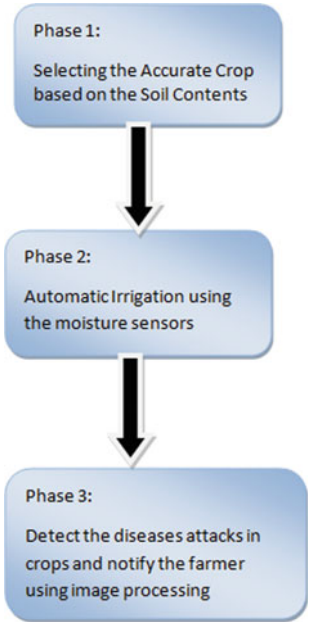


Fig. 4 Three phases of tillage drip

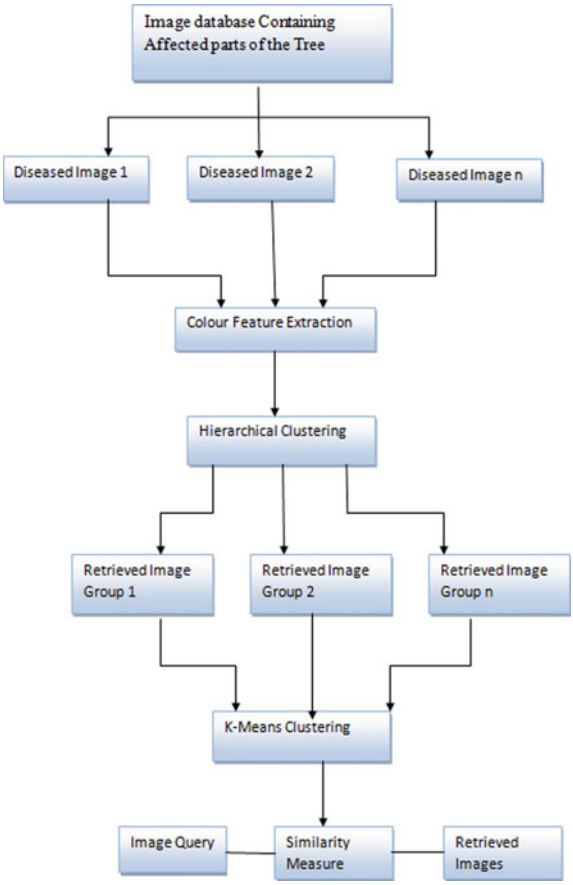


Fig. 5 Working of automatic irrigation system

Step 3. Initialize the moisture sensors to 0
Step 4. Arrange the servo positions to the servo object, Horizontal and Vertical
Step 5. Fix the Initial positions of the Servo
Step 6. If moisture value sensed by the sensor < trigger value given, according to the soil texture water the plant
Step 7. If moisture value returned = trigger value given, stop watering
Step 8. Print moisture values
Step 9. Wait for 15 m s to reach another plant
Step 10. Go to step 6
Step 11. Stop

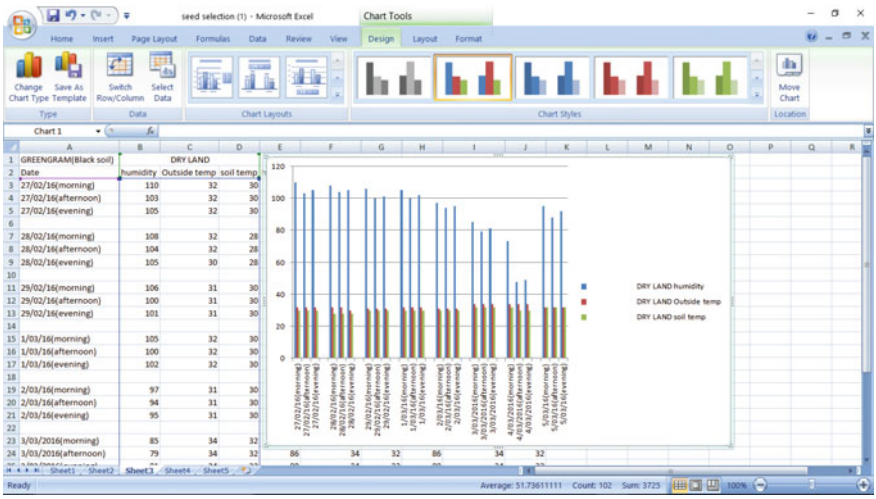
4.6 Algorithm for Disease Detection

Step 1. Start
Step 2. Initialize the Database with various types of diseases infected crops and the values of the mineral content which best suites the crop
Step 3. Place the Sensors in the soil
Step 4. Sensors returns pH value and mineral content in the soil
Step 5. Fix the cameras in the Field according to the crop positioning
Step 6. Initialize the cameras to click photographs for every 10 h
Step 7. Check the Clicked photographs with the photographs in the Database
Step 8. If Photos in Database match $\geq 20\%$ with the images clicked by the camera then alert the farmer with an SMS
Step 9. Stop

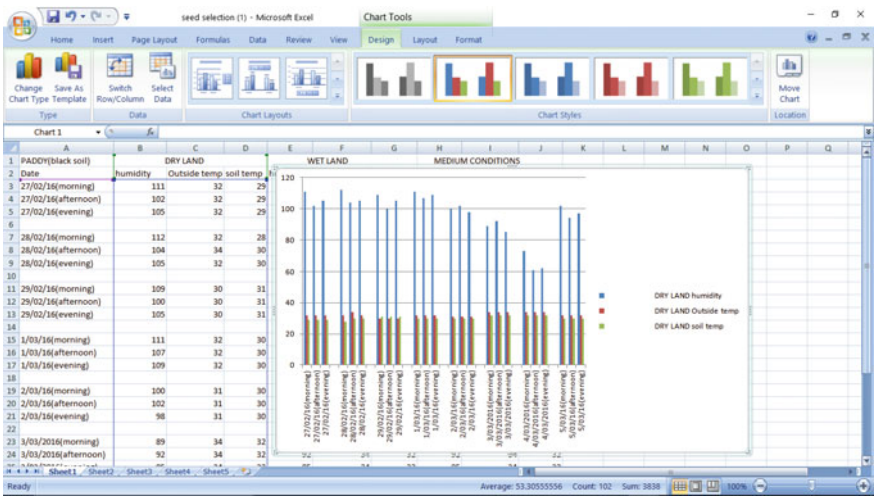
5 Experimental Results

5.1 Graphical Observations

Graphical representation of the growth in seeds with respect to the temperature and pH value (Graphs 1 and 2).



Graph 1 Representation of green gram in black soil of dry land



Graph 2 Representation of paddy in black soil of dry land

6 Conclusion and Future Work

The features proposed above not only talks about better recommendation model, but also performance in terms of how efficient seed selection based on soil can give accurate output. As it is a well-known concept that when the resource conservation is better, the probability achieved in conserving water resource would be more. In order to attain this we used tillage drip architecture in our paper. Going beyond this in future, the same recommendation can be much more efficient and successful using emerging technological advancements in senile agriculture.

References

1. H.T. Ingale, N.N. Kasat, "Automated Irrigation System", International Journal of Engineering Research and Development, Volume 4, Issue 11 (November 2012), PP.
2. Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel ÁngelPorta- Gándara, "Automated Irrigation System Using a Wireless Sensor Network and GPRS Module", IEEE transactions on instrumentation and measurement, 0018–9456.
3. J.M. Abrisquetaa, V. Planab, O.H. Mounzera, J. Mendezd, M.C. Ruiz-Sa ncheza, "Effects of soil tillage on runoff generation in a Mediterranean apricot orchard", agricultural water management 93 (2007) 11–1814.
4. Mehamed Ahmed Abdurrahman, Gebremedhn Mehari Gebru & Tsigabu Teame Bezabih, "Sensor Based Automatic Irrigation Management System", International Journal of Computer and Information Technology (ISSN: 2279–0764) Volume 04–Issue 03, May 2015.
5. Ravinder Singh Dhanoa, Ravinder Singh, "International journal of engineering sciences & research technology", Automatic Irrigation System using WSNs (2007).

6. Aniket H. Hade, Dr. M.K. Sengupta, “Automatic Control of Drip Irrigation System & Monitoring Of Soil by Wireless”, IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 4 Ver. III (Apr. 2014), PP 57–61.
7. Ms. Deweshvree Rane, Prof. P. R. Indurkar, Prof. D. M. Khatri, “review paper based on automatic irrigation system based on rf module”, IJAICT Volume 1, Issue 9, January 2015.
8. Yunseop (James) Kim, Member, IEEE, Robert G. Evans, and William M. Iversen, “Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network”, IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 57, NO. 7, JULY 2008.
9. Abhinav Rajpal, Sumit Jain, Nistha Khare and Anil Kumar Shukla, “Microcontroller-based Automatic Irrigation System with Moisture Sensors”, ICSE2011 2011, ISBN: 978-981-08-7931-0.
10. S. Darshna, T. Sangavi, Sheena Mohan, A. Soundharya, Sukanya Desikan, “Smart Irrigation System”, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278–2834, p- ISSN: 2278-8735. Volume 10, Issue 3, Ver. II (May—Jun. 2015), PP 32-36.
11. Pratik A. Patil, SangramV. Bhosale, Kunal R. Joshi, Digvijay T. Bhakare, Akash J. Gurav, “Prototype for automatically navigated water irrigation system”, The International Journal Of Engineering And Science (IJES) Volume 4 Issue 3 Pages PP.37–42 2015, ISSN (e): 2319–1813 ISSN (p): 2319–1805.
12. Sumeet. S. Bedekar, Manoj. A. Mechkul, “IoT Based Automated Irrigation System”, International Journal of Modern Trends in Engineering and Research, e-ISSN No.:2349–9745.

DVR for Identification and Mitigating of Voltage Sags Using Estimation Technique in Power Distribution Systems

P. Sasikiran, A. Deekshitha, P.V.V. Kishore and B. Sindhu

Abstract At the present time, electric power quality-related troubles are absorbed in electric power distribution networks. For compensating power quality voltage sag issues, different types of custom power devices are utilized. The dynamic voltage restorer (DVR) is one among the power electronics devices which might be used for boosting the PQ. To mitigate the voltage sag disturbances, the performance of DVR must be enhanced. In this paper for mitigation of voltage dip an estimation technique which depends on linear Kalman filter (LKF) is recommended. The recommended LKF estimation method is carried out to facilitate the control algorithm for producing reference signals of voltage source converter (VSC) of DVR. DVR offers the compensation voltage as output is inserted in the power line. With this suggested estimation method, voltage sag problems are resolved with precision and faster performance to revoke the sag appearance in nonlinear sensitivity load-connected distribution systems. The verification of the LKF algorithm is accomplished on Simulink platform. Simulation effects are inspected and the suggested one is compared with DVR.

P. Sasikiran (✉) · A. Deekshitha · P.V.V. Kishore · B. Sindhu
Department of Electronics and Communication Engineering, K L University, Green Fields, Vaddeswaram, Guntur, AP, India
e-mail: psasikiran9@kluniversity.in

A. Deekshitha
e-mail: deekshataa@gmail.com

P.V.V. Kishore
e-mail: pvvkishore@kluniversity.in

B. Sindhu
e-mail: sindhu44869@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_7

1 Introduction

The major purpose of an electrical power distribution system is to offer power to entity consumer location. Distribution of electric power is accomplished using the distribution system and the sharing of electric power to dissimilar consumers is fulfilled with low voltage level. The most vital problem for utilities nowadays were the quality of electrical power for consumers and instruments producers because of the consumption of nonlinear power electronic loads. Nonlinear loads like uninterrupted power supply (UPS), variable speed drives, and all types of rectifiers are major cause of power quality problems.

In distribution system the unremitting deliver of electrical power is an important challenge for the power utilities. The augmented procedure of changing devices and modern electronic circuitry by consumers frequently interrupts the accessibility of quality supply of power. To evade severe practical troubles from happening under these situations, the systems safe and consistent procedure requirements to be preserved concerning a variety of features of power flow and system transient management. This is because of the addition of undesired harmonics in power distribution network. Power utilities intended to preserve the voltage with steady amplitude and frequency without any deformation [1, 2].

Distribution power systems are operating at their extreme running limitation and frequently beyond profit consumption. One of the main points of particular regard is a characteristic of wide power quality area which should be compact with voltage uniqueness under standard operational conditions. Because of the quality of electrical power, e.g., the voltage at the point of common coupling (PCC) has become a significant characteristic. As well, a widespread use of power electronic loads, particularly in distribution networks, establishes novel difficulty to correct power system operation and demands [3].

The distribution networks were not intended to allow the power insertion from distributed generation (DG) basis and their association generates a wide collection of technical troubles. Whereas a collection of alternatives be present to moderate difficult impacts, under current possible preparations the developer will mostly tolerate the economic dependability for their execution. The financial suggestion can create probable methods with fewer attractive and, in few cases, have been an obstruction to renewable expansion [4, 5]. The probable solution to compensate the voltage dip/sag issues in the distribution system by using a variety of FACTS/custom power devices like dynamic voltage restorer (DVR).

1.1 Dynamic Voltage Restorer

Voltage dips or voltage sags are diminutive period under-voltages which mean there is a drop in RMS value of the voltage to between 0.1 and 0.9 p.u. for time from 0.5 cycles to 1 min. Voltage sag is the cause of fault occurred on any feeder or

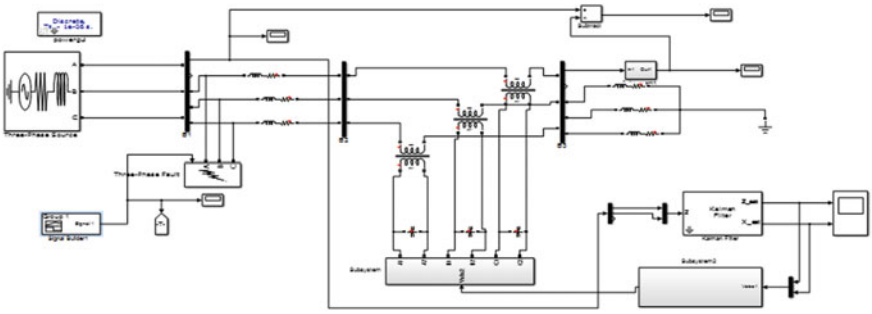


Fig. 1 The Simulink model of system

sudden starting of motor. Power supply with voltage sag is undesirable for critical loads, which leads to equipment damage or malfunctioning in industry. In order to protect sensitive electric loads from voltage sag/dip, a custom power device like dynamic voltage restorer (DVR) is connected in series with the power line between source and load through injection transformer as shown in Fig. 1.

DVR is employed for the compensation of voltage sag disturbance to prefault voltage, by injecting missing voltage of essential amplitude and frequency on the network. The major advantages of DVR are very small in size and cost is less when compared to other custom power devices.

2 Recent Research Works: An Overview

Sundarabalan et al. [6] have established the effective misuse of DVR for intersecting the proton exchange membrane fuel cell (PEMFC) load to the grid founded on enhanced PI and fuzzy logic (FL) controller. The actual coded GA was used to enhance the PI controller parameters. The PEMFC functioned boost converter was used to improve the fuel cell output voltage to poise the DC side supplies of the VSC. The DVR was a sequence associated with custom power device which recovers the excellence of power brought to the consumers. The DVR delivers balanced and unbalanced voltage sag/swell compensation, harmonic reduction in addition to a lively power injection to the grid. The intended technique also defends the sensitive loads after basis side PQ disturbances counting short-term break. The harmonic reimbursement performance of the work was authenticated additionally by associating with the consequences of the H1 controller based DVR lower than medium level voltage form.

Due to the application of nonlinear loads like fluorescent lamps, uninterrupted power supply (UPS), and arch furnaces which draws harmonic current components and reactive power components from AC supply are causes of power quality (PQ) problems which results in reduction of system efficiency and power factor particularly in three phase systems. Merazy et al. [7] have proposed a superior and

realistic time domain PQ theory-based control strategy to generate voltage or current compensation signals, that acts as heart of the shunt active power conditioner(Shunt APC) to alleviate PQ troubles in power systems.

Gonzalez et al. [8] have proposed a superior and realistic control strategy for DVR. The passivity-based control (PBC) lets a restored recompense recital below transient and stable state operating situations and affords following with zero error of some location for linear and nonlinear loads. The closed-loop source-DVR-PBC-load system was asymptotically stable at all operating points, with essentially very unimportant constraints; its fleeting answer was sooner than with classical administrator, and does not current flows. These appearances do not be contingent on basis voltage turbulences, the caring of load or parameter differences. The PBC uses less digital processes than the PI, and does not necessitate DQ transformations.

DVR topology was proposed by Chandrasekaran et al. [9]. The volume of the voltage source inverter (VSI) and principles of the filter was insignificant that would advance the return competence for voltage harmonic, swell and voltage sag extenuation under numerous liability conditions. The volume of the VSI and the standards for the connection filter associated amid the injection transformer and the inverter play a vital in the development of the DVR. The RLC filter was able to eradicate the substituting harmonics. The volume of the DC supply voltage was abridged when the value of inductance was minor. The DVR has high competence and the aptitude to recover the excellence of voltage.

A modeling of DVR for voltage correction was presented by Saeed et al. [10]. The presentation of the device under dissimilar voltage sag types was labeled, anywhere the voltage sag types were familiarized by means of the dissimilar categories of short-circuit faults. Voltage sags could be regular or unsymmetrical contingent on the sources of the sag. Largely, one of the greatest common events for justifying voltage sags was by the usage of DVRs. A DVR was defined as a controlled voltage source introduced amid the network and a sensitive load completed a booster transformer injecting voltage hooked on the network in order to precise any trouble moving a subtle load voltage. The heftiness of the device was assessed using the shared voltage sag indices, while captivating into account voltage and present unbalance percentages, where upholding the entire harmonic alteration percentage of the load voltage within a stated range was anticipated.

3 LKF Model-Aided Control Unit for DVR

This paper proposes, analyzes and discusses about the execution of hasty and precise identification of power system disturbances based on an estimation technique for observation and mitigation of voltage sag. Kalman filter requires knowledge in mathematics like linear algebra, statistics, optimization theory for better understanding. This technique has already been proven throughout decades. There are more computing steps, but also numerous variables and computation itself seems to be more complicated. But implementation is much simple. There is a

relationship between the design of Kalman filter and low-pass filter. The core principle is same as to that of the first-order low-pass filter (LPF). The whole calculation procedure for linear Kalman filter is explained through equations. Kalman filter is a sequential execution of steps 1 through 5. KF is a recursive form, which reuses the previous result and hence it has good efficiency in calculation. Also, recursive expression has advantage in the aspect of memory storage. Kalman filter (KF) is utilized as an estimator of the amplitude and phase angles of voltage dip disturbances in power systems from sampled voltage data.

The organization of KF algorithm is very straightforward. Kalman filter algorithm is executed recursively. It accepts only one measurement as input and returns one estimate value as output. KF is a recursive filter, where there is no need to store a large amount of data; it requires only the present state and the preceding state. The inside process of KF is done through a four-step computation, but according to the meaning, it is only two parts. They are prediction process and estimation process.

Step 1 is for prediction. Once initial values are set, predict state covariance and error covariance using Eq. 1

$$\begin{aligned} \hat{x}_k^- &= A\hat{x}_{k-1} \\ P_k^- &= AP_{k-1}A^{\mathrm{T}} + Q \end{aligned} \tag{1}$$

In Step 2, Kalman gain is being calculated using Eq. 2

$$K_k = P_k^- H^{\mathrm{T}} \left(HP_k^- H^{\mathrm{T}} + R\right)^{-1} \tag{2}$$

In Step 3, an estimation is calculated using Eq. (3) from a input measurement Z_k.

$$\hat{x}_k = \hat{x}_k^- + K_k\left(z_k - H\hat{x}_k^-\right) \tag{3}$$

In Step 4, error covariance is calculated using Eq. (4).

$$P_k = P_k^- - K_k HP_k^- \tag{4}$$

Error covariance is an assessment demonstrating how perfect the estimation is. Steps 2, 3, and 4 fall into estimation process. The superscript '−' means predicted value. The LKF model gives the filtered signal to the Pulse Width Modulation of DVR as shown in Fig. 1, which generates the signal to the voltage source inverter. The voltage sag can be mitigated with the make use of the injected voltage from the DVR.

4 Results and Discussion

In this paper, the validation of the LKF control module for DVR system is presented. The proposed method is tested on a 3-bus system. In this system, DVR is connected in series through 3-single phase transformers on the power line. They are

Table 1 The testing conditions for LKF-based system

S. No.	Fault timing	Sag time (in s)	
		Start time	Stop time
1	Begin	0.01	0.06
2	End	0.18	0.20

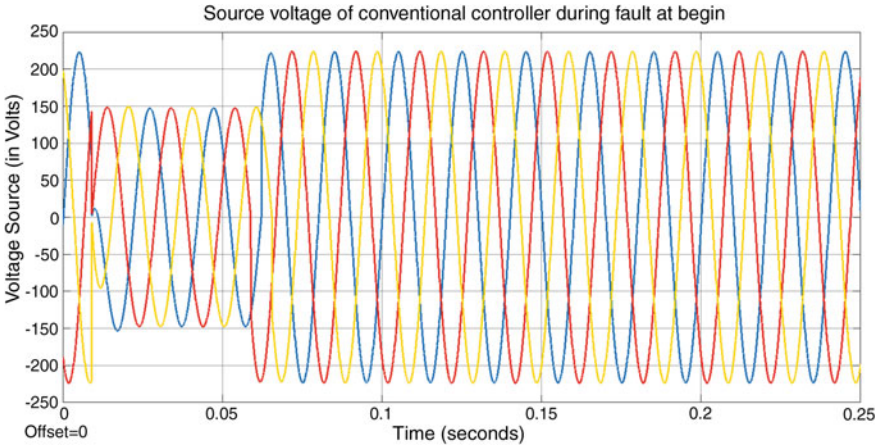


Fig. 2 The supply voltage with sag

connected to voltage source converter (VSC) of DVR for injecting compensation voltage. To verify the compensation performance of the LKF method, a 3-phase fault is introduced in the system, it draws more current from the lines and bus voltage will experience voltage sag. This voltage sag is compensated by proposed methodology and provides fundamental sinusoidal supply voltage to the nonlinear load. The Simulink model of the LKF-based system is shown in Fig. 1. The performance of the proposed system is checked at different fault timings as shown in Table 1.

In Fig. 2, the supply voltage with sag during start time of the simulation and in Fig. 3, relates load voltage due to the conventional controller is offered. The total simulation time is 0.25 s. However, it is not up to the mark of actual supply voltage, 230 V.

Similarly, in Figs. 4 and 5, with same voltage dip of 80 V, the ordinary controller is verified during end time of the simulation.

In Figs. 6 and 7 the supply voltages and load voltages of DVR due to the LKF model controller are offered. Due to this, the load voltages are enhanced from conventional controller and are close to the required voltage with a sag of 30 V which is superior than 80 V.

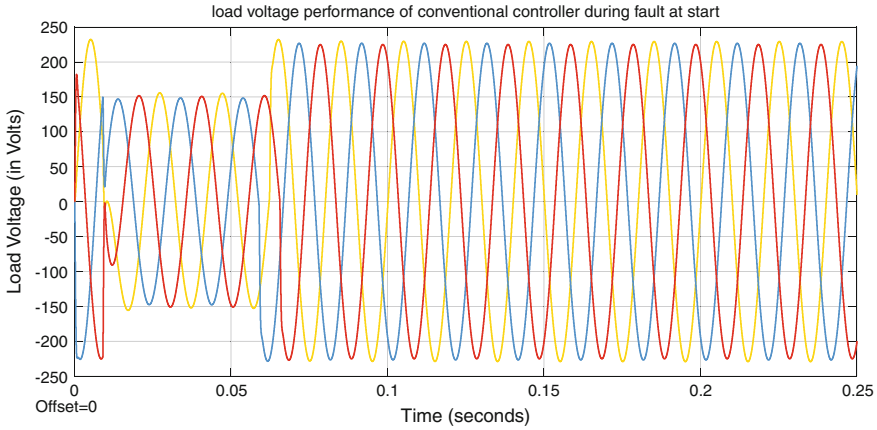


Fig. 3 Load voltage due to the conventional controller

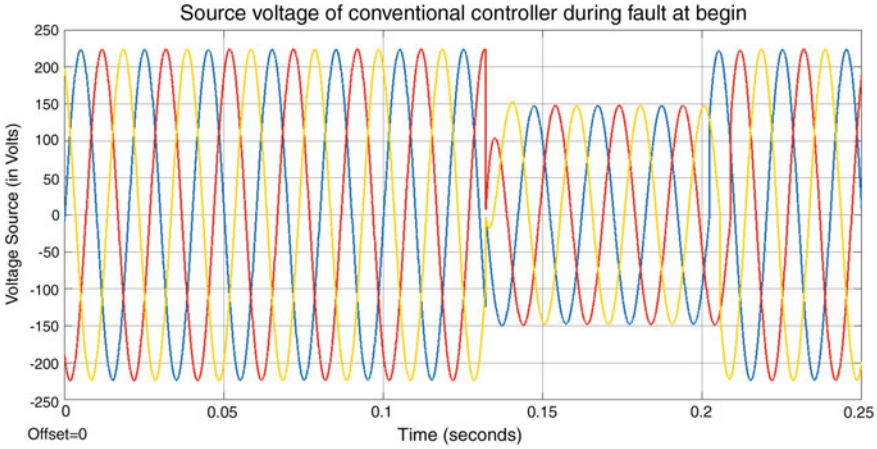


Fig. 4 The supply voltage with sag during end time

In Figs. 8 and 9, the appearance of supply and load voltages of DVR system due to the LKF-aided controller are presented. Due to this controller, the load voltages are enhanced from conventional controller and are close to the desired voltage, which is better than 80 V.

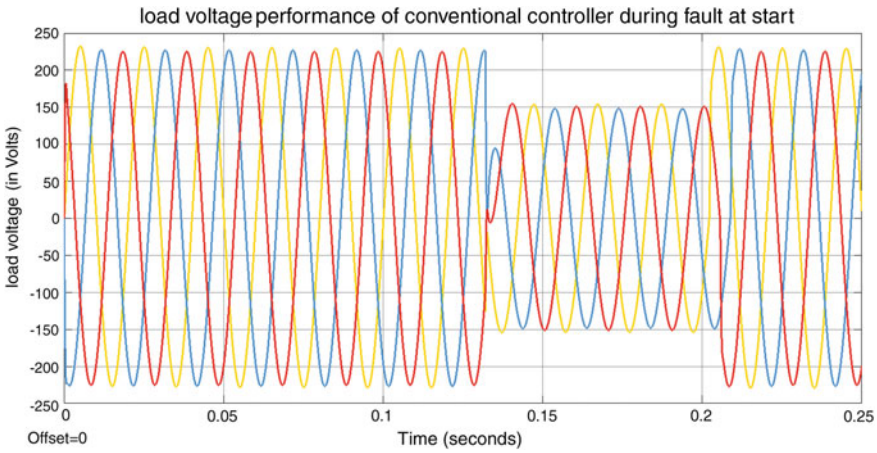


Fig. 5 Load voltage due to the conventional controller during end time

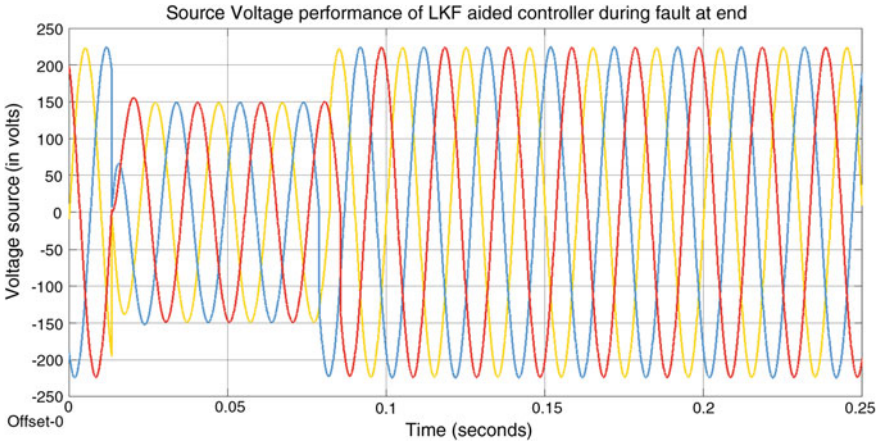


Fig. 6 Supply voltages of DVR system at start

From Table 2, it shows that during fault time source voltage is around 150 V, where the amplitude of voltage sag is 80 V. The conventional controller improves the load voltage from 150 to 165 V only by injecting 15 V. Whereas LKF-aided controller enhances the load voltage from 150 to 210 V by injecting 60 V.

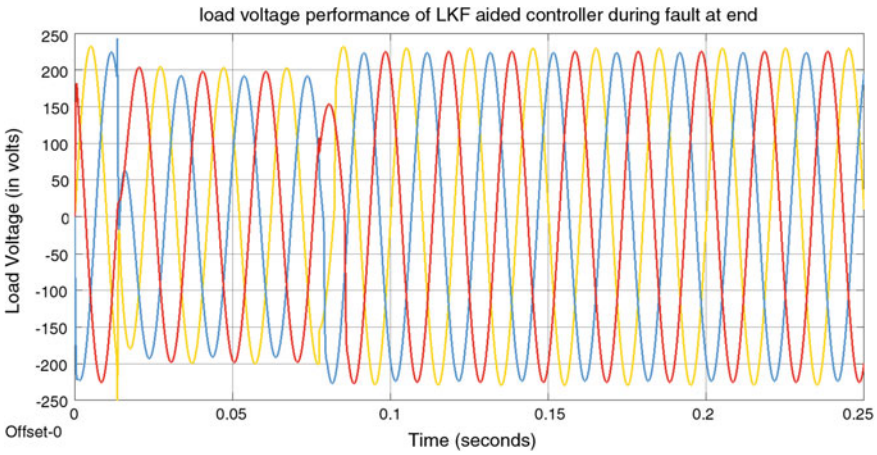


Fig. 7 Load voltages of DVR system due to the LKF at start

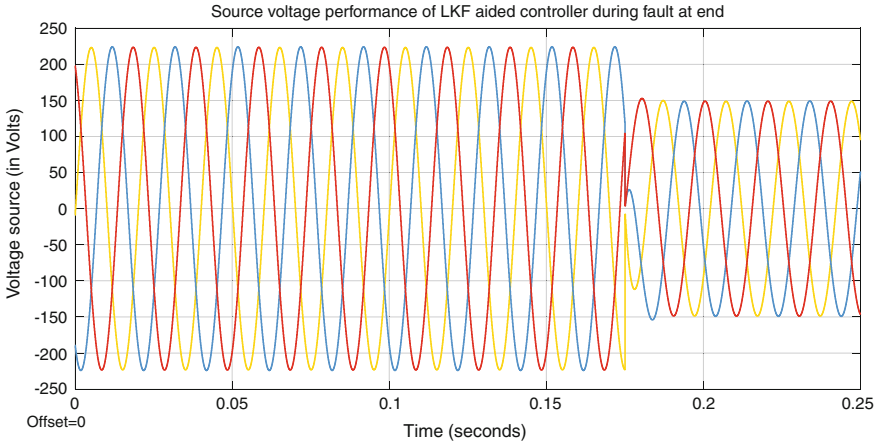


Fig. 8 Supply voltages of DVR system at end

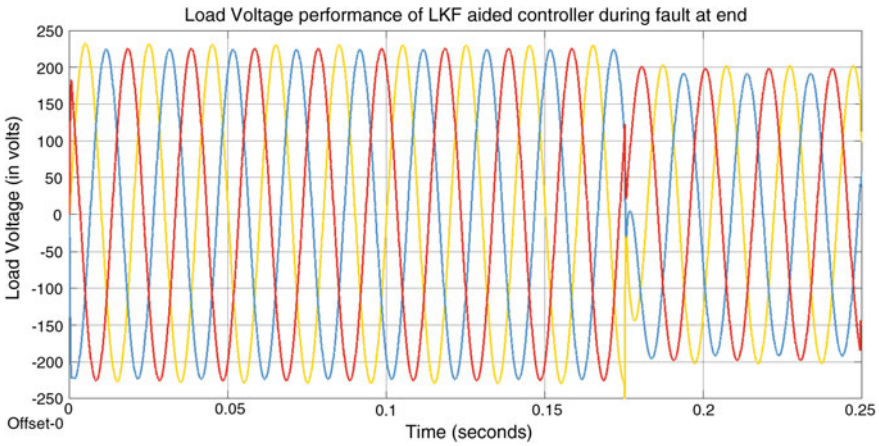


Fig. 9 Load voltages of DVR system due to the LKF at end

Table 2 The performance comparison of the controllers

S. No.	Fault time	During fault		DVR with PI controller		DVR with LKF-aided controller	
		Source voltage (V)	Sag amplitude (V)	Load voltage (V_L)	Injected voltage (V_{inj})	Load voltage (V_L)	Injected voltage (V_{inj})
1	Start	150	80	165	15	210	60
2	End	150	80	165	15	210	60

5 Conclusion

For voltage sag recompense by DVR with LKF model is exhibited in this paper. The recommended LKF-based model is engaged to facilitate the control algorithm for creating reference signals of Pulse Width Modulation. Therefore, DVR offers the compensation voltage as its output which is inserted in the power line. This activity invalidates the sag appearance. Voltage sag issues are identified definitely and quick performance is accomplished with the proposed estimation method. This kind of performance is liable for guarding the sensitivity load. The proposed estimation method is inspected in terms of supplying the basic sinusoidal waveform to the nonlinear load. The validation of the recommended estimation algorithm was executed on MATLAB platform. For ordinary and proposed controllers simulation effects are inspected. From the comparison results, the LKF controller has superior performance in compensating load voltage.

References

1. Patel D, Goswami A and Singh S, "Voltage sag mitigation in an Indian distribution system using dynamic voltage restorer", International Journal of Electrical Power & Energy Systems, Vol. 71, pp. 231–241, 2015.
2. Z Paracha, A Kalam and R Ali, "A novel approach of harmonic analysis in power distribution networks using artificial intelligence", In proceedings of International Conference on Information and Communication Technologies, pp. 157–160, 2009.
3. A Bachry, Z A Styczynski, "An Analysis of Distribution System Power Quality Problems resulting from Load Unbalance and Harmonics", In proceedings of IEEE Conference Publications, Vol. 2, pp. 763–766, 2003.
4. R. Gupta, A Ghosh and A Joshi, "Performance Comparison of VSC-Based Shunt and Series Compensators Used for Load Voltage Control in Distribution Systems", IEEE Transaction on Power Delivery, Vol. 26, No. 1, pp. 268–278, 2011.
5. G Harrison and A Wallace, "Maximizing distributed generation capacity in deregulated", In proceedings of IEEE PES Transmission and Distribution Conference and Exposition, Vol. 2, pp. 527–530, 2003.
6. C.K.Sundarabalan and K.Selvi, "Compensation of voltage disturbances using PEMFC supported Dynamic Voltage Restorer", International Journal of Electrical Power and Energy Systems, Vol.71, pp.77–92, 2015.
7. Mostafa A. Merazy, Adel A. Ahmed and Fared N. Abdel-Bar, "P-q Theory Based Shunt Active Power Conditioner for Mitigation of Power Quality Problems", The International Institute for Science, Technology and Education (IISTE), Vol 2, No 7, pp. 70–77, 2011.
8. Mario Gonzalez, Victor Cardenas and Gerardo Espinosa, "Advantages of the passivity based control in dynamic voltage restorers for power quality improvement", International Journal of Simulation Modelling Practice and Theory, Vol.47, pp.221–235, 2014.
9. K.Chandrasekaran and V.K.Ramachandaramurthy, "An improved Dynamic Voltage Restorer for power quality improvement", International Journal of Electrical Power and Energy Systems, Vol.82, pp.354–362, 2016.
10. Ahmed M.Saeed, Shady H.E.Abdel Aleem, Ahmed M.Ibrahim, Murat E.Balci and Essam E. A.El-Zahab, "Power Conditioning Using Dynamic Voltage Restorers under Different Voltage Sag Types", International Journal of Advanced Research, Vol.7, No.1, pp.95–103, 2016.

Multiband Fractal Slot Antenna with Closed Ground Structure

V. Ugendra, Habibulla Khan, B.T.P. Madhav and Ch. Joshna

Abstract This article presents a multiband slot antenna with closed ground structure and coplanar waveguide feeding. The fractal structure is attained by placing multiple slots in a particular orientation on the radiating element. The ground plane was constructed on same side of the substrate along with fractal-structured patch in closed loop orientation. The designed antenna is resonating at multiple bands, which include Wi-Fi, Wi-MAX for mobile communication systems. The antenna properties like return-loss, gain, radiation pattern and field distributions are analysed through electromagnetic simulation and measurement.

1 Introduction

Now-a-days there is a rapid growth of technologies in transmission of speeds and more in capacity broadband services for supporting (multimedia, speech, image) data communication which meets the demand of wireless communication systems. So according to the growing demand there must be an antenna which is responsible for more frequency bands. Multiband antennas can be operable in any of the systems. In many of the literatures there are many multiband antennas developed since so many years which are in advance to be achieved and involved in various

V. Ugendra (✉) · H. Khan · B.T.P. Madhav · Ch. Joshna
Deptartment of ECE, K L University, Green fields, Vaddeswaram, Guntur, AP, India
e-mail: sriyugi.yugi443@gmail.com

H. Khan
e-mail: habibullai@kluniversity.in

B.T.P. Madhav
e-mail: btpmadhav@kluniversity.in

Ch. Joshna
e-mail: joshna999ch@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_8

multiband operations [1–6]. In recent times, the advance antennas are enhanced by using the fractal approach. The name Fractal geometry was first commenced by Mandelbrot to elucidate generations of the complicated architecture those having self-resemblance or self-comparability in the geometry system. We ourselves initiated few advantages of the fractal geometry that backs the characteristic of multiband-frequency operations [7, 8]. In recent times, Sierpinski gasket monopole antenna was popularized by Puente. Here the suitable antenna uses the self-comparability equity of the fractal model to convert into its electromagnetic behaviour. Next the typical Sierpinski gasket was evolved by achieving the Pascal triangle. Even yet, more antennas having the characteristics of multiband generated through the fractal geometry. These are the antennas "Multiple Ring Monopole Antennas, Coplanar Waveguide Fed, Circular Fractal Slot Antenna, Double Square Loop Antenna". Here the paper consists of the modified fractal slot antenna fed by CPW is observed that will be operating in Wi-MAX (2.5 GHz) Worldwide Interoperability for Microwave Access, Fourth Generation (4G) mobile communication system (4.2 GHz), HIPER LAN/2 (4.6–4.8 GHz), Wi-Fi (Wireless Fidelity) [9–12]. Here proposed antenna subsists of a matching CPW fed line that is connected in between 50-CPW line. Then the modified fractal slot is applied to generate the various multiple resonant frequencies. Even yet, the proposed antenna parameters are checked by simulation using the "high frequency structural simulator (HFSS)" software. The analysis of the antenna can be performed.

2 Antenna Geometry

A coplanar waveguide fed fractal slot antenna for multiband communication system is proposed in this work. The radiating element of rectangular patch was subdivided into number of slots to form fractal geometry. The inner metallic patch length and width are fine-tuned and fed by coplanar waveguide line of thickness W_f of 50 Ω. The complete antenna dimensional characteristics are presented in Table 1 and the structure is presented in Fig. 1. Figure 1 gives the basic fractal slot antenna (*figure on left*) and figure on the right gives the modified fractal structure. The antenna prototyped on FR-4 substrate material ($\epsilon r = 4.1$) with thickness $h = 1.6$ and dielectric loss tangent 0.019.

Table 1 Parameters of the designed antenna

Parameter	Size (in mm)	Parameter	Size (in mm)	Parameter	Size (in mm)
W_{G1}	53.37	L_{G3}	39.75	L_f	14.50
W_{G2}	38.54	W_S	32.57	S_U	16.050
L_{G1}	75.20	W_t	0.94	S	4.751
L_{G2}	34.07	L_t	21.33	S_L	16.050

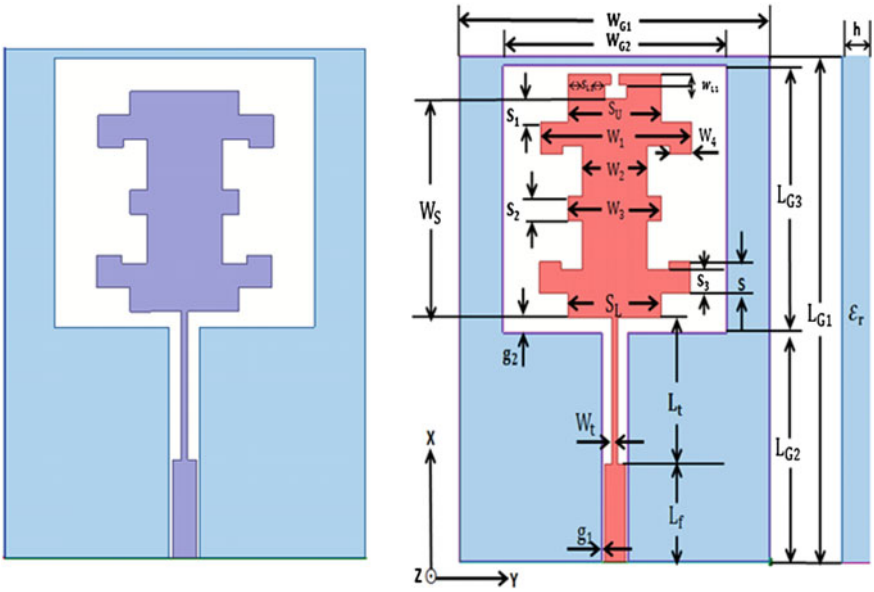


Fig. 1 Basic fractal slot antenna (*figure on left*) and modified fractal structure (*figure on the right*)

3 Antenna Parameters

The width of the patch is affecting the initial altitude of the generator. The width of the patch is smaller than one-third of the width of the substrate. The iteration factor can be calculated as follows:

$$\eta = (Wp * 3)/Ws, \quad \text{where } 0 < \eta < 1 \tag{1}$$

The approximated value of iteration factor of η is 0.66 to produce fractal slot. The dimensional characteristics of the proposed antenna are presented in Table 1.

4 Results and Analysis

This section provides the information regarding design and simulation of the proposed antenna model and its validation through measurement results. Initially a basic fractal slot antenna was designed and its performance characteristics are noted. The modified slot fractal antenna which can cover multiple bands is designed, and its analysis is presented in this section. The reflection coefficient of the proposed antenna is presented in Fig. 2. It has been observed that antenna is resonating seven bands in the range of 2–16 GHz.

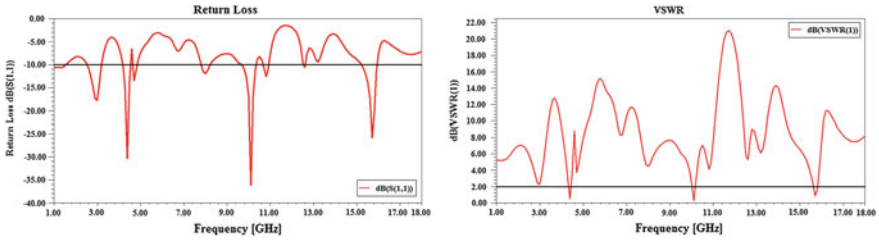


Fig. 2 Reflection coefficient of the proposed antenna (*figure on the left*) the voltage standing wave ratio for antenna (*figure on the right*)

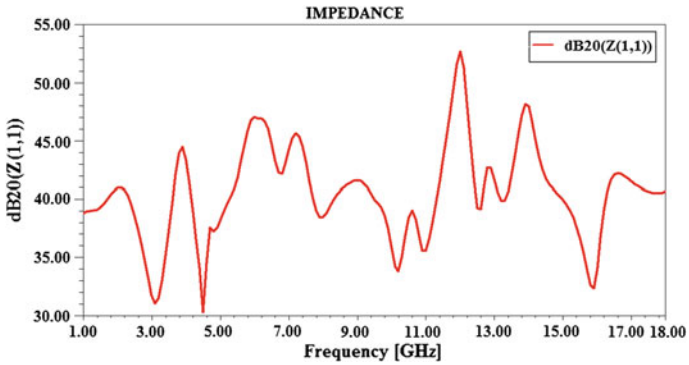


Fig. 3 Impedance characteristics of designed antenna

The fundamental resonant frequency is at 3 GHz with bandwidth of 0.8 GHz. The second resonant frequency is at 4.5 GHz with bandwidth of 0.5 GHz. The third resonant frequency is at 5 GHz with bandwidth of 0.3 GHz. The fourth resonant frequency is at 8 GHz with bandwidth of 0.4 GHz. The fifth resonant frequency is at 10 GHz with bandwidth of 0.7 GHz. The sixth resonant frequency is at 11 GHz with bandwidth of 0.2 GHz. The seventh resonant frequency is at 16 GHz with bandwidth of 0.9 GHz. The voltage standing wave ratio for the proposed antenna is presented in Fig. 2. The VSWR curve shows that the antenna is resonating at Quad-band instead of seven bands. A VSWR value of less than two is maintained at four operating bands 3, 4.5, 10 and 16 GHz, respectively. An impedance of 50 Ω SMI connector is used for impedance matching in this design; Fig. 3 shows the impedance characteristics of designed antenna with respect to operating bands. An average impedance of 45 Ω is maintained by the designed antenna in the simulation characteristics.

To optimize the proposed antenna before fabrication, the slot dimensions in fractal geometry are analysed through parametric analysis in HFSS and the corresponding results are presented in Figs. 4, 5, 6 and 7.

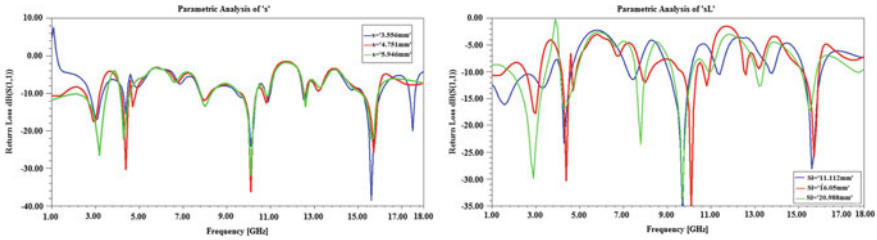


Fig. 4 Parametric analysis of 'S' (*figure on the left*) parametric analysis of 'S_L' (*figure on the right*)

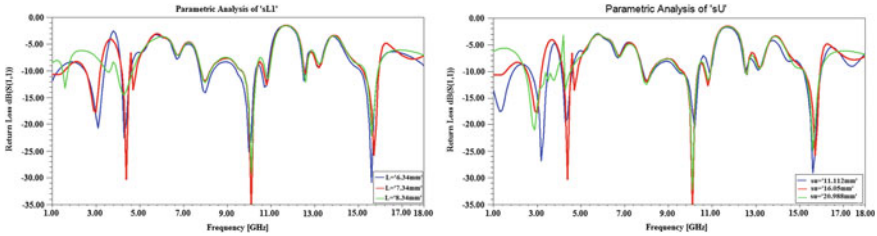


Fig. 5 Parametric analysis of 'S_{L1}' (*figure on the left*) parametric analysis of 'S_U' (*figure on the right*)

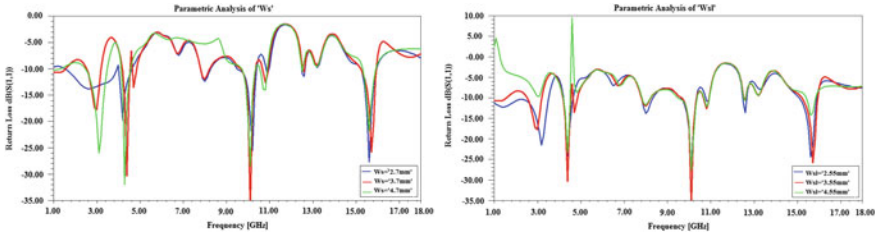


Fig. 6 Parametric analysis of 'W_S' (*figure on the left*) parametric analysis of 'W_{S1}' (*figure on the right*)

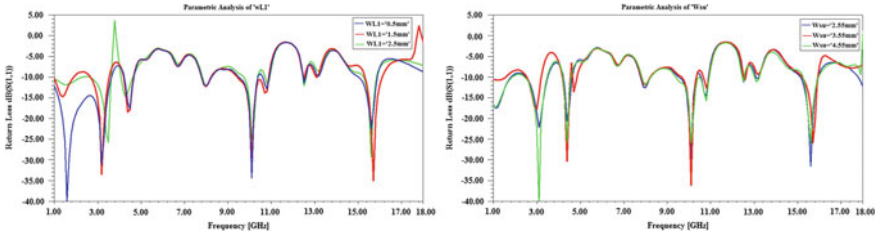


Fig. 7 Parametric analysis of 'W_{L1}' (*figure on the left*) parametric analysis of 'W_{SU}' (*figure on the right*)

5 Parametric Analysis

There is a significant difference observed with change in and parameters from obtained results. The dimensions of the final model are fixed on the basis of the parametric analysis results of HFSS.

The gain characteristics of multiband antenna with respect to its operating frequencies are shown in Fig. 8. A peak realized gain of 26 dB is obtained at 4.5 GHz and an average gain of 4 dB is attained from the gain characteristics curve.

The three-dimensional and two-dimensional gain characteristic curves are shown in Figs. 9 and 10, respectively, at different operating bands. At all these operating bands the proposed antenna is working with good impedance bandwidth.

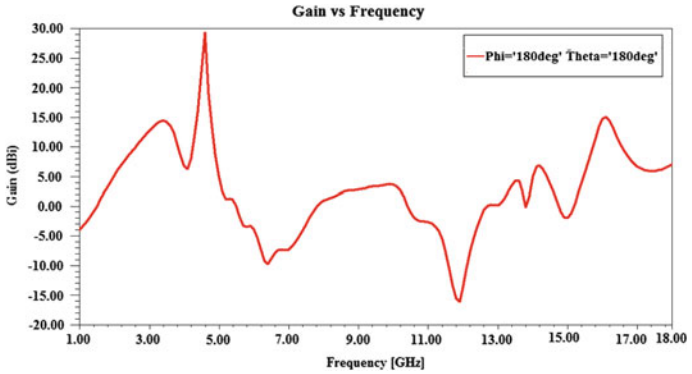


Fig. 8 Gain characteristics versus operating frequency

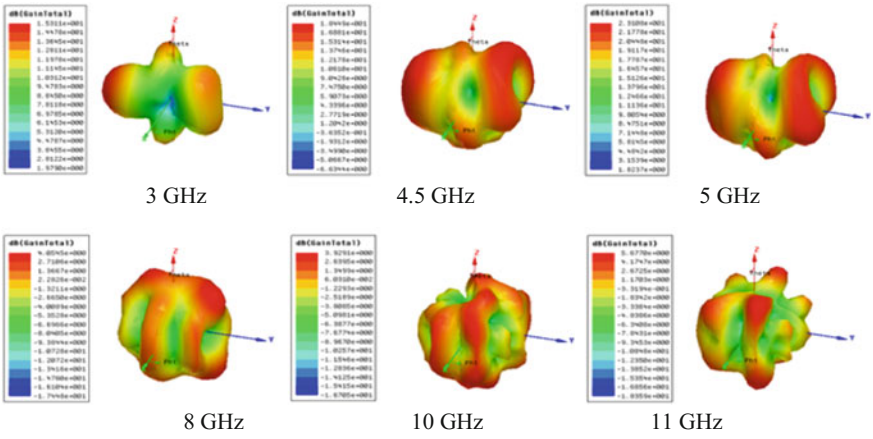


Fig. 9 Simulated 3D Gain characteristics at different operating bands

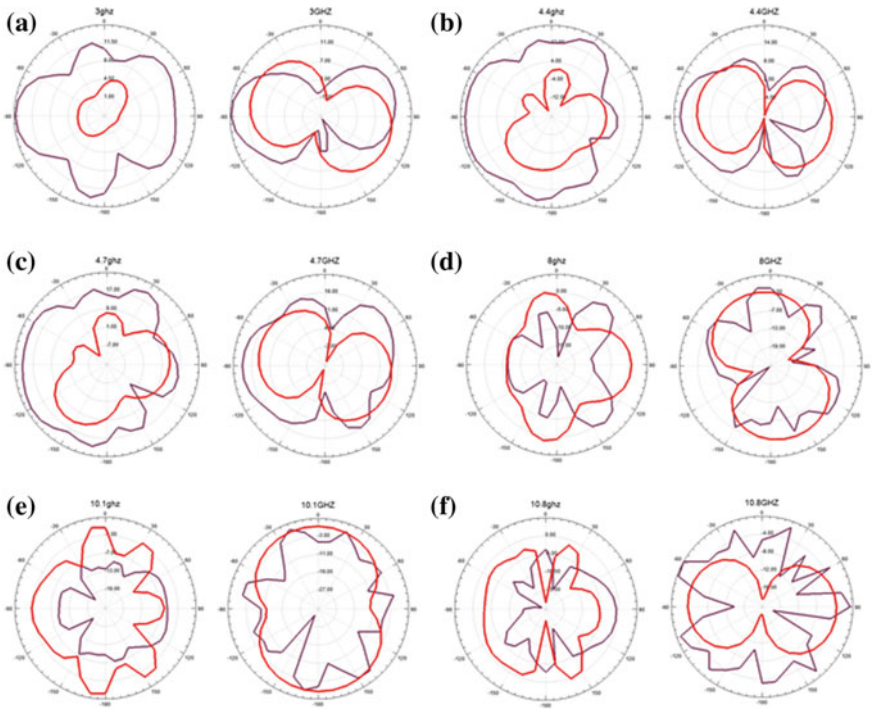


Fig. 10 Measured radiation patterns at **a** 3 GHz, **b** 4.5 GHz, **c** 5 GHz, **d** 8 GHz, **e** 10 GHz, **f** 11 GHz

The surface current distribution is also presented in Fig. 11 at different operating bands. The orientation of current direction will determine the corresponding resonant mode and its radiation mechanism (Fig. 12).

6 Conclusion

In this paper a fractal slot antenna is been designed and the complete analysis is demonstrated. The parametric analysis with respect to fractal slot elements is carried to improve the impedance bandwidth at various multiband communication applications. At multiple resonant bands the proposed antenna is having communication applications like Wi-Fi, Wi-MAX, etc. At each operating band the radiation patterns and current distributions are analysed and presented in this work.

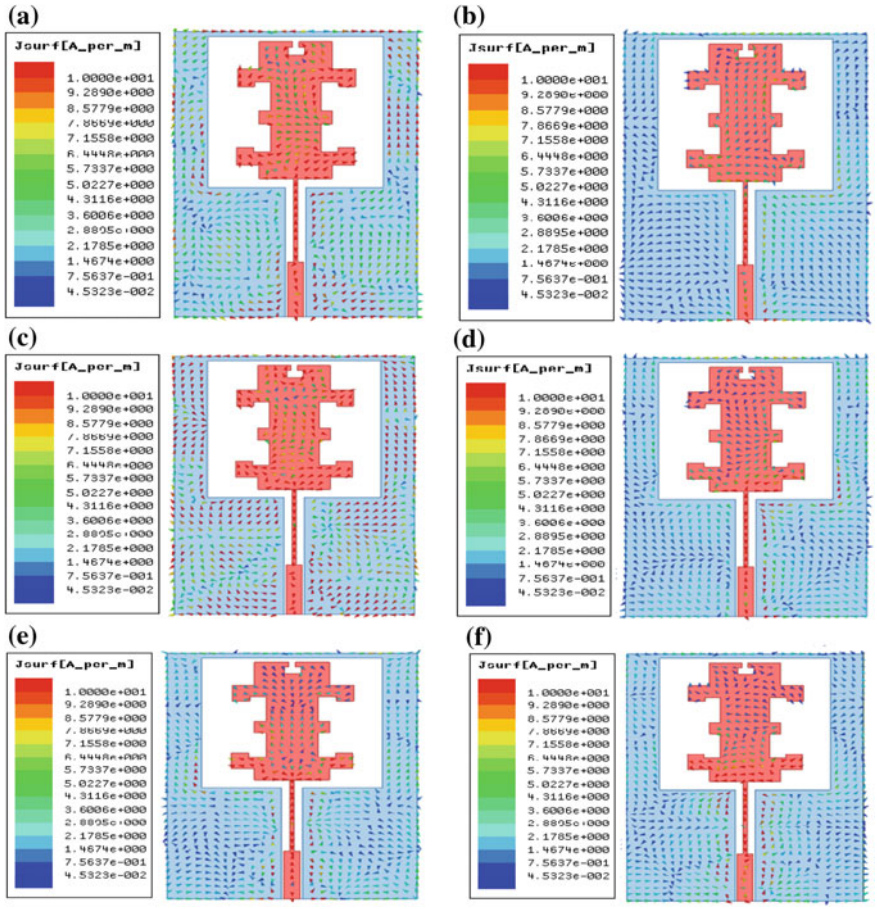


Fig. 11 Surface current distributions at 3, 4.5, 5, 8, 10, 11 GHz

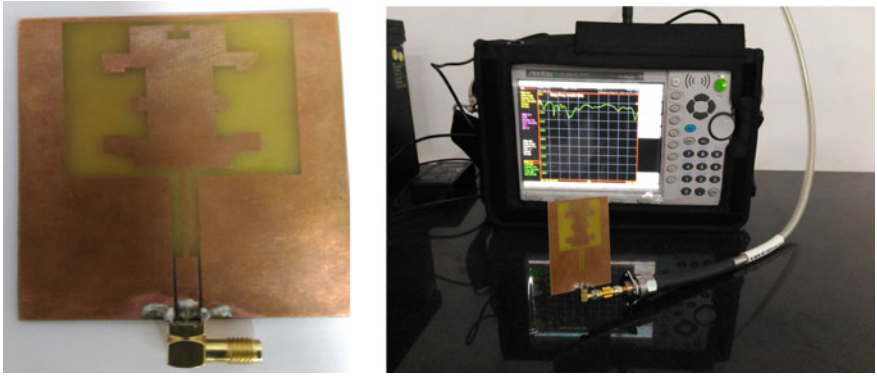


Fig. 12 Prototyped antenna on FR4 substrate and measured S11 on Anritsu MS2037C

Acknowledgements Authors like to say their sincere thanks to department of ECE of KLU for the support and encouragement during this work. Further, authors like to express their gratitude to DST through their grant ECR/2016/000569/and SR/FST/ETI-316/2012.

References

1. Werner, D. H., Ganguly, S.: An Overview of Fractal Antenna Engineering Research. IEEE Antennas Prop. Mag. 45(1), 38–57 (2003).
2. G. Srivatsun, S. Subha Rani.: A Compact wideband fractal cantor antenna for wireless applications. Int. J Electron. Commun. (AEÜ). 65, 719–723 (2011).
3. Cohen, N.: Fractal Antenna Applications in wireless Telecommunications. In: Professional Program Proceedings, pp. 43–9. Electronic Industries Forum Of New England, May 1997.
4. T V Rama Krishna, B T P Madhav, T Sri Rama Krishna, K. Sravanthi, G Dinesh Gopi.: Strip Loaded Closed Loop Resonator Based Multiband Defected Ground Structured Antenna. J. of Engineering and Applied Sciences. 11(6), 1417–1422 (2016).
5. Li, Y.-S., Yang, X.-D., C.-Y. Liu, Jiang, T.: Analysis and investigation of a cantor set fractal UWB antenna with a notch-band characteristic. Prog. Electromagn. Res. B. 33, 99–114 (2011).
6. Lin Y. C., Hung K. J.: Compact ultra-wideband rectangular aperture antenna and band-notched designs. IEEE Trans. Antennas. Propag. 54(11), 3075–3081 (2006).
7. Anguera, J., Martínez-Ortigosa, E., Puente, C., Borja, C., Solar, J.: Broadband triple-frequency micro strip patch radiator combining a dual-band modified sierpinski fractal and a mono band antenna. IEEE Trans. Antennas. Propag. 54(11), 3367–3373 (2006).
8. B. T. P. Madhav, M. Manjeera, M. S. Navya, D. Sharada Devi, V. Sumanth.: Novel Metamaterial Loaded Multiband Patch Antenna. Indian J. of Science and Technology. 9(37), 1–9 (2016).
9. K V L Bhavani, Habibulla Khan, B T P Madhav.: Multiband Slotted Aperture Antenna With Defected Ground Structure For C And X-Band Communication Applications. J. of Theoretical and Applied Information Technology. 82(3), 454–461 (2015).
10. Islam MT, et al.: Triple band-notched planar UWB antenna using parasitic strips. Prog. Electromagn. Res. 129, 161–179 (2012).
11. D S Ram Kiran, B T P Madhav.: Novel compact asymmetrical fractal aperture Notch band antenna. Leonardo Electronic Journal of Practices and Technologies. 27(2), 1–12 (2015).
12. G. V. Krishna, B. T. P. Madhav.: Bandwidth Enhanced Antipodal Vivaldi Antenna for Wide Band Communication Applications. Indian J. of Science and Technology. 9(31), 1–6 (2016).

Frequency-Selective Surface-Based Wideband High-Gain Antenna

Ch. Joshna, T.V. Ramakrishna, B.T.P. Madhav and V. Ugendra

Abstract This article narrates the design and development of a wideband antenna on FSS structure to improve the gain characteristics. The modeled antenna is using the coplanar waveguide feeding with defected ground in the basic structure. Rectangular slots on the radiating structure as well as 'U'-shaped slot on the feed line are converting this model as a notch-band antenna to block certain microwave bands in the operating frequency. The basic structure which is suffering with low gain is enhanced with a special structure of FSS beneath the antenna. The proposed model is providing a peak-realized gain of 9.6 dB and directivity of almost 10 dB. The modeling of the proposed antenna with FSS is carried through simulation and real-time measurement in this work. The detailed analysis which is carried in this work has been presented in these subsequent sections.

1 Introduction

In ultra wideband communication (UWB) there is always an increasing demand for high gain and desired bandwidth. The federal communication commission (FCC) stated an unlicensed RF band, i.e., 3.1–10.6 GHz for communication operations [1, 2]. To work in desired band of operation several researchers suggested different innovative designs of microstrip antennas. UWB communication main disadvantage is gain in the design of wideband antennas [3–5]. Gain of

Ch. Joshna (✉) · T.V. Ramakrishna · B.T.P. Madhav · V. Ugendra
Department of ECE, K L University, Green Fields, Vaddeswaram, Guntur, AP, India
e-mail: joshna999ch@gmail.com

T.V. Ramakrishna
e-mail: tottempudi@kluniversity.in

B.T.P. Madhav
e-mail: btpmadhav@kluniversity.in

V. Ugendra
e-mail: sriyugi.yugi443@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_9

the basic antenna designed is low and we have to increase it. By making this as main objective, we suggested two different structures of FSS which can get high gain with considerable bandwidth. In this paper, "Frequency-Selective Surface-Based Wideband High-Gain Antenna" basic design exhibiting wide bandwidth of 8.62 GHz between the frequency ranges (2.84–11.4 GHz) but low gain and no notching occurs at selected frequencies, so to obtain the notch characteristics at dual bands a modified design, i.e., "U"-shaped slot is introduced and two models of FSS layer designed are added to increase the gain [6–9]. Frequency-selective surface acts as a reflector and produces phase reflection over wideband and improvement in matching of impedance. FSS is a 2D frequency filter exhibiting reflection and transmission properties that can be engineered to exhibit band-pass, band-stop, low pass, (or) high pass characteristics depending on design [10–12]. The FSS layer is a square loop printed on vacuum-type material is placed under FR 4 substrate which is of thickness h = 1.6 mm, dielectric constant of 4.4 loss tangent of 0.02 which acts as a reflector [13, 14].

In this paper, a Novel wideband antenna is designed with FEM-based ANSYS HFSS tool. The basic wideband antenna is turned into slotted antenna by incorporating slots in the antenna structure. To improve the overall gain, two types of FSS structures are been proposed and implemented in the model. A low pass filter-based FSS and HP filter-based FSS are examined in this work to analyze the gain characteristics of the designed antenna model.

2 Antenna Design and Analysis

High pass filter passes signals which are of high frequency and attenuates the low frequency signals. High frequency signals refer to signals higher than cutoff and low frequency signals refer to signals lower than cutoff. High pass filter is designed as linear time invariant filter. It is used to block DC from circuitry-sensitive devices to nonzero average voltages or RF devices. The cutoff frequency is given by f_c. Low pass filter passes signals which are lower than cutoff frequency and attenuates the signals higher the cutoff frequency. Low pass filter exists in electronic circuits like, hiss filter used in audio, anti-aliasing filters (Figs 1, 2, and 3).

$$f_c = 1/2\pi RC. \tag{1}$$

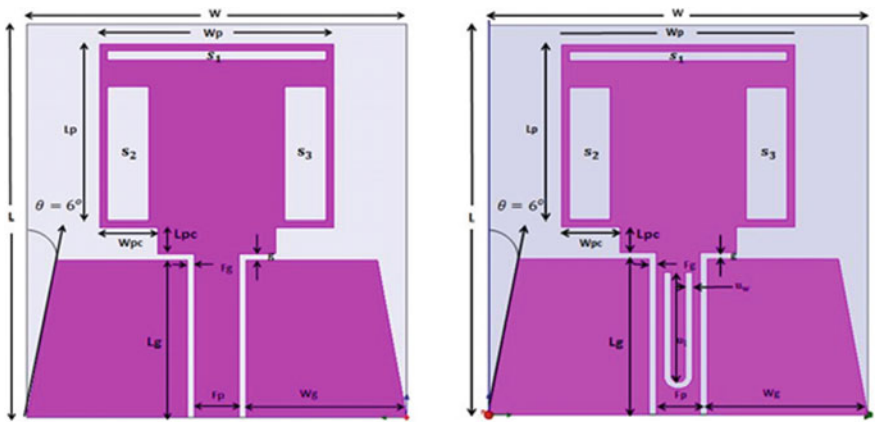


Fig. 1 Slots-loaded wideband antenna (*figure on left*) and U-slot-loaded wideband antenna (*figure on the right*)

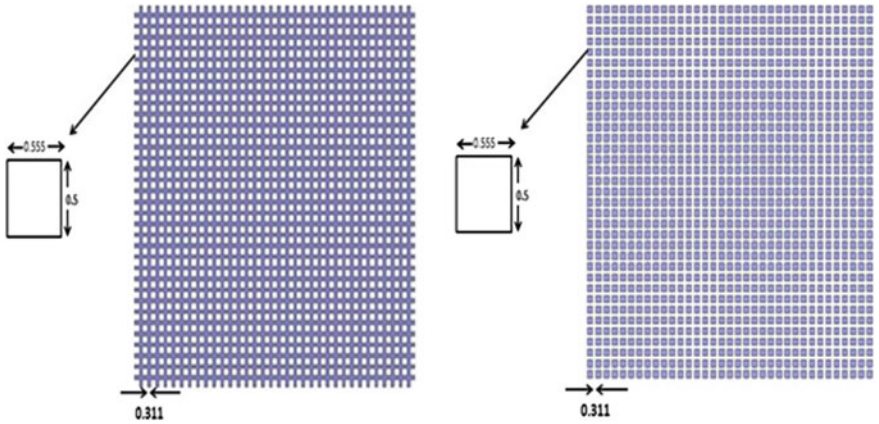


Fig. 2 High pass filter (*figure on left*) and low pass filter (*figure on the right*)

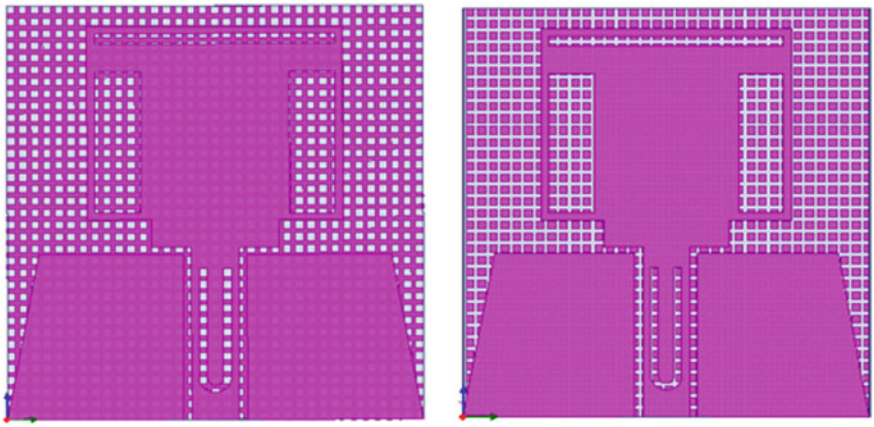


Fig. 3 Wideband antenna with high pass filter-based FSS (*figure on left*) and wideband antenna with low pass filter-based FSS (*figure on the right*)

Table 1 Dimensions of antenna designed

Parameter	Size (in mm)	Parameter	Size (in mm)	Parameter	Size (in mm)
W	26	U_1	8	S_{W1}	3
L	30	U_W	0.5	S_{L1}	0.75
W_p	16	F_p	3	S_{W2}	2.85
L_p	16	F_g	0.5	S_{L2}	10.25
W_g	11	W_{PC}	4	S_{W3}	2.85
L_g	12.5	L_{PC}	2	S_{L3}	10.25

3 Antenna Parameters

The dimensions of the antenna are presented in Table 1. The overall dimension of the antenna is around 26 × 30 × 1.6 mm^3. The length of the slots 'L' at center frequency of notch band is calculated.

$$L = c/2f\sqrt{(\in_r + 1)/2}. \tag{2}$$

4 Results and Discussion

In order to verify the antenna-working condition of the designed frequency, the antenna reflection coefficient will provide the solution. Figure 7 shows the designed antenna models reflection coefficient characteristics w.r.t operating frequency. The basic slotted antenna is providing a wide bandwidth of more than 8 GHz between 3

and 11 GHz operating band. The basic model is covering the ultra-wideband and also providing the additional bandwidth of 1 GHz in the operating band. The modified design with 'U'-slot structure is providing the lower bandwidth when compared with initial design. The modified structure is providing notch-band characteristics at lower half and at middle of the operating band as shown in Fig. 4.

Figure 5 shows the impedance characteristics of the designed antennas w.r.t operating frequency are provided. The impedance results are not stable in the operating band and they are fluctuating between 30 and 45 Ω (ideal case of 50 Ω).

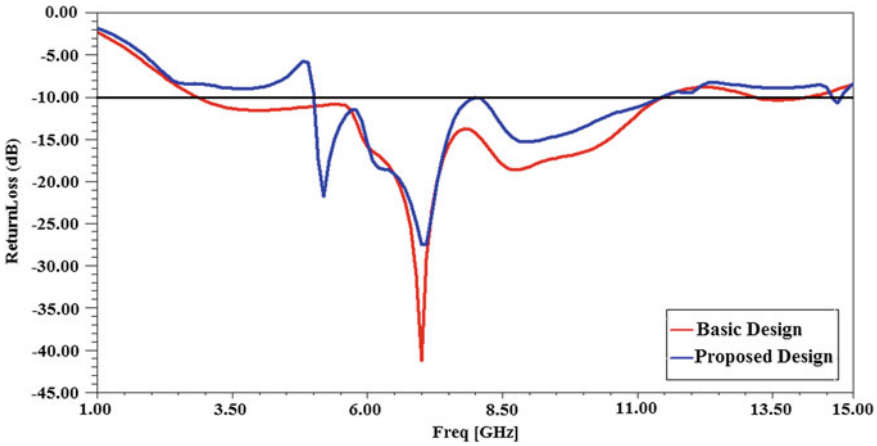


Fig. 4 Reflection coefficient of basic and proposed design

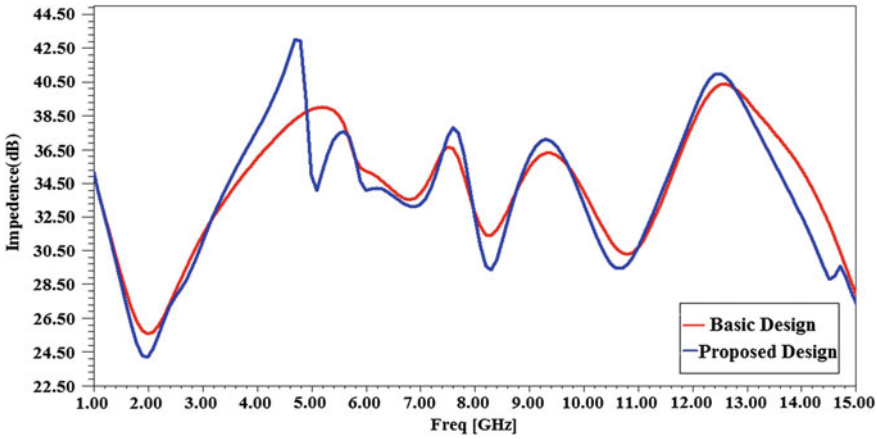


Fig. 5 Impedance of basic and proposed design

5 Parametric Analysis

The designed antenna's performance characteristics are fine-tuned with parametric analysis. Figures 6 and 7 show the parametric analysis of dimensional characteristics on the designed antenna models. The parameters like *L*1, *L*2, *L*3, *W*1, *W*2, and *W*3 are analyzed through parametric analysis in HFSS tool and the optimized dimensions are utilized in the prototyping of the antenna.

The optimized dimensions are determined after taking the parametric analysis into consideration. The dimensions like *L*1, *L*2, and *L*3 are showing significant impact on the performance of the antenna and that can be observed from Figs. 9 and 10. The width parameters *W*1, *W*2, and *W*3 are not having considerable impact on the resonant frequencies in the near range.

An experimental verification is carried in this work by placing frequency-selective surface beneath the antenna structure. The corresponding result w.r.t HPF-based FSS and LPF-based FSS are presented in Fig. 8.

From obtained results, we observed that HPF-based FSS structure is providing better gain characteristics of peak-realized gain 9.6 dB when compare with LPF-based FSS peak-realized gain 5.9 dB. After analyzing the gain characteristics, we came to a conclusion that HPF-based FSS is constructed with slots in the structure whereas LPF-based FSS is constructed with strips in the structure.

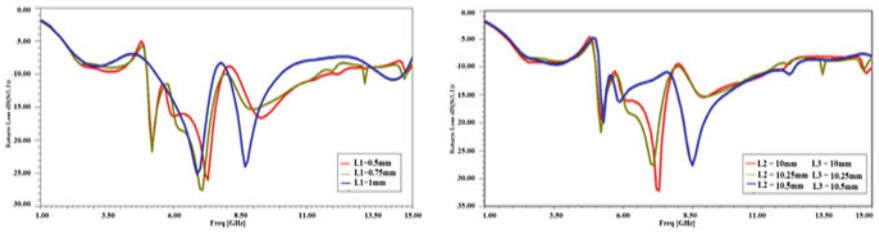


Fig. 6 Parametric analysis with respect to *L*1 (*figure on the left*) parametric analysis with respect to *L*2 and *L*3 (*figure on the right*)

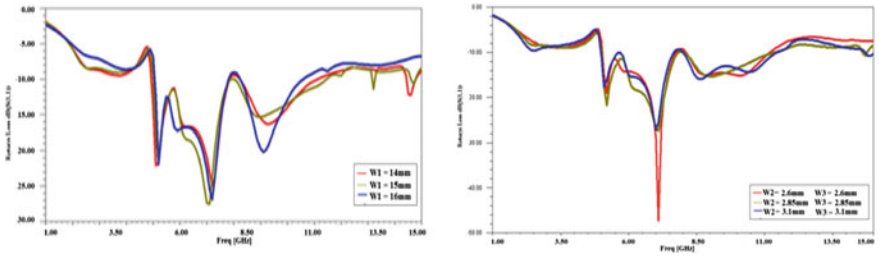


Fig. 7 Parametric analysis with respect to *W*1 (*figure on the left*) parametric analysis with respect to *W*2 and *W*3 (*figure on the right*)

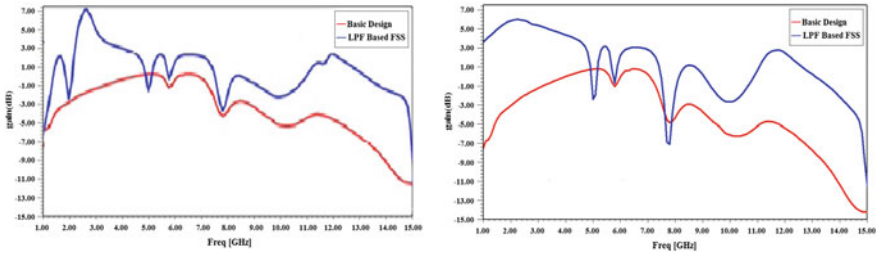


Fig. 8 Gain versus frequency of HPF-based FSS (*figure on the left*) and LPF-based FSS (*figure on the right*)

The structural variation in the reflector is providing the variation in the Gain characteristics. The slots which are incorporated in the HPF-based FSS are giving rise to additional resonant modes, and which may in turn is providing better reflection of back lobes to push them toward the other side. The strips that are incorporated in LPF-based FSS are providing better reflection characteristics to improve the main lobe radiation.

The radiation efficiency of the designed antenna models with respect to operating band is provided in Fig. 9. The basic model is providing an efficiency of more than 90% over the operating band whereas the other notch-band models are providing little bit less when compared with basic antenna structure. The notch-band models are showing poor radiation efficiency at corresponding notch bands and efficiency more than 80% at other operating bands. The radiation characteristics of notch-bands models with FSS structures in polar coordinates are provided in Figs. 10 and 11.

By incorporating FSS in the structure is giving rise to distributed current elements movement on the radiating structure of the notch-band antenna model are shown in Figs. 12 and 13.

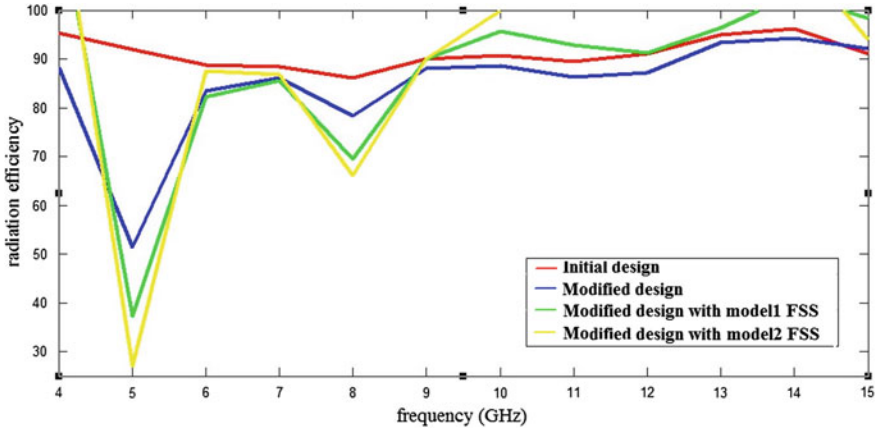


Fig. 9 Radiation efficiency versus frequency characteristics

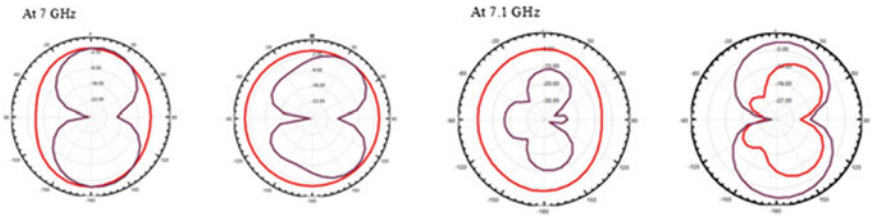


Fig. 10 Radiation pattern for slot-loaded wideband antenna (*figure on the left*) radiation pattern for U-slot-loaded wideband antenna (*figure on the right*)

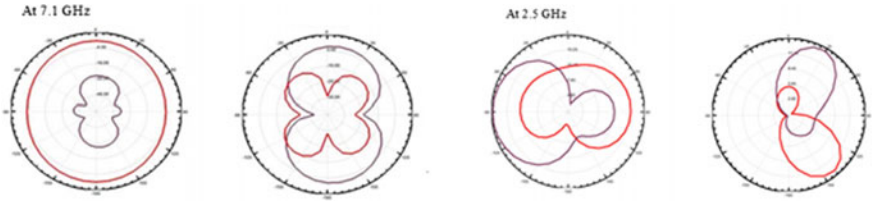


Fig. 11 Radiation pattern of HPF-based FSS (*figure on the left*) radiation pattern of LPF-based FSS (*figure on the right*)

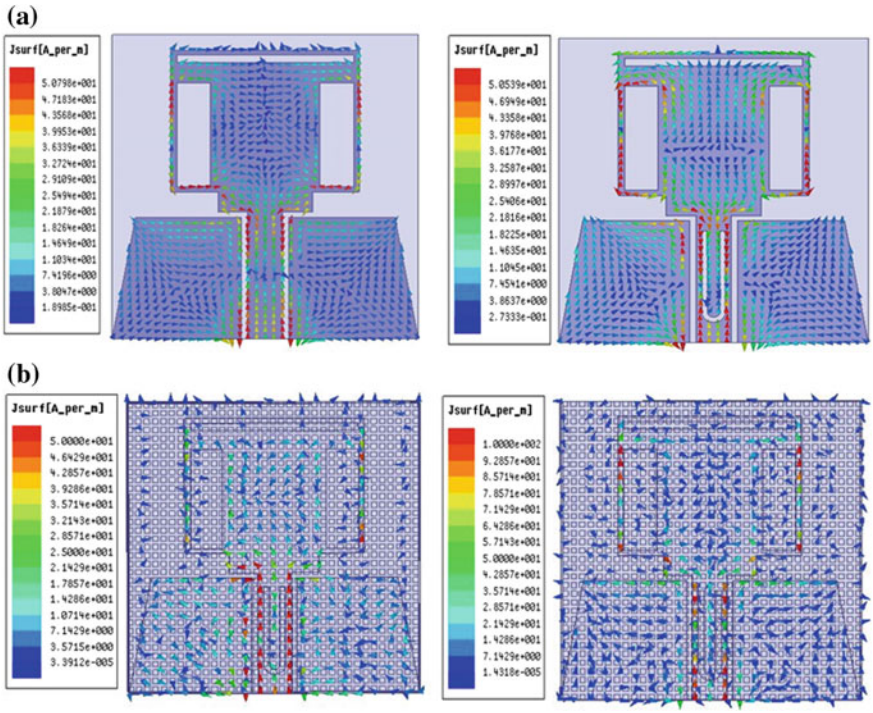


Fig. 12 Current distribution characteristics of designed models at **a** 7 GHz **b** 2.5 GHz

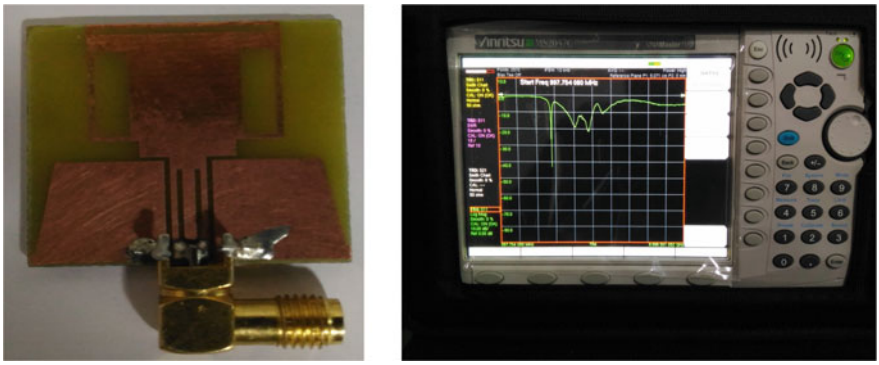


Fig. 13 Prototyped antenna on FR4 substrate and measured S11 on Anritsu MS2037C VNA

6 Conclusion

Frequency-Selective Surface-based notch-band antenna models are designed and analyzed in this paper. Two types of FSS structure are incorporated in the antenna model to improve gain of 9.6 dB from HPF-based FSS and peak-realized Gain of 5.9 dB from LPF-based FSS are obtained from current study. The slots which are incorporated in HPF-based FSS are giving rise to additional resonant modes, and which may in turn is providing better reflection of back lobes to push toward the other sides. The strips are incorporated in LPF-based FSS are not providing better reflection characteristics to improve the main lobe radiation. The measured results on VNA are in good agreement with simulation of HFSS.

Acknowledgements Authors like to say their sincere thanks to department of ECE of KLU for the support and encouragement during this work. Further authors like to express their gratitude to DST through their grant ECR/2016/000569/and SR/FST/ETI-316/2012.

References

1. Liang, J., C. C. Chiau, X. Chen, C. G. Parini.: Study of a printed circular disc monopole antenna for UWB systems. IEEE Trans. Antennas. Propag. 53(11), 3500–3504 (2005).
2. Soheilifar, M. R., Sadeghzadeh, R. A.: Design, fabrication and characterization of stacked layers planar broad band material absorber at microwave frequency. Int. J Electron. Commun. (AEÜ). 69, 126–32 (2015).
3. V. Sai Krishna, P. Pardhasaradhi, B. T. P. Madhav.: High Bandwidth Circularly Polarized X-Slot Antenna. Far East Journal of Electronics and Communications. 16(3), 561–572 (2016).
4. Lin, H.-N., K.-W. Lin, and S.-C. Chen.: Use of frequency selective surfaces to prevent SAR and improve antenna performance of cellular phones. Far East Journal of Electronics and Communications. In: PIERS Proceedings, pp. 214–218. Suzhou, China (2011).

5. Pirhadi, A., H. Bahrami, J. Nasri.: Wideband high directive aperture coupled micro strip antenna design by using a FSS superstrate layer. IEEE Trans. Antennas. Propag. 60(4), 2101–2106 (2012).
6. T V Rama Krishna, B T P Madhav, G Monica, V Janakiram, S Md Abid Basha.: Microstrip Line Fed Leaky Wave Antenna with Shorting Vias for Wideband Systems. Int. J. Electrical and Computer Engineering (IJECE). 6(4), 1725–1731 (2016).
7. Chen H-Y, Tao Y.: Bandwidth enhancement of a U-slot patch antenna using dual-band frequency-selective surface with double rectangular ring elements. Microw. Opt. Technol. Lett. 53(7), 1547–1553 (2011).
8. Qu S-W, Li JL, Xue Q.: A band-notched ultra wide band printed monopole antenna. IEEE Antenn. Wireless Propag. Lett. 5(1), 495–498 (2006).
9. Wang J. W., Pan, J. Y., Na Ma, X., Sun, Y. Q.: A band-notched UWB antenna with L-shaped slots and open-loop resonator. In: IEEE International Conference on Applied Superconductivity and Electromagnetic Devices, pp. 312–315. IEEE Press, New York (2013).
10. Asa Jyothi, B. T. P. Madhav, M. Deepthi, C. Sindhoora, V. Jayanth.: A Novel Compact CPW-Fed Polarization Diversity Dual Band Antenna using H-Shaped Slots. Indian J. of Science and Technology. 9(37), 1–8 (2016).
11. K. Phanisrinivas, Habibulla Khan, B. T. P. Madhav.: Multiband MSP Spiral Slot Antenna with Defected Ground Structure. ARPN Journal of Engineering and Applied Sciences. 11(15), 9461–9470 (2016).
12. Ranga, Y, Matekovits, L., Weily, A. R., Esselle, K. P.: A constant gain ultra-wideband antenna with a multi-layer frequency selective surface. Prog. Electromagn. Res. Lett. 38, 119–25 (2013).
13. B. T. P. Madhav, A. V. Chaitanya, R. Jayaprada, M. Pavani.: Circular Monopole Slotted Antenna with FSS for High Gain Applications. ARPN Journal of Engineering and Applied Sciences. 11(15), 1–7 (2016).
14. Chen, Q., Zheng, H.-L., Quan, T., Li, X.: Broadband CPW-fed circularly polarized antenna with equiangular tapered-shaped feedline for ultra-wideband applications. Prog. Electromagn. Res. C. 26, 83–95 (2012).

Evaluating the Progressive Performance of Machine Learning Techniques on E-commerce Data

Bindu Madhuri Cheekati and Sai Varun Padala

Abstract The web in current years has been a big tendency, which helps researchers to make it a source of information and essential in the various fields of a commercial area that represents the e-commerce. Machine learning, a branch of artificial intelligence, plays a vital role in creating a great experience at e-commerce companies. Machine learning techniques follow different efficient ways to extract knowledge from huge amount of data. A reliable products analysis of the performance of any e-commerce company is critical. However, due to its various global infrastructures, many likely products get grouped in a different way. So, the analysis of quality of product always depends on the accuracy of the products classification. The better the classification, the more insights can be generating good category of products. Classification is a fundamental problem in machine learning. The main motto of this study is to compare the performance analysis (basis of accuracy). Different machine learning (supervised) methods are used to classify the products. In this paper we compare different machine learning techniques (Nonlinear and rule-based) to classify the products. These approaches have been tested with data from the Kaggle Otto Group Product Classification dataset. The performances of algorithms are measured in two cases, i.e., dataset before feature selection (before preprocessing) and dataset set after feature selection (after preprocessing) and compared in terms of accuracy. The experimental result shows that the overall performance of nonlinear machine learning (KNN) techniques is better than rule-based (C5.0) techniques. The result shows that among the individual classifiers implemented, *k*-nearest neighbor is having highest accuracy of around 88%. An extensive study is given to explain the efficiency of different classifiers.

B.M. Cheekati (✉) · S.V. Padala (✉)
Jntuk-Ucev, Vizianagaram, Andhra Pradesh, India
e-mail: chbmadhuri.it@jntukucev.ac.in

S.V. Padala
e-mail: saivarun.padala@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_10

1 Introduction

Nowadays, there is an enormous demand for data analysts in the market segments like e-commerce. As day by day the big companies are becoming larger and inventive tech startups are cropping up. So, if they want to cope up with the competition, they need to expand its effective utilization of potential machine learning applications in e-commerce business spectrum. Machine learning always looks to build an efficient computational system with trained data. The classification models are used to categorizing samples into exactly one category without any uncertainty.

A variety of machine learners (Nonlinear and rule-based) were tested in the extraction of the correlations between the predictors/independent variables from the Kaggle Otto Group Product Classification dataset. The fitted models were used to classify the products accurately. While making the effective or crucial decisions (i.e. in decision-making task), the classification plays most challenging problem. In classification process, a set of records (training set) given, where each record consisting of several predictors/attributes. The predictors are either continues or categorical in nature. One of the features called the classifying feature (dependent variable), which indicates the class to which each record belongs to.

The main aim of this paper is to present an extensive study to show the effectiveness of different classifiers on e-commerce data. Classification is a fundamental problem in machine learning context. In this paper, we describe the product classification problem on Otto Group, the biggest e-commerce company in the world. The Otto Group product classification problem is considered as the medium-scale classification problem because it requires classifying lakhs of product descriptions into different product types (like fashion, electronics, etc.) over an extensive period of time.

For example, consider the product type “electronics”, which revolves to have various subtypes. A domain analyst would need to spend hours searching the Web to understand the different subtypes, in order to classify the sample for electronics (that contains examples of all subtypes). The same goes for “fashions”. Such problematic types are quite common at the scale of 90+ product types, thus making it extremely time-consuming to classify the products accurately. We would like to use different machine learning techniques to classify product categories (e.g., ‘electronics’) and its potential subcategories (e.g., ‘Printers’). This study is very useful for the case where a list of new products is added and they want to automatically classify these products based on training data. The experimental analysis evaluates and compares seven different machine learners as classification algorithms for classifying the products.

1.1 Related Work

Most of the real-world problems like predicting cancer, biological science [1], credit scoring, bankruptcy prediction, quality control, handwritten character recognition, speech recognition, stock market analysis [2], industry and medicine [3], etc. can be treated as machine learning (supervised) problems. There are many researchers working on a number of classification methods like KNN, Naïve Bayes, and SVM [4–9], developed by statistics, neural networks, and machine learning researchers. The alternative classification method for different conventional classification models is neural classification [9] methods like ANN and FLANN.

Classification techniques are treated as an elementary problem in machine learning domain and data management domain [10, 11]; a variety of learning-based text classification techniques [12], such as KNN [13] and Naive Bayes [14, 15], has been proven very effective for classification. For a large number of product types (large-scale problems), not only the learning-based models but also rules are used to perform effective classification. A collection of "if … then …" rules is used to determine the categories of products in rule-based classifier [16]. In recent research activities, the rule-based classifiers focus on how to learn rules from the training data. In [17, 18] they performed classification based on the taxonomy structure and a two-level classification approach is used for product classification on eBay. Not only that they have combined multiple signals from different classifiers, but also they include both learning- and rule-based ones.

1.2 Classifiers

Machine learning methods are often used to create rule-based classifiers. The classifiers have to build a model or rule set from training data as an effective classifier (linear or nonlinear) or a set of high-quality rules (rule-based), which is used to predict the class labels for unknown instances [19]. To perform classification tasks most of the researchers preferred in using the rule-based algorithms due to their ease of interpretability and understanding. Rule-based classifiers [20–23] are widely used by many of the researchers because it performs extremely well on processed datasets, i.e. cleaned, correct, and no missing values.

A correlation cannot be explained as a linear combination of its independent variables; then the nonlinearity will be the main issue when examining cause–effect relations. The nonlinear data requires complex modeling and hypothesis to classify or predict the class label for unseen or unknown instances. However, the nonlinearity models do not need any clear explanation that can lead to random, unforecasted outcomes such as chaos.

While performing any classification task we must be very conscious as the real-world data is often incomplete. To provide a solution for such type of incomplete data we must be very careful in choosing the suitable classifier, which is

used to perform the task effectively. In the classification process, we need to build a model based on the training data. When testing is performing on the model built, the accuracy of the classifier may suffer due to the test data used to evaluate the model is not as complete as the training data used to build the model, as the model tends to follow the training data too closely. Thus, it is advantageous to have a rule set or model which is robust and can make accurate predictions when the test data is incomplete.

1.2.1 Rule-Based Classifier

Classification And Regression Trees (CART) and QUantile Estimation after Supervised Training (QUEST) are statistical and a binary classification method with maximum accuracy for predicting the value of a categorical dependent. A nonbinary tree generates decision trees using chi-square statistics to identify optimal splits called Chi-Square Automatic Interaction Detection (CHAID). The C5.0 builds a decision tree and calculates the maximum information gain at each level while generating the rules.

1.2.2 Nonlinear Classifiers

K-Nearest Neighbors (KNN) is a statistical method, which considers *k*-nearest points and the sign of the larger part is used to classify the training data. The performance of the KNN algorithm is influenced by three main factors: (1) the distance measure (Euclidean) used to identify the nearest neighbors; (2) the generated decision rule used to perform the classification from the *k*-nearest neighbors; and (3) the number of neighbors used to classify the new sample. A neural network classifier determines the nonlinear relationships during the learning process. If it is more appropriate, the neural network will automatically approximate the "correct" model structure. The network learns by examining individual input vector, generating a prediction for each vector, and performing the weight adjustments whenever it makes incorrect predictions. This process continues until the correct predictions done, i.e., error reduced or no of epochs reached. The Bayesian network is a probability model to establish the likelihood of occurrences of the predictors to classify the products.

The context of this study is to evaluate the progressive performance of different classifiers like rule-based (QUEST, CART, CHAID, C5.0) and nonlinear classifiers (Bayes net, NN, KNN) from the Kaggle Otto Group Product Classification as a dataset consists of 9 classes (1–9) and 93 features.

2 Proposed Work, Results, Performance Evaluations, and Discussions

In this paper, we evaluated different machine learning algorithms from Otto Group Product Classification dataset. We have compared the results of nonlinear with rule-based classification methods such as QUEST, CART, CHAID, C5.0, Bayes net, NN, and KNN. This section is divided into two subsections. Section 2.1 discusses the nature and characteristics of the datasets being classified. Finally, the methods considered for comparative study and the performance different model are demonstrated in Sect. 2.2 with a discussion.

The proposed system gives the complete process of the Kaggle Otto Group Product Classification dataset to classify the data correctly with the following steps:

1. The dataset was partitioned into training, validation, and a test.
2. The preprocessing (feature selection) phase performed on the total dataset.
3. The following base classifiers were trained to classify the products, using 60% training set:

   Nonlinear: Neural networks, K-NN, and Bayesian net
   Rule-based: QUEST, CART, CHAID, and C5.0.

4. 20% of the train is considered as the validation dataset, to be referred to as the working validation dataset. Each of the listed classifiers from step 3 was applied to the working validation dataset.
5. Remaining 20% of the train is considered as the test dataset, to be referred to as the working test dataset. Each of the listed classifiers from step 3 was applied to the working test data set.
6. The classification results from the listed classifiers were evaluated with respect to Performance.

In the case of (Case 1: dataset before feature selection), the step 2 is excluded.

2.1 Description of the Dataset

The Otto Group is the biggest e-commerce company in the world, selling millions of products worldwide everyday, with several thousand products being added to their product line. The Kaggle Otto Group Product Classification dataset consists of 9 (1–9) categories for all products and a total of 93 numerical features; and each row in the dataset represents the product. Each target category represents one of their most important product categories (like fashion, electronics, etc.). The products for the training and testing sets are selected randomly [24].

id	an anonymous id unique to a product
feat_1, feat_2, …, feat_93	the various features of a product
target	the class of a product

The training dataset contains information about 61,878, on the 93 features and the target variable is a class label. Here, Table 1 shows some of the data values for the first 10 records for the first handful of fields. Figure 2 shows us an overview of some of the continuous predictors, including histogram and some summary statistics (min, max, mean, std.dev, etc.) (Fig. 1).

The feature selection processes have been performed on 93 features and 61,878 instances and there are no missing values have been identified in the given dataset. So all the features have been ranked as important according to the thresholds taken. So we thought of defining our own threshold to identify the important features, 77 features and 61,898 (the chosen features do not show any effect on the original accuracy of the classifiers in classification process) and this was chosen as benchmark based on the experimentation; the UCI machine repository bench mark datasets (iris, wine, car evaluation) are chosen and applied for the same threshold value.

2.2 *Classification Performance of Different Machine Learning Classifiers*

This study systematically involves two different types of machine learning classifiers (Rule-based and Nonlinear). This includes feature selection and application of different classifiers on the given dataset. Each classifier has produced different results to classify the products accurately. Tables 2, 3, and 4 show the agreement

Table 1 Quick look at Kaggle Otto Group Product classification dataset

Id	Feat_1	Feat_2	Feat_3	…	Feat_91	Feat_92	Feat_93	Target
1	0	0	0	…	2	1	2	Class_1
2	0	0	0	…	2	1	2	Class_1
								. .
23456	0	0	0	…	2	1	2	Class_2
24567	0	0	0	…	2	1	2	Class_2
								. .
43212	0	0	0	…	2	1	2	Class_3
								. . .
61878	0	0	0	…	2	1	2	Class_9

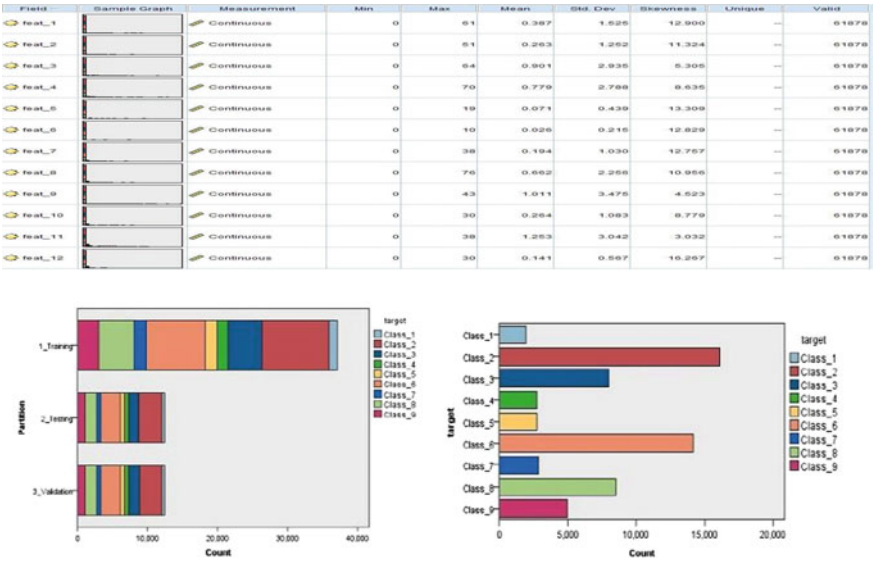


Fig. 1 An overview of some of the continuous predictors, including a histogram and some summary statistics (min, max, mean, std.dev, etc.)

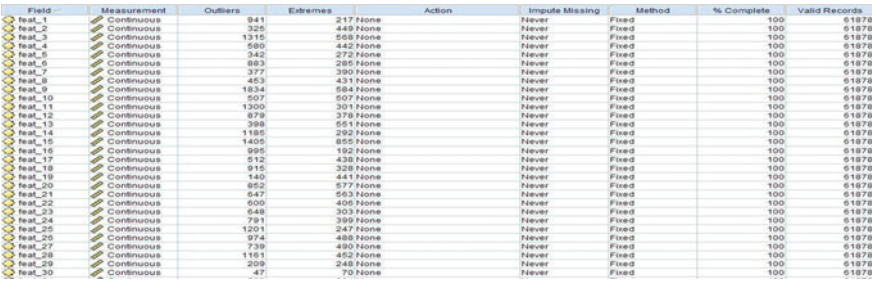


Fig. 2 The Kaggle Otto Group Product classification dataset with no missing values

between rule-based classifier (with and without feature selection) and accuracy of rule-based classifier with respect to the target and performance evaluation of rule-based classifier (with and without feature selection).

The experimental result shows that, in both the cases, the overall performance of C5.0 is better than the other three rule-based classifiers (QUEST, CART, and CHAID). The result shows that among the individual classifiers implemented, C5.0 is having highest accuracy of around **87.44%** (Table 5).

Tables 6, 7, 8, and 9 show the agreement between nonlinear classifier (with and without feature selection), accuracy of rule-based classifier with respect to the target, and performance evaluation of rule-based classifier (with and without feature selection).

Table 2 Agreement between rule-based classifier (with and without feature selection)

Model		Partitioning					
Rule-based classifiers (QUEST, CART, CHAID, C5.0)	Without feature selection (Case 1)		1_Training		2_Testing		3_Validation	
		Agree	17,339	46.8%	5,784	46.53%	5,722	46.16%
		Disagree	19,714	53.2%	6,646	53.47%	6,673	53.84%
		Total	37,053		12,430		12,395	
	With feature selection (Case 2)	Agree	17,329	46.7%	5,807	46.72%	5,670	45.74%
		Disagree	19,724	53.2%	6,623	53.28%	6,725	54.26%
		Total	37,053		12,430		12,395	

Table 3 Accuracy of rule-based classifier with respect to the target

Model		Partitioning					
Rule-based classifiers (QUEST, CART, CHAID, **C5.0**)	Without feature selection (Case 1)		1_Training		2_Testing		3_Validation	
		Correct	15,170	**87.4%**	4,806	**83.09%**	4,625	**80.83%**
		Wrong	2,169	12.5%	978	16.91%	1,097	19.17%
		Total	17,339		5,784		5,722	
	With feature selection (Case 2)	Correct	15,186	**87.6%**	4,812	**82.87%**	4,607	**81.25%**
		Wrong	2,143	12.3%	995	17.13%	1,063	18.75%
		Total	17,329		5,807		5,670	

Table 4 Performance evaluation of rule-based classifiers (with and without feature selection)

Model		Partition	Class-2	Class-5	Class-6
Rule-based classifiers (QUEST, CART, CHAID, **C5.0**)	With feature selection (Case 2)	1_Training	0.6	2.605	0.968
		2_Testing	0.611	2.58	0.947
		3_Validation	0.606	2.561	0.961
	Without feature selection (Case 1)	1_Training	0.601	2.607	0.964
		2_Testing	0.617	2.583	0.939
		3_Validation	0.599	2.57	0.971

The experimental result shows that, in both the cases, the overall performance of KNN is better than the other three nonlinear classifiers (NN, KNN, and Bayes Net). The result shows that among the individual classifiers implemented, KNN is having highest accuracy of around **88.2%**. Analysis for the training dataset is 37,053 and the predicted accuracy is 86.36% using KNN classifier. Initially, the original dataset (61,878) is split into two independent subsets: the 70% (43,314) training data used to build the classifier and 30% (18,564) test data for evaluation for the rule-based classifiers. To measure the goodness of the classifiers, we have used cross validation. The machine learning classifiers such as neural networks and support vector machines face the problem like over fitting. To validate the model and prevent from

Table 5 Confidence values report for rule-based classifier

Evaluation measures	1_Training	2_Testing	3_Validation
Range	0.286–0.951	0.286–0.951	0.286–0.951
Mean correct	0.695	0.711	0.713
Mean incorrect	0.475	0.478	0.469
Always correct above	0.94 (16.45% of cases)	0.945 (11.79% of cases)	0.951 (0% of cases)
Always incorrect below	0.293 (0% of cases)	0.293 (0% of cases)	0.313 (0.07% of cases)
90.1% accuracy above	0.436	0.457	0.466
2.0-fold correct above	0.469 (93.91% of cases)	0.469 (91.55% of cases)	0.469 (90.45% of cases)

Table 6 Agreement between nonlinear classifier (with and without feature selection)

Model		Partitioning					
Nonlinear classifiers (NN, KNN, Bayes Net)	Without feature selection (Case 1)		1_Training		2_Testing		3_Validation	
		Agree	20,608	55.62%	6,951	55.92%	6,813	54.97%
		Disagree	16,445	44.38%	5,479	44.08%	5,582	45.03%
		Total	37,053		12,430		12,395	
	With feature selection (Case 2)	Agree	20,698	55.86%	6,885	55.39%	6,809	54.93%
		Disagree	16,355	44.14%	5,545	44.61%	5,586	
		Total	37,053		12,430		12,395	

Table 7 Accuracy of nonlinear classifiers with respect to the target

Model		Partitioning					
Nonlinear classifiers (NN, KNN, Bayes Net)	Without feature selection (Case 1)		1_Training		2_Testing		3_Validation	
		Correct	18,241	**88.51%**	5,914	**85.08%**	5,721	**83.97%**
		Wrong	2,367	11.49%	1,037	14.92%	1,092	16.03%
		Total	20,608		6,951		6,813	
	With feature selection (Case 2)	Correct	18,379	**88.8%**	5,878	**85.37%**	5,743	**84.34%**
		Wrong	2,319	11.2%	1,007	14.63%	1,066	15.66%
		Total	20,698		6,885		6,809	

over fitting, the dataset is split into three parts: 60% training, 20% testing, and 20% validation sets.

Using a validation process, the *k*-nearest neighbor and C5.0 resulted in the highest accuracy of 80%; the models such as rule-based and nonlinear classifiers were preferred due to their ease of interpretability and understanding of the results

Table 8 Performance evaluation of nonlinear classifiers (with and without feature selection)

Partition	Class-1	Class-2	Class-3	Class-4	Class-5	Class-6	Class-7	Class-8	Class-9
Performance evaluation nonlinear classifiers (NN, KNN, Bayes Net) for Case 1									
1_Training	4.785	0.779	2.148	3.826	3.723	1.262	3.575	2.145	2.606
2_Testing	4.694	0.729	1.687	3.511	3.807	1.252	3.615	2.188	2.66
3_Validation	4.562	0.748	1.703	3.432	3.543	1.291	3.501	2.14	2.661
Performance evaluation nonlinear classifiers (NN, KNN, Bayes Net) for Case 2									
1_Training	4.702	0.752	2.108	3.863	3.735	1.274	3.58	2.164	2.698
2_Testing	4.661	0.707	1.787	3.654	3.797	1.27	3.646	2.2	2.705
3_Validation	4.516	0.73	1.699	3.456	3.559	1.305	3.463	2.146	2.729

Table 9 Confidence values report for agreement for nonlinear classifiers

Evaluation Measures	1_Training	2_Testing	3_Validation
Range	0.208–0.795	0.212–0.795	0.209–0.795
Mean correct	0.649	0.65	0.653
Mean incorrect	0.47	0.474	0.477
Always correct above	0.763 (34.68% of cases)	0.783 (22.87% of cases)	0.788 (19.36% of cases)
Always incorrect below	0.238 (0% of cases)	0.264 (0.04% of cases)	0.254 (0.01% of cases)
90.1% accuracy above	0.364	0.444	0.462
2.0-fold correct Above	0.491 (94.27% of cases)	0.499 (92.56% of cases)	0.502 (91.99% of cases)

while resulting in alike accuracies ranging from 45 to 80%. Always the choice of model and sample design greatly influences the outputs. This study provides an extensive evaluation of machine learning techniques in the classification process. Among the machine learning classifiers (Rule-based and nonlinear), the nonlinear classifier (KNN) has performed better than the rule-based classifier (C5.0) in both the cases (1, 2).

3 Conclusion

In summary, we have compared different machine learning classifiers (Rule-based and nonlinear) on 93 features under two different situations (before and after pre-processing). Here we have observed that our dataset does not contain any missing values but contains some outliers, so the basic feature selection was chosen and 77 features have been extracted and performed the classification on that we got same accuracies even after the attributes are reduced. After the feature selection process, the machine learning classifiers have applied and produced 88% accuracy. Using a validation process, the *k*-nearest neighbor and C5.0 produced an accuracy of 80% and above; however, the machine learning classifiers such as rule-based and non-linear classifiers were chosen due to their parameterization speed and the inter-pretability of the results while resulting in similar accuracies ranging from 45 to 80%. The proposed approach has performed on 120,000 datasets and got the same accuracies as specified earlier. The rest of rule-based and nonlinear classifiers are suitable for smaller data size and give the accurate results.

This study can be used to select suitable classifier for classifying the dataset. In further proposed approach, it can be utilized as a reference for any classification approach with the suitable datasets. Machine learning methods are often used to create rule-based classifiers and if the data is not linearly separable for

high-dimensional data, then the nonlinear classifiers are chosen to perform the efficient classification. In this paper, we have chosen rule-based classifier and nonlinear classifiers to perform classification tasks and got good accuracy with 80 and 88% and above for the large dataset with more than 100,000 instances.

While experimenting the results we found two main difficulties working with the dataset (6000 instances and 120,000). In this process, we found that using multiple classification techniques, the notion of strong accuracies significantly made sense in the context of categorizing products. In particular, we believe that using multiple classifications is one of the main ways to select suitable classifier for classifying the dataset. In further proposed approach can be utilized as a reference for any classification approach with the suitable data sets.

References

1. Pereira, M., Costa, V.S., Camacho, R., Fonseca, N.A., Simoes, C., Brito, R.M., 2009. Comparative study of classification algorithms using molecular descriptors in toxicological databases. In: Proceedings of the 4th Brazilian Symposium on Bioinformatics: Advances in Bioinformatics and Computational Biology, BSB'09, Berlin, Heidelberg, Springer-Verlag, pp. 121–132.
2. Decker, R., Kroll, F., 2007. Classification in marketing research by means of LEM2-generated rules. In: Decker, R., Lenz, H.J. (Eds.), Advances in Data Analysis, Studies in Classification, Data Analysis, and Knowledge Organization. Springer Berlin Heidelberg, pp. 425–432.
3. Marinakis, Y., Marinaki, M., Dounias, G., Jantzen, J., Bjerregaard, B., 2009. Intelligent and nature inspired optimization methods in medicine: the pap smear cell classification problem. Expert Systems 26 (5), 433–457.
4. Dehuri, S., Patnaik, S., Ghosh, A., Mall, R., 2008. Application of elitist multi-objective genetic algorithm for classification rule generation. Applied Soft Computing 8 (1), 477–487.
5. Hamamoto, Y., Uchimura, S., Tomita, S., 1997. A bootstrap technique for nearest neighbor classifier design. IEEE Transactions on Pattern Analysis and Machine Intelligence 19 (1), 73–79.
6. Quinlan, J.R., 1993. C4. 5: programs for machine learning. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.
7. Yager, R.R., 2006. An extension of the naive Bayesian classifier. Information Sciences 176 (5), 577–588.
8. Yung, Y., Shaw, M.J., 1995. Introduction to fuzzy decision tree. Fuzzy Set and Systems 69 (1), 125–139.
9. Zhang, G.P., 2000. Neural networks for classification: a survey. IEEE Transactions on Systems Man and Cybernetics. Part C: Applications and Reviews 30 (4), 451–462.
10. T. M. Mitchell. Machine learning. McGraw Hill series in computer science. McGraw-Hill, 1997.
11. R. Ramakrishnan and J. Gehrke. Database management systems (3. ed.). McGraw-Hill, 2003.
12. C. D. Manning and H. Schütze. Foundations of Statistical Natural Language Processing. MIT Press, 1999.
13. Y. Yang and X. Liu. A re-examination of text categorization methods. In SIGIR, pages 42–49, 1999.
14. D. D. Lewis. Representation and Learning in Information Retrieval. PhD thesis, 1992.

15. A. McCallum and K. Nigam. A comparison of event models for naive bayes text classification. In AAAI-98 Workshop, 1998.
16. W. W. Cohen. Fast effective rule induction. In ICML, pages 115–123, 1995.
17. D. Shen, J.-D. Ruvini, and B. Sarwar. Large-scale item categorization for e-commerce. In CIKM, pages 595–604, 2012.
18. D. Shen, J. D. Ruvini, M. Somaiya, and N. Sundaresan. Item categorization in the e-commerce domain. In CIKM, pages 1921–1924, 2011.
19. J. Wang, G. Karypis. BAMBOO: Accelerating Closed Item set Mining by Deeply Pushing the Length Decreasing Support Constraint, SDM'04.
20. Sajida Perveena, Muhammad Shahbaza, Aziz Guergachib and Karim Keshavjeec. Performance Analysis of Data Mining Classification Techniques to Predict Diabetes. Procedia Computer Science 82 (2016) 115–121.
21. Kandhasamy, J. P., and S. B. Performance Analysis of Classifier Models to Predict Diabetes Mellitus. Procedia Computer Science. 47, (2015), 45-51.3.
22. Leo Breiman, Jerome H. Friedman, Richard A. Olshen and Charles J. Stone. Classification and Regression Trees. Wadsworth & Brooks, 1984.
23. Deepthi S, Aswathy Ravikumar and R. Vikraman Nair Evaluation of Classification Techniques for Arrhythmia Screening of Astronauts. Procedia Technology 24 (2016) 1232–1239.
24. https://www.kaggle.com/c/otto-group-product-classification-challenge/data.

Analysis of Variant Approaches for Initial Centroid Selection in *K*-Means Clustering Algorithm

N. Sandhya and M. Raja Sekar

Abstract The basic *K*-means procedure is modified aimed at an efficient selection of initial seeds. Different final partitions may be formed as a result of different choices of initial seed sets. An iterative partitional grouping procedure is used and the grouping correctness is calculated. In this work variant approaches for finding initial centroids in *k*-means are proposed. The initial centroids are chosen using these different approaches: (a) Random generation, (b) Buckshot approach, and (c) ranking technique. The research analyzed the influence of the initial seed selection on cluster quality in *k*-means algorithm with three different similarity measures in synchrony with various vector representations. The initial centroids chosen play a crucial role toward the accuracy of the clusters and efficiency of the partition-based grouping systems. In the experiment, *k*-means procedure is applied, and also initial centroids for *k*-means are chosen by using different proposed approaches. Our investigational outcomes display the accuracy in clusters and efficiency of the *k*-means procedure is improved compared to traditional way for choosing initial centroids. A numeral of trials was performed and the statistical significance of the consequences is ensured using entropy. The applied methods unfolded the clustering performance for Pearson, Cos and Jaccard correlation resemblances.

1 Introduction

Text clustering is assembling the similar documents into clusters. Clustering can be used to segment the data and categorizing similar objects [1–4]. The precision and recall can be improved by using technique [5–8]. Document clustering is an

N. Sandhya (✉) · M. Raja Sekar
Department of CSE, VNRVJIET, Hyderabad, Telangana, India
e-mail: sandhyanadela@gmail.com

M. Raja Sekar
e-mail: rajasekarm9@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_11

unsupervised learning from unstructured textual data and aids in improving the efficiency of various information retrieval (IR) methods.

Text documents may be represented by an algebraic model called vector space model [9–11]. This model has various applications like information retrieval, indexing, information filtering, etc. The three different approaches of vector space model are term frequency, Boolean and inverse document frequency.

An exact definition for the likeness among items, in the form of whichever the sets are sensible resemblance or vastness, is needed for clustering [12] accuracy. The similarity measure is used for comparing objects, and such widely applied and proposed measures are Pearson Association Factor, Jaccard constant Cos resemblance, and Euclidean detachment.

K-means is one of the unsupervised clustering algorithms that categorize an assumed database throughout a particular numeral of fixed apriori (k) groups. This procedure targets at reducing an objective gathering known as squared error function.

K-means clustering [13–15] divides the n clarifications into k groups. The clustering process involves the selection of the initial centroids randomly. The work here proposes to find the best initial centroids. The choice of the initial seeds influences the partitioning-based procedures by reducing the numeral repetitions. Improving quality of the initial centroids helps in affecting the efficiency of the algorithm. From the previous study [16], it is proven that Boolean depiction by these resemblance procedures acted not performs better. It is also seen that Euclidean distance achieves poorest. Consequently, now an analysis of these groups by the occurrence and TF–IDF depiction with Pearson correlation coefficient measures, Jaccard and Cosine is attempted.

2 Related Work

2.1 Vector Space Procedure

In this paper, IDs are signified by the vector space procedure,

There are basically three vector model demonstrations, which are

(1) Boolean vector space procedure
(2) Frequency calculation vector space procedure
(3) Inverted certificate frequency vector space method.

2.2 Resemblance Methods

The resemblance procedures used for discovery of correspondence between the known IDs are

(1) Cos resemblance quantity
(2) Jaccard Factor
(3) Pearson Relationship Factor.

2.2.1 Cos Resemblance Quantity

The best usually used correspondence quantity is the Cos utility:

$$\cos(A, B) = \frac{\sum_{i=1}^{n} A_i * B_i}{\sqrt{\sum_{i=1}^{n} \|A_i\|^2} * \sqrt{\sum_{i=1}^{n} \|B_i\|^2}}. \tag{1}$$

The cos(A, B) assessment is 1 when twofold IDs are same. In the case of different documents its value is zero condition here it is zilch to corporate among them (i.e., their manuscripts directions are reciprocally perpendicular each other).

2.2.2 Jaccard Measurement

Jaccard factor is derived from the concept of cosine factor as

$$\text{JacardCoff}(A, B) = \frac{\sum_{i=1}^{n} A_i * B_i}{\sqrt{\sum_{i=1}^{n} \|A_i\|^2} * \sqrt{\sum_{i=1}^{n} \|B_i\|^2} - \sum_{i=1}^{n} A_i * B_i} \tag{2}$$

$$\text{JacardIndex}(C, D) = \frac{C \cap D}{C \cup D}. \tag{3}$$

2.2.3 Pearson Association Factor

This gap is built on the Pearson association factor that is computed from the model principles and their typical eccentricities:

$$\text{PCC}(A, B) = \frac{\sum_{i=1}^{n} A_i * B_i - \sum_{i=1}^{n} A_i * \sum_{i=1}^{n} B_i}{\sum_{i=1}^{n} \|A_i\|^2 * \sum_{i=1}^{n} \|B_i\|^2}. \tag{4}$$

2.3 K-*Means*

K-means is one of the easiest unsupported knowledge procedures, where the mean of a group points called centroid applied to the given data in an incessant *n*-dimensional space. The algorithm first begins with user-specified parameter *k* as clusters with chosen initial centroids. The vastness among objects and the centroid of every group are calculated as the following phase in the proposed procedure. Next, every point is allocated for proximity centroid. The group centroids are updated depending on the points assigned. This process is reiterated till the centroids remain the same with a goal of reducing squared error function.

2.3.1 Buckshot

From the assumed usual of IDs choose $\sqrt{kn}$ wherever *n* signifies quantity of IDs and *k* signifies quantity of groups.

Let $Y = \{y1, y2, y3, \ldots, yn\}$ be the collection of data points, $X = \{y1, y2, y3, \ldots, y\sqrt{kn}\}$ and

$V = \{w1, w2, \ldots, wc\}$ be the collection of midpoints.

Step 1. Arbitrarily choose '*c*' group midpoints from *X*.
Step 2. Compute the gap among every data point in *X* and group midpoints.
Step 3. Allocate the data point to the group midpoint whose space from the group midpoint is least of all the group midpoints.
Step 4. Recompute the novel group midpoint by

$$v_i = 1/d_j \sum_{i=1}^{n} y_i, \tag{6}$$

where 'd_j' signifies quantity in *j*th group.

Step 5. Recompute the gap among every point and novel gained group midpoints.
Step 6. If there are no allotment of points then stop, else reiterate from Step 2.
Step 7. Allocate these ultimate centroids as preliminary centroids to IDs in *Y* and employ *k*-means.

2.3.2 Ranking Method

Occasionally, very few IDs in dissimilar groups may be analogous to every other and dividing them just based on the pairwise resemblance is not suitable enough. This condition may occur when the groups are not properly divided. The perceptions of neighbors and relation to manuscript grouping may be useful to overcome this type of condition [17, 18].

The twofold statistics points are measured as neighbors when they are similar enough. Each outlet can require a set of nearest points in given database in the given resemblance limit. The number of their collective nearest points can be characterized by the link among multiple data points. So the ideas of nearest data points and association may deliver appreciated evidence around the IDs in the gathering procedure. Consequently, intracollection resemblance can be improved not only using the vastness among the IDs and the centroid, but also by considering their nearest neighbors. The association utility yields the evidence of neighboring IDs hooked on deliberation. Consequently, it can be cast off to the betterment of the assessment of the nearness among IDs.

Neighbors and Link

The manuscript d's neighbor in a database are those IDs that are measured analogous toward it. Let cls(c_i, c_j) be a resemblance task apprehending the pairwise resemblance between c_i and c_j, and takes values between 1 and 0, by a larger value giving superior resemblance. For an assumed limit l, c_i and c_j are described as neighbors if cls(c_i; c_j) $\geq$ t; by $0 \leq t \leq 1$.

Now t is a programmer-specified limit to the device in what way analogous a couple of IDs must be in order to be measured as closeness of each other. If we use the cosine as cls and set t to 1, a manuscript is controlled to be a closeness of other identical IDs. On the complementary part, if t were set to 0, any pair of IDs would be nearest points. Varying on the application, the operator can select an appropriate value for t.

A proximity array can characterize the data around the neighbors of each manuscript in the database. A proximity array for a database of m IDs is an $m \times m$ adjacency array M, in which an admittance $M[i, j]$ is 1 or 0 differing on whether IDs c_i and c_j are nearer or not. $N(c_i)$ signifies the quantity of closed points of a manuscript c_i in the database, and it is in the ith row of the two-dimensional array M wherever values are 1.

The amount of shared adjacent IDs among c_i and c_j describes the assessment of association (c_i, c_j). Magnifying the ith row of the neighbor matrix M with its jth column can attain this: clus(c_i, c_j) = $\sum M[i, m] * M[m, j]$ wherever $m = 1$ to n. Consequently, if clus(c_i, c_j) is huge, then it is more likely that c_i and c_j are near enough to be in the same group. Since the cos(A, B) processes merely measure the resemblance for binary text IDs, taking it alone can be measured as a native technique for grouping. The association utility customs the information of closed IDs in assessing the association for the deliberate IDs making it a universal method for grouping. While calculating the nearness of two IDs that are needed, clus utility will show worthy.

Assortment of Early Collection Central Points Built on Grades

A suitable applicant aimed at a first central point should not only be nearly adequate to a particular collection of IDs but also satisfactorily be divided from supplementary central points. By putting an accurate threshold x, the quantity of closed points in the given data might be cast off to assess in the numerous IDs that are near to the manuscript. To assess the variance of two IDs, which are preliminary central applicants, together the cos and association utilities are used.

Initially, by inspecting the proximity array of the database, we catalog the IDs in downhill order of their number of nearest points. In order to discover a collection of preliminary central contestants, each of which is nearly adequate to an assured collection of IDs, the topmost n IDs are designated from this list. This collection of n first central points nominees is signified through Um with $1 = k +$ oplus.

Where the anticipated amount of groups is k and the additional quantity of applicants designated is plus. Subsequently, these n applicants must be the greatest proximity in the database, we adopt them as further probable middles of the groups.

Following, we attain the cos and association costs between every pairs of documents in Sm, and then grade the manuscript couples in scaling order of their cos and association prices, correspondingly.

For a couple of IDs c_i and c_j, let us describe rank(c_i, c_j) be its grade founded on the cos assessment, rank(c_i, c_j) be its rank founded on the association assessment, and rank(d_i, d_j) be the quantity of rank(c_i, c_j) and rank(c_i, c_j). Aimed at together rank (c_i, c_j) and ranklink(d_i, d_j), a smaller value represents a higher rank, and 0 corresponds to the highest rank. The manuscript couples with high classes could be deliberated as decent early central points.

2.3.3 Random Generation

This technique is the most basic and simple one. In this method, the program randomly chooses any document as the initial centroid for a cluster.

3 Results and Discussion

The standard dataset, Classic dataset gathered from uci.kdd sources is used to experiment. Four dissimilar groups, viz., labeled as 1. CACM, 2. CISI, 3. CRAN, and 4. MED of the typical dataset, are studied. Out of the total 7095 IDs 800 IDs are studied.

The similarity of a cluster is indicated by entropy: low entropy denotes a great similarity, and vice versa. The principle for entropy for a group C_i is

$$E(C_i) = -\sum_{i=0}^{k-1} pr_{ij} \log(pr_{ij}), \tag{7}$$

where pr_{ij} signifies the amount of elements from class j that are confined in group i. The general entropy is specified by

$$\text{Entropy}(S) = \sum_{i=1}^{n} \frac{n_i}{n} E(C_i). \tag{8}$$

Here in this effort entropy measure is used for assessing group quality. Selecting of the first centroid assortment is tried by buckshot, ranking, and random methods. The outcomes from Tables 1, 8, and 15 display that cosine smashes with TF–IDF illustration compared to other resemblance measures. The number of repetitions is condensed with these styles of preliminary seed assortment. The centroids selected using ranking algorithm method prove to be superior in the initial centroid selection with superior grouping competence for *k*-means.

3.1 Buckshot Algorithm

The buckshot algorithm is shown in Tables 2, 3, and 4.

Outcomes for TF–IDF illustration

We perceive from both the illustrations that cos resemblance smashes the other resemblances and TF–IDF illustration has exhibited decent implementation (Tables 5, 6, and 7).

Table 1 Total entropy results for the classic dataset

	Cos	Jaccard	Pearson
Frequency count	0.119	0.1770	0.16906
TF–IDF	0.1637	0.1329	0.2555

Table 2 Grouping outcomes from FC illustration for Jaccard measure by traditional database PRECISION = 68.869

	1	2	3	4	Label
Group [0]	1	0	0	148	4
Group [1]	15	3	199	25	3
Group [2]	183	153	1	2	1
Group [3]	0	44	0	25	2

Table 3 Grouping outcomes from FC illustration for PCC measure by traditional database PRECISION = 80.0394

	1	2	3	4	Label
Group [0]	25	93	9	7	2
Group [1]	2	0	0	189	4
Group [2]	171	107	1	2	1
Group [3]	1	0	190	2	3

Table 4 Grouping outcomes from frequency count illustration for Cos measure using standard dataset PRECISION = 91.84

	1	2	3	4	Label
Group [0]	0	150	0	1	2
Group [1]	2	3	196	2	3
Group [2]	195	45	2	3	1
Group [3]	2	2	2	194	4

Table 5 Grouping outcomes after TF–IDF illustration for Jaccard measure using standard database PRECISION = 92.29

	1	2	3	4	Label
Group [0]	9	179	0	15	1
Group [1]	0	1	0	180	4
Group [2]	179	15	0	1	1
Group [3]	11	5	200	4	2

Table 6 Grouping outcomes after TF–IDF illustration for PCC measure using standard database PRECISION = 72.888

	1	2	3	4	Label
Group [0]	0	0	97	65	3
Group [1]	184	15	103	14	1
Group [2]	14	185	0	2	2
Group [3]	1	0	0	119	4

Table 7 Grouping outcomes from TF–IDF illustration for Cos measure by typical dataset ACCURACY = 87.708

	1	2	3	4	Label
Group [0]	1	152	0	32	2
Group [1]	0	0	188	2	3
Group [2]	199	48	12	4	1
Group [3]	0	0	0	162	4

3.2 Ranking Algorithm

The entropy results in Table 8 provide the evidence that ranking technique approach deemed to have contributed more to the clustering of documents.

Results for TF representation:

The results of TF representation are represented in Tables 9, 10, and 11.

Table 8 Overall entropy outcomes using standard dataset

	Cos	Jaccard	Pearson
Frequency count	0.136	0.1607	0.1374
TF–IDF	0.101	0.1478	0.1191

Table 9 Grouping outcomes from FC depiction for Jaccard measure using standard database PRECISION = 87.37, NOI = 9

	1	2	3	4	Label
Group [0]	194	56	1	3	1
Group [1]	1	0	1	167	4
Group [2]	0	141	0	0	2
Group [3]	5	3	198	30	3

Table 10 Grouping outcomes after FC illustration for PCC measure using standard database PRECISION = 86.34, NOI = 9

	1	2	3	4	Label
Group [0]	196	83	2	3	1
Group [1]	3	6	3	196	4
Group [2]	0	109	0	0	2
Group [3]	1	2	195	1	3

Table 11 Grouping outcomes from FC illustration for Cos measure by standard database PRECISION = 87.49, NOI = 8

	1	2	3	4	Label
Group [0]	196	75	2	3	1
Group [1]	3	6	2	195	4
Group [2]	0	117	0	0	2
Group [3]	1	2	196	2	3

Table 12 Grouping outcomes after FC illustration for Jaccard measure using standard database PRECISION = 89.88, NOI = 16

	1	2	3	4	Label
Group [0]	191	45	1	4	1
Group [1]	1	151	0	0	2
Group [2]	6	3	198	17	3
Group [3]	1	1	1	179	4

Results for TF–IDF Representation:

The results of TF–IDF representation are represented in Tables 12, 13, and 14.

3.3 Random Generation Procedure

The results of TF representation is represented in Table 15.

Table 13 Grouping outcomes after FC illustration for PCC measure using standard database PRECISION = 90.967, NOI = 10

	1	2	3	4	Label
Group [0]	197	55	4	3	1
Group [1]	0	142	0	0	2
Group [2]	2	2	3	196	4
Group [3]	0	1	193	1	3

Table 14 Grouping outcomes from FC illustration for Cos measure using standard database PRECISION = 92.85, NOI = 20

	1	2	3	4	Label
Group [0]	1	2	197	0	3
Group [1]	0	153	0	0	2
Group [2]	196	43	1	3	1
Group [3]	2	2	2	197	4

Table 15 Overall entropy outcomes for the standard dataset

	Cos	Jaccard	Pearson
Frequency count	0.1195	0.1541	0.1809
TF–IDF	0.106	0.123	0.184

Table 16 Grouping consequences after FC illustration for Jaccard measure using standard database PRECISION = 89.37

	1	2	3	4	Label
Group [0]	193	39	1	3	1
Group [1]	1	157	0	2	2
Group [2]	0	1	1	167	4
Group [3]	5	3	198	28	3

Table 17 Grouping outcomes from FC illustration for PCC measure using standard database PRECISION = 83.84

	1	2	3	4	Label
Group [0]	2	135	1	50	2
Group [1]	0	1	2	147	4
Group [2]	1	2	193	0	3
Group [3]	196	62	4	3	1

Results for TF representation:

The results of TF representation are represented in Tables 16, 17, and 18.

Outcomes for TF–IDF illustration:

From all the above outcomes, it has been perceived that Jaccard measure does not yield apt groups (Tables 19, 20, and 21).

In Fig. 1, it is observed that Cosine measure performs enhanced in producing consistent groups.

Table 18 Grouping outcomes from FC illustration for Cos measure by standard database PRECISION = 91.32

	1	2	3	4	Label
Group [0]	0	146	0	0	2
Group [1]	2	1	2	193	4
Group [2]	2	3	197	4	3
Group [3]	195	50	1	3	1

Table 19 Grouping outcomes from TF–IDF illustration for Jaccard measure using standard database PRECISION = 92.80

	1	2	3	4	Label
Group [0]	7	176	1	10	2
Group [1]	11	3	198	2	3
Group [2]	0	0	0	187	4
Group [3]	181	21	1	1	1

Table 20 Grouping outcomes from TF–IDF representation for PCC measure using standard database PRECISION = 70.209

	1	2	3	4	Label
Group [0]	0	0	0	47	4
Group [1]	198	57	5	2	1
Group [2]	1	143	7	151	2
Group [3]	0	0	188	0	3

Table 21 Grouping outcomes from TF–IDF illustration for Cos measure using standard database PRECISION = 85.026

	1	2	3	4	Label
Group [0]	1	96	0	1	2
Group [1]	0	0	1	194	4
Group [2]	198	104	1	5	1
Group [3]	0	0	198	0	3

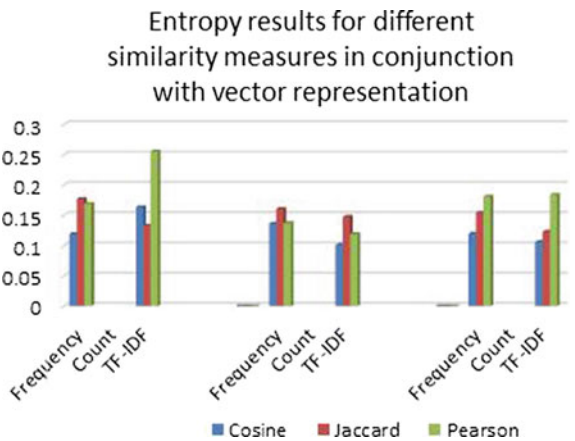


Fig. 1 Entropy results

4 Conclusion

The clusters formed by this research can be useful for text mining. Adopting this approach of initial seed selection in *k*-means clustering procedure in the quantity of repetitions can be reduced and thus increasing the algorithm efficiency. This can be used in the applications of document clustering.

In the ranking algorithm approach since the threshold values used in the ranking algorithm vary with the documents number and input representations, the result varies with the threshold values. As a future enhancement, we may probe in fixing the variant threshold value. Also, this work may be extended for an exhaustive study by applying semantic knowledge [19, 20] to the document representations and performing *k*-means clustering with these variant approaches.

References

1. M. S. Aldenderfer and R. K. Blashfield Cluster Analysis Sage Publications, Los Angeles, 1985.
2. P. Berkhin. Survey Of Clustering Data Mining Techniques. Technical report, Accrue Software, San.
3. J. Hartigan. Clustering Algorithms Wiley, New York, 1975.
4. P.J. Flynn, A.K. Jain, M.N. Murty, 1999. Data Clustering: A Review. ACM Computing Surveys, vol. 31, no. 3: 264–323.
5. Tague-Sutcliffe, J., Blustein, J.: A statistical analysis of the TREC-3 data. In Harman, D., ed.: Proceedings of the third Text Retrieval Conference (TREC). (1994) 385–398.
6. C.J. Van Rijsbergen, (1989), Information Retrieval, Buttersworth, London, Second Edition.
7. G. Kowalski, Information Retrieval Systems—Theory and Implementation, Kluwer Academic Publishers, 1997.
8. Mizzaro, S.: A new measure of retrieval effectiveness (or: What's wrong with precision and recall). In: In T. Ojala editor, International Workshop on Information Retrieval (IR'2001) (2001).
9. G. Salton and C. Buckley, "Term-Weighting Approaches in Automatic Text Retrieval," Information Processing and Management Vol. 24, No. 5, 1988, pp. 513-523.
10. Salton, G., Wong, A., Yang, C.S. (1975). A vector space modelfor automatic indexing. Communications of the ACM, 18(11):613-620.
11. D.L. Lee, H. Chuang, and K. Seamons. Document ranking and the vector space model IEEE Transactions on Software, 14(2): 1997.
12. Anna Huang Similarity Measures for Text Document Clustering published in the proceedings of New Zealand Computer Science Research Student Conference 2008.
13. G. Hamerly and C. Elkan. Alternatives to the k-means algorithm that find better clusterings. In Proc. of the 11th Intl. Conf. on Information and Knowledge Management, pages 600–607, McLean, Virginia, 2002. ACM Press.
14. D. Arthur and S. Vassilvitskii. k-means++ the advantages of careful seeding. In Symposium on Discrete Algorithms, 2007.
15. Technische Universität Dresden, An Empirical Study of K-Means Initialization Methods for Document Clustering.
16. N. Sandhya, Y. Srilalitha, V. Sowmya, K. Anuradha, Dr. A. Govardhan Analysis of Stemming Algorithm for Text Clustering International Journal of Computer Science and Issues.

17. R. A. Jarvis and E. A. Patrick, Clustering Using a Similarity Measure Based on Shared Nearest Neighbors IEEE Transactions on Computers, Vol. C-22, No. 11, November, 1973.
18. L. Ertöz, M. Steinbach, V. Kumar, Finding topics in collections of documents: a shared nearest neighbor approach, in: W. Wu, H. Xiong, S. Shekhar (Eds.), Clustering and Information Retrieval, Kluwer Academic Publishers, 2004, pp. 83–104.
19. Miller, G.: WordNet: a lexical database for English. Communications of the ACM, Volume 38, Issue 11 , pp. 39-41 (1995).
20. A. Hotho, S. Staab, and G. Stumme. Ontologies improve text document clustering. In Proc. IEEE Int. Conf. on Data Mining (ICDM 03), pages 541–544, 2003.

Experimental Investigation on Navigation of Mobile Robot Using Ant Colony Optimization

A. Mallikarjuna Rao, K. Ramji and B.S.K. Sundara Siva Rao

Abstract In the present work, mobile robot (MR) system is designed such that it has to reach its target by overcoming the obstacle having various shapes/cross sections. The path optimization between the sources to the destination is considered with innovative logic, ant colony optimization (ACO). The sensors fixed on the periphery of the MR recognize the obstacles and the information is transmitted to the controller. The ACO algorithm generates the shortest route between the source and the target after making successive iterations in various paths. The microprocessor controller output regulates the velocity of front two wheels of MR. The experimental setup is taken into consideration with various environmental conditions and the MR is tested for navigation to attain the goal. The artificial ants generate the random path considered as traffic and the route is optimized after successive iterations. The safe boundary algorithm (SBA) is adopted to improve the intelligence while cross over the obstacles with minimizing the distance travelled. The experimental results are validated against the simulation results and proven that the ACO integrated with SBA method is an optimistic method of navigation.

1 Introduction

Several techniques are applied to navigate the MR in a scrupulous path, to reach the goal/target. The adoption of artificial intelligence makes the MR with better intelligence for navigation in various environmental conditions. Ant colony optimization is method of optimizing the route between sources to destination. This proposed algorithm is based on the Probabilistic method which gives the optimal

A. Mallikarjuna Rao (✉)
V R Siddhartha Engineering College, Vijayawada, AP, India
e-mail: amrao9@gmail.com

K. Ramji · B.S.K. Sundara Siva Rao
A.U. College of Engineering, Andhra University, Visakhapatnam, AP, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_12

path. It is enthused from the search behaviour of ants. The ants discharge the chemical essence named, pheromone, along the way they plan up and return to nest. The quantity of pheromone deposited on the way is proposed to the quality of the food. The concentration of pheromone makes the indication of a shortest path to the ants.

Han et al. [1] presented a method of navigation of mobile robot against critical obstacles using ACO with considering initial transition probability, so the decision-making was easy among various available paths. Englot et al. [2] solved multi-goal path planning problem using ACO and compared with traditions methods. He proved that his approach is best fit for underwater robots. Mohanraj et al. [3] simulated the ACO algorithms to generate path planning of robot in obstacle environment with minimizing difficulty in computation. Gigras and Gupta [4] used the ACO algorithms to generate the optimization techniques for industrial automation. They also recommended the same algorithm for military applications, for recognition of hazardous material.

Hachour [5] proposed an algorithm for navigation of autonomous mobile robot using Ant Colony Optimization. This algorithm was applied in C++ language, afterwards tested using visual basics language. Angus [6] identified the shortest route with Ant Colony Optimization by considering three parameters cost, visibility and pheromone. These parameters influence the navigation of mobile robot and lead to better approach towards the goal. Dorigo [7] formulated an arithmetical model for shortest path in line with Ant Colony Optimization. The higher pheromone concentration leads to indicate the shortest path to reach the goal.

Rishiwal et al. [8] developed the algorithm using Ant Colony Optimization in terrain maps. The features of terrain such as land, forest, etc. are recognized with dissimilar colour permutations and combinations. Each colour is coupled with a scrupulous penalty assessment for an area on landscape map. By using Ant Colony Optimization, the simulation process is carried out between the source and destination by considering different penalty values. Bin et al. [9] proposed the improved ant colony optimization linked with vehicle steering problem for navigation of vehicles by avoiding the obstacles on the road.

Guan-Zheng [10] proposed to utilize Maklink diagram theory to create free space sculpt of the autonomous mobile robot with Dijkstra algorithm to locate collision-free path and followed by ACO algorithm for route optimization.

In the above literature many of simulated the robot in virtual environments, some authors tried for experimentation with similar shaped obstacles. Hence, the research organized still now is not suited to navigate the MR in a realistic environment using ACO.

In this paper, we have organized the simulation and experimentation in various environments, having irregular shaped obstacles. In addition, the SBA is integrated to make path optimization while crossing the obstacles.

2 Kinematic Analysis of Mobile Robot

2.1 Design of Mobile Robot

The proposed MR is designed with valid kinematic analysis, to generate the experimental assessment for navigation in a right path. The wheels of the MR are actuated by the signal generated from the controller, which leads to attain the desired position and orientation.

The MR is supported with four wheels with identical dimension. The front wheels are driving wheels. The robot is similar in the rectangular shape in the top view, having the centre of gravity (CG) at point, G and geometrical centre at point, P, as shown in Fig. 1.

The proposed MR is taken into deliberation that no slip exists between the wheel and the floor plane:

$$\text{Vel.}_T = 0.5 \times [\text{Vel.}_R + \text{Vel.}_L] \tag{1}$$

where $\text{Vel.}_R = r \times \omega_R$, $\text{Vel.}_L = r \times \omega_L$, Vel. = linear velocity, ω = angular velocity and r = radius of the wheel.

Here, suffixes of R, L and T indicate right wheel, left wheel and tangential direction, respectively.

The MR location and path is symbolized by means of the vector information as

$$P = [X_C \quad Y_C \quad \theta]^T \tag{2}$$

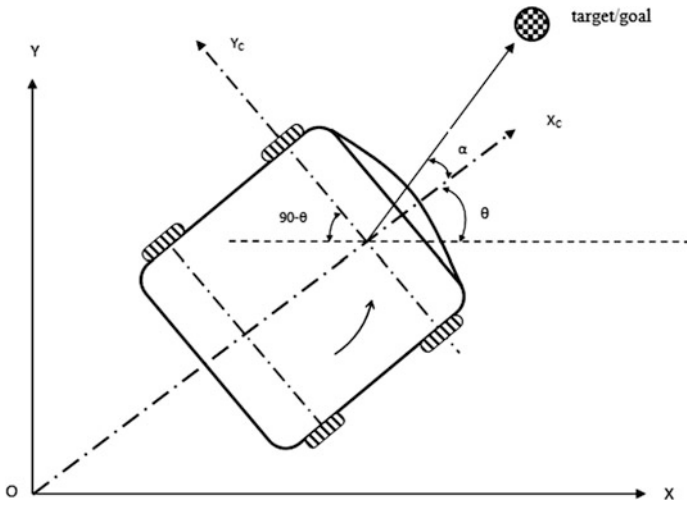


Fig. 1 Kinematic analysis of mobile robot

Here, C is the point in the global coordinate frame having the coordinates, X_C and Y_C. The variable, θ, is the orientation angle with respect to the horizontal axis.

With considering the assumption, the slip between wheel and floor is zero; hence, the velocity component orthogonal to the surface of wheel is zero:

$$\begin{bmatrix} \dot{Y}_c \sin\theta & -\dot{X}_c \cos\theta & -\dot{d}\theta \end{bmatrix} = 0 \tag{3}$$

Let us consider all kinematics limitations are sovereign of time, and can be articulated as,

$$A(p)\dot{p} = 0 \tag{4}$$

where $A(p)$ is the constrained matrix

$$A(p) = \begin{bmatrix} -\sin\theta & \cos\theta & -d\theta \end{bmatrix} \tag{5}$$

This matrix is applied to plan the motion in the global reference frame [X Y] to motion with stipulations of the local reference frame [X_cY_c]. It is easy to verify equations of motion in terms of linear and angular velocity:

$$C = \begin{bmatrix} \cos\theta & -d\sin\theta \\ \sin\theta & -d\cos\theta \\ 0 & 1 \end{bmatrix} \tag{6}$$

$$Vt = \begin{bmatrix} V & \omega \end{bmatrix}^T \tag{7}$$

where V is the maximum linear velocity ($|V| \leq V$ max) and ω is the maximum angular velocity ($|\omega| \leq \omega$ max) is at the point 'p' along the robot axis.

The kinematic equation is

$$\dot{q} = \begin{bmatrix} \dot{X}_c \\ \dot{Y}_c \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} \cos\theta & -d\sin\theta \\ \sin\theta & -d\cos\theta \\ 0 & 1 \end{bmatrix} \begin{bmatrix} V \\ \omega \end{bmatrix} \tag{8}$$

3 Definition of Problem

3.1 Grid Environment

The MR is navigated in a grid environment with dimensions (100 × 100) mm containing irregular shaped obstacles. MR starts at source point, $S(0, 0)$ and reaches the target point, $T(100, 100)$ by crossing over the obstacles. The path planning is developed from S to T with a minimum distance of travel. The optimized algorithm computes the shortest path as in Fig. 2.

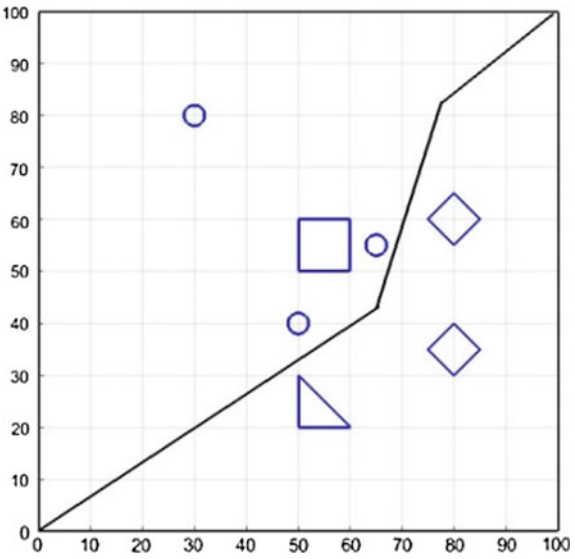


Fig. 2 Environment model for problem

3.2 Methodology

The objective is to navigate the MR from the source point, *S*, to target point, *T*, against irregularly shaped obstacles with the optimized path. To solve this difficulty, ant colony optimization is considered, which simulates the real ant behaviour for searching the food to MR for finding the shortest path. The ant releases the pheromone in the travelled path; the concentration of pheromone makes the indication to compute the shortest route. The probability for searching the path by an ant called transition probability is P_{ij}^{k}.

The equation for the assessment of transition probability in ACO [3] is

$$p_{ij}^{k} = \frac{\left\{\tau_{ij}\right\}^{\alpha}}{\sum_{j\varepsilon N_i^k}^{m}\left\{\tau_{ij}\right\}^{\alpha}} \tag{9}$$

where τ_{ij} = trial of pheromone, m = No. of ants, α = weight rate.

Here, ρ_{ij}^{k} symbolizes the transition probability, where ant k navigates starting from ith node to jth node.

Pheromone evaporation [3] is executed by

$$\tau_{ij} = (1-\rho)^{*}\tau_{ij} \tag{10}$$

where $0 < \rho \leq 1$ is the rate of pheromone evaporation.

The change of the pheromone is the following [7]:

$$\tau_{ij} = \tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij} \tag{11}$$

where $\Delta\tau_{ij}$ is the quantity of pheromone ant k deposits on the route

$$\tau_{ij} = \frac{1}{C^k} \tag{12}$$

where C^k is the path extent made by the kth ant.

3.3 Pseudocode of ACO

```
Initiate concentration of Pheromone τij;
reiterate for all ants i: build result (i);
    for the entire ants i: global concentration of-
    Pheromone revise (i);
    for the entire boundaries: dissolve pheromone;
                    (τi−j := (1 − ρ)τi−j)
Build result (i):
Initiate ant;
While not get a result:
    Develop the result by one boundary probabilistic-
    cally according to the concentration of Pheromone
                    (τρi−j/∑ρi−j τρi−j ;)
global_pheromone_revise (i):
for entire boundaries in the result;
    amplify the concentration of pheromone with re-
    spect to the quality
          Δτj−j :=1/length of the route accumulated
```

3.4 Safe Boundary Concept

The safe boundary improves the navigation while crossing over the obstacles. The required physical parameters are taken by various sensors, used for decision-making of the robot about the turn either right or left side of the obstacle as in Fig. 3.

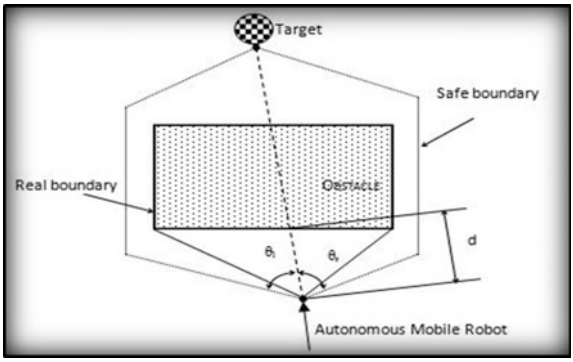


Fig. 3 Safe boundary concept

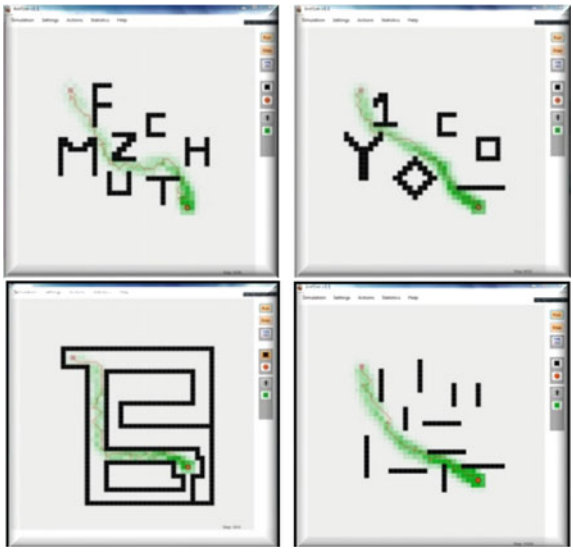


Fig. 4 Simulation of MR in various environments

The sensors fastened on the front side of the MR recognizes the distance between the MR and boundary of obstacle, and subsequently the computation algorithm calculates the angles: left angle, θ_l and right angle, θ_r. The MR computes left and right angles and subsequently cross over with higher angle. This method optimizes the distance travelled while crossing the obstacles.

4 Simulation of Navigation

The MR is simulated in various environments using ANTSIM V1.1 software. As shown in Fig. 4, the optimized path is generated using ACO algorithm. After successive iterations, the ants generate the optimized path against irregular

cross-sectional obstacles and between narrow walls. The green shadow indicates the traffic of ants and red line represents the optimized path after successive iterations using ACO algorithm with the concern of pheromone concentration.

Environment 1: Obstacles having the cross sections like alphabets are positioned and the MR is navigated in a collision-free path.

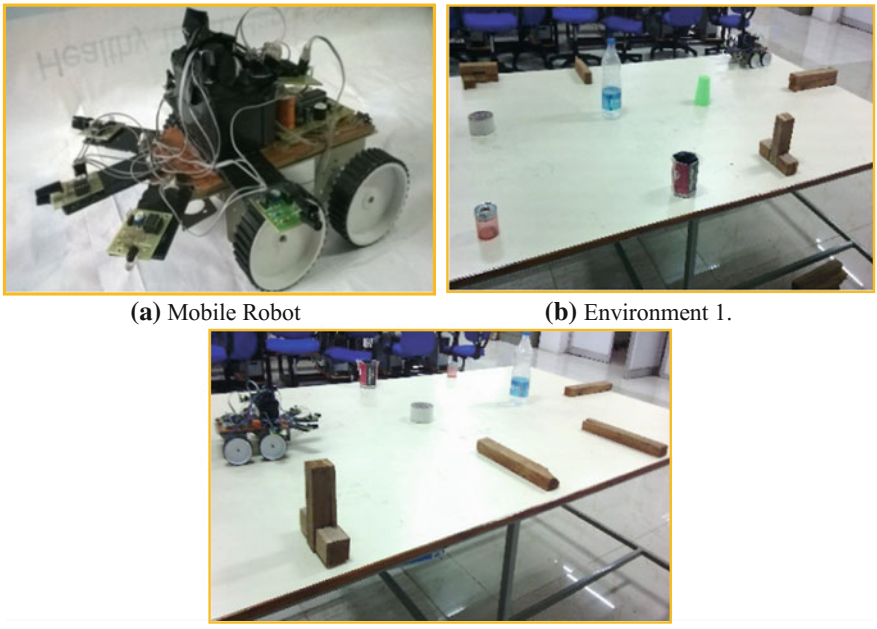
Environment 2: Dissimilar shaped obstacles were placed in the environment and the MR is navigated from source to target. The path is optimized effectively even the presence of irregular obstacles.

Environment 3: The MR is navigated in a wall boundary crucial narrow path without touching the boundary walls.

Environment 4: The MR is navigated in a rectangular obstacles environment without touching edges of the obstacles.

5 Experimental Results

The MR is tested with valid experimental setup after the successive simulations. Various obstacles having different shapes of the cross section are kept in the arena and MR is navigated under collision-free path to reach the goal/target.



(a) Mobile Robot **(b)** Environment 1.

(c) Environment 2.

Fig. 5 Experimental setup for navigation of MR

After successive iterations of navigation, the ACO algorithm makes the optimized path generation under collision-free environment. The safe boundary algorithm improves the navigation while crossing the obstacles with smooth curves. The following results are shown improvement of navigation and better collision-free path using ACO algorithm with the safe boundary condition, as shown in different environments as in Fig. 5.

Smooth collation-free navigation is attained by the MR under the different tested environmental conditions. Any irregular cross-sectioned obstacles are overcome by robot with convenient angle of overcome with safe boundary algorithm.

6 Conclusion

As in Fig. 6, it is proved that time requirement is low for ACO with safe boundary algorithm in all environments. Different environments are arranged with various cross-sectioned obstacles, and the ACO with safe boundary algorithm highlighted among all with minimum time requirement for navigation.

The safe boundary concept minimizes the time consumption while crossing the obstacles. Hence, the ACO-based safe boundary algorithm yields a better result in the navigation of MR.

The experimental results are proved that ACO with SBA method fit moderately for irregular cross-sectioned obstacles. Hence, it was recommended to program in MR to serve the public in realistic environments like earthquakes, train accidents, etc. The same work may be extended with incorporating the combination of more artificial intelligence (AI) techniques.

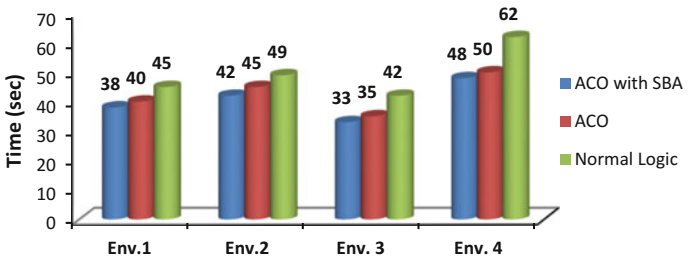


Fig. 6 Navigation time versus environment

References

1. Jihee Han, Hyungjune Park and Yoonho Seo.: Path planning for a mobile robot using ant colony optimization and the influence of critical obstacle, International Conference on Industrial Engineering and Operations Management Detroit, Michigan, USA, September 23–25, 2016.
2. Englot, Brendan J., and Franz S. Hover.: Multi-goal feasible path planning using ant colony optimization. 2011 IEEE International Conference on Robotics and Automation (ICRA) (2011). 2255–2260.
3. T. Mohanraj, S. Arunkumar, M. Raghunath, M. Anand.: Mobile robot path planning using ant colony optimization, International Journal of Research in Engineering and Technology, Vol. 3 Special Issue: 11, NCAMESHE - 2014, June, 2014.
4. Yogita Gigras and Kusum Gupta.: Ant colony based path planning algorithm for autonomous robotic vehicles, International Journal of Artificial Intelligence & Applications (IJAIA), Vol. 3, No. 6, November 2012.
5. O. Hachour.: Path Planning of Autonomous Mobile Robot, International journal of systems applications, engineering & development, Issue 4, Volume 2, 2008.
6. Daniel Angus.: Solving a unique Shortest Path problem using Ant Colony Optimization, Communicated by T. Baeck, 2005.
7. Marco Dorigo & Christian Blum,: Ant Colony Optimization Theory: A Survey, Theoretical Computer Science, Elsevier, Volume 344, Issues 2–3, 17 November 2005, Pages 243–278.
8. Vinay Rishiwal, Mano Yadav, K.V. Arya.: Finding Optimal Paths on Terrain Maps using Ant Colony Algorithm, International journal of computer theory and engineering, Vol. 2, No. 3, June 2010.
9. Yu Bin, Yang Zhong-Zhen, Yao Baozhenl.: An improved ant colony optimization for vehicle routing problem, Elsevier, European Journal of Operational Research 196 (2009) 171–176.
10. TAN Guan-Zheng HE Huan, Sloman Aaron,: Ant Colony System Algorithm for Real-Time Globally Optimal Path Planning of Mobile Robots, Acta Automatic Sinica, Vol. No: 33, No. 3, March, 2007.

Iterative Sorting-Based Non-dominated Sorting Algorithm for Bi-objective Optimization

Vikas Palakonda and Rammohan Mallipeddi

Abstract This paper proposes an iterative sorting-based non-dominated sorting (NDS) for bi-objective optimization to reduce the overall runtime of NDS by iteratively employing computationally efficient conventional sorting algorithms. Proposed method is based on the observation that a set of non-dominated solutions on a bi-objective space have the same average rank. Hence, a set of N solutions are sorted by each of the two objectives and an integer rank is assigned to each solution on both the objectives. Then, the average rank of each solution is computed and compared with a threshold (depends on the solutions present in the set) to determine and remove dominated solutions. The process is terminated when all the solutions in the set have same average rank and equal to the threshold. The set of solutions with same average ranks being non-dominated is assigned to the current front. This procedure is repeated until every solution in the set is assigned to respective fronts. The performance of proposed method is evaluated and compared with existing NDS algorithms.

1 Introduction

In Pareto-based multi-objective evolutionary algorithms (MOEAs) [1, 2], quality of candidate solutions is determined based on Pareto-dominance. The Pareto-dominance relationships in a given set of solutions can be established through non-dominated sorting (NDS). NDS can be defined as the process of grouping a set of solutions into different levels referred to as Pareto-fronts depending on the dominance relationships or quality of the solutions. In other words, NDS groups solutions in a way that "solutions in a given front remain non-dominated [3] with respect to each other and are dominated by at least one solution in the previous front" [4].

V. Palakonda (✉) · R. Mallipeddi
School of Electronics Engineering, Kyungpook National University,
Bukgu, Daegu 702 701, Republic of Korea
e-mail: vikas.11475@gmail.com

R. Mallipeddi
e-mail: mallipeddi.ram@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_13

However, NDS is computationally intensive as it involves a pair-wise comparison between solutions to determine the Pareto-dominance relationships. In addition, since the comparison between two solutions involves all the objectives, the computational complexity of NDS increases with the objectives (M) and population size (N). Therefore, an effective NDS plays a vital role in the implementation of Pareto-based MOEAs. In addition to the naïve approach [1], various computationally efficient NDS algorithms such as fast NDS [2], deductive sort [5], corner sort [6], effective non-dominated sorting (ENS) [4], etc. were proposed.

A naïve approach to perform NDS [1] is to compare each solution with the others in the set and the solutions which are non-dominated are assigned to the current front and are temporarily removed. The remaining solutions are then compared to each other to find the non-dominated solutions that need to be assigned to the next front. Due to repetitive comparisons between the similar pairs of solutions, the naïve approach is computationally intensive. Therefore, fast NDS was proposed [2] in which a book-keeping procedure is adopted to store the dominance relationships so that the repetitive comparisons can be avoided. In other words, the time complexity is reduced with an increase in the space complexity. In deductive sort [5], the dominance relationships are stored effectively in the form of a graph which reduces the space complexity of deductive sort compared to fast NDS. In corner sort [6], non-dominated solution termed as corner solution is first obtained and is compared with the other solutions to mark the dominated solutions thus avoiding redundant comparisons. In other words, if the corner solution dominates a solution, then the dominated solution need not be compared to any other solutions in the set. However, corner sort is efficient only when the objectives are high.

NDS algorithms based on the divide and conquer mechanism have been proposed in [7, 8]. In Jensen's sort, the solutions are recursively divided by sorting on one of the objectives before comparing. However, Jensen's sort is not applicable when the population contains duplicate solutions [5]. In addition to the concept of divide and conquer, the authors in [8] adopt a data structure called dominance tree to reduce the computational complexity and memory requirements. Recently, an efficient NDS referred to as ENS [4] was proposed where the solutions are sorted on one of the objectives (generally first objective). In the sorted order, the first solution being non-dominated is assigned to the first front and the solutions that follow are compared only with those solutions which have been already assigned to the respective fronts. Depending on the sequence in which the algorithm proceeds to find the appropriate front, two variants referred as sequential search and binary search have been proposed [4]. The binary search approach performs better in bi-objective while the sequential search performs better with the increase in the objectives.

From the above, it is evident most previous works **aim to reduce the dominance comparisons in order to reduce overall runtime**. ***However, none of the works considers the actual structure of MOEAs in reducing the time complexity of NDS during the optimization procedure***. In other words, when optimizing a multi-objective problem using Pareto-based MOEAs, it is observed that:

(1) number of Pareto-fronts in the population decreases with increase in the number of generations [9].
(2) individuals from the top-ranked fronts will be parents of next generation [2].

Therefore, designing a NDS algorithm with computational complexity going from worst-case to best-case with the decrease in the fronts present in the population would be appropriate. In addition, during the selection operation in elitism-based MOEAs, only the individuals in the top few fronts are considered as the solutions in the first front are considered to be better than solutions in the second front and so on. Therefore, a NDS algorithm that sorts individuals' front-by-front (top-ranked solutions are assigned to the first front in the first iteration and so on) is more apt as the sorting procedure can be stopped once the required number of solutions is obtained after obtaining the first few fronts. Hence, it can save the overall execution time of MOEA.

In this chapter, we propose a NDS algorithm that ***iteratively*** employs the computationally ***efficient conventional sorting algorithms which sort and rank the individual solutions on each of the objectives***. In a given set of N solutions, after sorting and ranking, the average rank of each individual is calculated and solutions that have an average rank greater than the threshold $(N+1)/2$ are termed as dominated and removed temporarily. The procedure is iterated with the remaining set of solutions until all the solutions in the current set have the same average rank equal to $(N'+1)/2$, where N' is the cardinality of the current set. The set of solutions that have the same average rank equal to the threshold is said to be non-dominated and is assigned to the same front. This process repeats until all the N solutions in the original set are assigned to the respective fronts. Since the proposed method employs the conventional sorting algorithms iteratively, it is referred to as ***iterative sorting-based non-dominated sorting*** (ISNDS). The proposed ISNDS satisfies the two conditions: (1) it has the best-case complexity when the number of fronts is minimal and (2) assigns solutions front-by-front. ***However, ISNDS is applicable only for bi-objective optimization problems***. In addition, it is to be noted that NDS algorithms such as Jensen's sort [4] and ENS [6] also employ conventional sorting algorithms. In ENS, the solutions are sorted only once and on one of the objectives to order the solutions and then assign solution-by-solution to the respective fronts.

The rest of the paper is organized as follows. In Sect. 2, the description of the proposed ISNDS algorithm for bi-objective optimization is presented. In Sect. 3, the experimental setup and analysis of the simulation results are presented. Finally, the conclusion is presented in Sect. 4.

2 Iterative Sorting-Based NDS Algorithm

In this paper, an iterative sorting-based NDS applicable to bi-dimensional objective spaces is proposed. To reduce overall runtime complexity of NDS procedure, the proposed algorithm employs computationally efficient conventional sorting

algorithms to sort solutions on each of the two objectives separately. Because of iterative sorting, the number of pair-wise comparisons between the solutions required to determine the Pareto-dominance reduces, resulting in the reduction of the runtime complexity. In addition, the overall runtime of the proposed ISNDS can be reduced further due to the effectiveness of the conventional sorting algorithms. The proposed algorithm is based on the following observations.

Observation 1: In a bi-objective space, given a set of $\boldsymbol{N}$ solutions, if all the solutions are non-dominated, then the average rank of each solution would be $(\boldsymbol{N}+1)/2$.
Observation 2: In a bi-objective space, given a set of $\boldsymbol{N}$ solutions where $(\boldsymbol{N}-1)$ solutions are non-dominated with each other and the other solution being dominated then the average rank of the dominated solution will be greater than $(\boldsymbol{N}+1)/2$.

As described in Algorithm 1, the proposed method starts by sorting and ranking the solutions on each objective. Then, the average rank of each solution is computed and compared with the threshold. The threshold depends on the solutions in the current set that are sorted and ranked. In other words, if $\boldsymbol{N}'$ solutions present in the current set then the threshold is $(\boldsymbol{N}'+1)/2$. The solutions having average rank greater than the threshold are eliminated as they are dominated (**Observation 2**). After removing the dominated solutions, the process of sorting, ranking, calculations, and comparing the average ranks with the threshold continues until no solutions are eliminated. The threshold needs to be evaluated every iteration depending on the cardinality of the current set. When none of the solutions are eliminated then the average rank of all the solutions in the set will be the same and will equal to the threshold. Then the solutions in the set are non-dominated and are assigned to the current front (**Observation 1**). The process continues until all the solutions present in the original population $\boldsymbol{P}$ are assigned to some front or the other.

The graphical illustration of the proposed algorithm is depicted in Fig. 1. Figure 1a shows the location of the solutions in the bi-objective space, their individual ranks, the average rank and the threshold. Based on the threshold solutions, S_1, S_2, S_6, S_9, and S_{10} can be removed as they are dominated and cannot be in the current front (Front 1). Similarly, from Fig. 1b, depending on the threshold solutions, S_4 and S_5 are identified as dominated and are removed. From Fig. 1c, it can be witnessed that none of the solutions can be removed because all the solutions have the same average and equal to the threshold. Therefore, according to **Observation 1**, they are non-dominated and can be assigned to the current front (Front 1). After assigning solutions to Front 1, the solutions belonging to Front 1 are temporarily removed and the above procedure is repeated to fill Front 2. The process goes until all the solutions are assigned to some of the fronts as shown in Fig. 1.

Algorithm 1: Proposed ISNDS

Input: Population $\boldsymbol{P}$ of size $\boldsymbol{N}$
Output: NoF (Front number of each solution in $\boldsymbol{P}$)
$i = 1$
DO
  Unmark solutions that are not assigned to any front
  $\boldsymbol{Q}$ = Set of all unmarked solutions
  N' = Number of solutions in $\boldsymbol{Q}$
  DO
    Sort & rank solutions in $\boldsymbol{Q}$ on each objective
    Calculate the average rank of each solution and the threshold $(N' + 1)/2$
    Mark and remove solutions with average rank > threshold
  UNTIL no solutions are eliminated
  Assign the unmarked solutions to front $\boldsymbol{i}$
  $\boldsymbol{i} = \boldsymbol{i} + 1$
UNTIL all the solutions in $\boldsymbol{P}$ are assigned to some fronts.

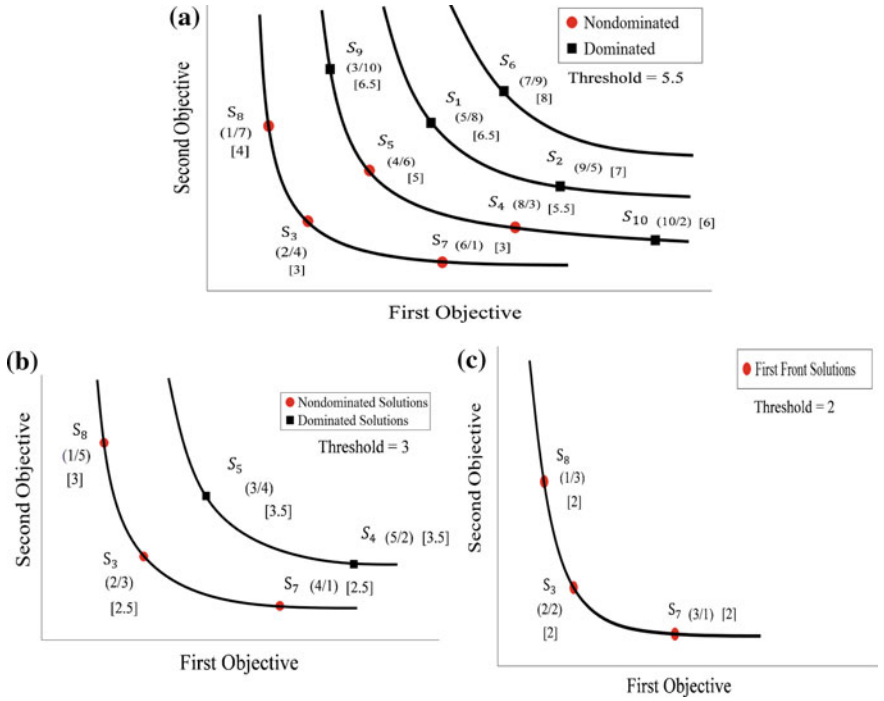


Fig. 1 Graphical illustration of proposed ISNDS algorithm. Values in ( ) represent the ranks on first and second objectives, respectively, while value in [ ] represents the average rank

3 Experimental Setup and Analysis of Simulation Results

In this section, we present the simulation results to compare and investigate the performance of the proposed NDS algorithm. Since the proposed method is designed to work on a bi-objective space, we compare its performance with ENS approaches (ENS-SS and ENS-BS) as they are proved to be more efficient for bi-objectives in terms of runtime complexity. To compare the performance, we performed the experiments on two different artificial datasets—(a) random population of solutions referred to as cloud and (b) population of solutions with a different number of fronts. As in literature [4], we employ the following two performance indicators to assess the NDS algorithms: (a) ***number of comparisons (sorting and pair-wise dominance comparisons in ENS, sorting and threshold comparisons in ISNDS)*** and (b) ***runtime***.

In MOEAs, the number of fronts in the population keeps decreasing as the population evolves over the generations. Therefore, we test the performance of NDS algorithms by incorporating in an MOEA framework that is used to solve a bi-objective optimization problem. All the simulations reported are performed on a PC with a 3.40 GHz Intel Core i7-2600QM CPU and Windows 10 64-bit operating system.

3.1 Experiments on Dataset with Fixed Number of Fronts

To study the effect of varying number of fronts, we divide a population into a fixed number of fronts where the fronts vary from 1 to 70. In the current study, a fixed population of 2000 solutions is assigned a fixed number of fronts [4].

Figure 2 summarizes the simulation results of the proposed ISNDS along with ENS-SS and ENS-BS. In Fig. 2a, the sorting comparisons, the comparisons with

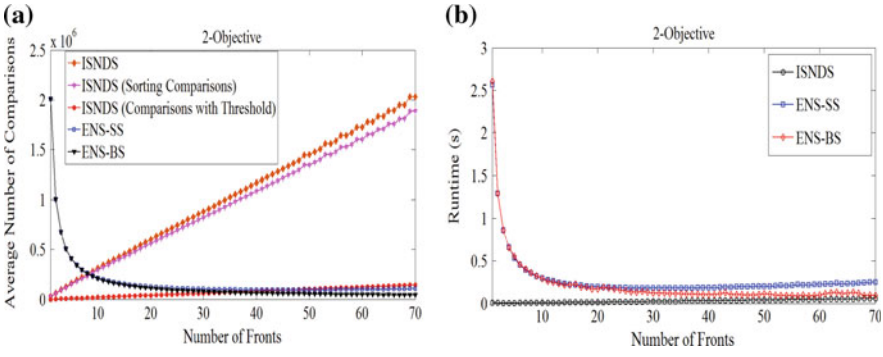


Fig. 2 Comparison of ENS and ISNDS on fixed fronts

the threshold and the total comparisons are presented to better analyze the proposed algorithm. From Fig. 2a, it can be observed that the total comparisons taken by the proposed algorithm are significantly lower than ENS-SS and ENS-BS when the number of fronts is less. However, as the fronts in the population increase the total average number of comparisons needed for the NDS procedure increases steeply in the case of the proposed algorithm. In ISNDS, the increase in the total comparisons is mainly due to the increase in the number of times the conventional sorting procedure is repeated. In other words, in a set with fixed population size, as the fronts increase the quantity of solutions per front decreases leading to the increase in the number of times the conventional sorting procedure needs to be iterated.

However, from Fig. 2b, it can be observed that the time taken by ISNDS increases with the fronts but less compared to the time taken by ENS-SS and ENS-BS. Even though the comparisons required by ISNDS are higher compared to ENS versions, the runtime of ISNDS is significantly low or comparable due to the type of comparisons that are being performed. In other words, ISNDS performs conventional sorting and comparisons with a threshold which are significantly faster compared to the pair-wise comparisons performed in ENS. Therefore, the total run time of the proposed method is significantly low when the number of fronts is low and comparable when the fronts increase. In addition, it can be observed that ISNDS has best-case complexity when the number of fronts is minimal and therefore would be more suitable to be employed in MOEAs.

3.2 Experiments on Random Populations

In this setup, we generated random populations with different sizes varying from 100 to 5000 at an increment of 100 solutions. For analysis, we generated a population randomly, which consists of the candidate solutions whose objective values are arbitrarily sampled from a uniform distribution on the interval [0, 1].

From Fig. 3a, it can be observed that ISNDS requires more comparisons than ENS-BS and ENS-SS. In addition, the total comparisons increase drastically with increasing population size. The increase in the total comparisons is due to the increase of fronts with increasing population size. The increase in the fronts requires the sorting procedure to be employed multiple times increasing the sorting comparisons. However, the runtime taken by ISNDS is comparatively low when compared to ENS as observed in Fig. 3b. As discussed above, the reduction in the runtime of the proposed ISNDS can be attributed to the type of comparisons that are performed.

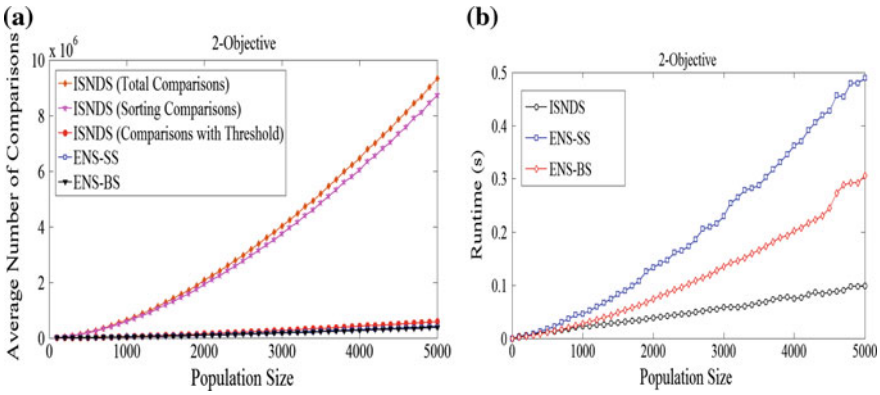


Fig. 3 Comparison of ENS and ISNDS on random populations

Table 1 Runtimes (mean and standard deviation) of NSGA-II for 10 runs on DTLZ1

N	Runtimes (mean and standard deviation)		
	ENS-BS	ENS-SS	ISNDS
200	2.62 (0.04)	4.20 (0.18)	**1.54 (0.06)**
800	11.15 (0.21)	31.19 (1.09)	**4.62 (0.18)**
1000	14.58 (0.25)	44.41 (1.33)	**5.60 (0.13)**
2000	30.35 (0.35)	132.93 (3.60)	**11.62 (0.16)**

3.3 Performance Comparison of NDS Algorithms in NSGA-II Framework

In this setup, we compare the runtime of different NDS algorithms in the NSGA-II framework on a bi-objective optimization problem (DTLZ1). We simulated each set of experiments for 10 times for 250 generations with population sizes of 200, 800, 1000, and 2000 individuals. The parameters of NSGA-II employed are SBX crossover, whose crossover ratio is 1, polynomial mutation strategy with mutation ratio of (1/dimension). The simulation results are presented in Table 1. The best results are highlighted in bold.

From the results, it can be witnessed that ISNDS performs better than ENS in NSGA-II framework. In addition, as the population size increases the runtime of ISNDS reduces significantly compared to ENS-BS and ENS-SS. The improved performance of ISNDS compared to ENS can be attributed to the following—(a) during evolution, as the fronts in the population diminish; the runtime of ISNDS reduces as it approaches the best-case unlike in ENS; (b) sorting procedure of ISNDS can be halted once the required number of solutions is assigned to the fronts because the dominance relationship between those solutions is not of any importance. Because, in NSGA-II, after combining the parents and offspring population, exactly half of the best individuals go to the next generation.

4 Conclusion

In this paper, an iterative sorting-based NDS algorithm (ISNDS) for bi-objective optimization problems is proposed. The proposed method shows significant improvement in terms of runtime compared with the state-of-the-art algorithms such as efficient NDS (ENS). The effectiveness of the proposed ISNDS algorithm is more significant when incorporated in MOEA framework. The significant improvement in the performance is due to (a) conventional sorting procedure which is computationally efficient, (b) comparisons are done with respect to a threshold or constant that are significantly fast, (c) computational complexity decreases with decrease in number of fronts which is essential when incorporated in MOEAs, (d) assigns solutions in a front-by-front basis and therefore can be halted once the required number of solutions is obtained from the currently available fronts. In future, we would like to investigate the current sorting-based algorithm for the problem of level update that is generally employed in steady-state MOEAs for non-dominated sorting.

Acknowledgements This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology under the Grant NRF-2015R1C1A1A01055669.

References

1. N. Srinivas and K. Deb, "Muiltiobjective optimization using nondominated sorting in genetic algorithms," Evolutionary Computation, vol. 2, pp. 221–248, 1994.
2. K. Deb, A. Pratap, S. Agarwal, and T. Meyarivan, "A fast and elitist multiobjective genetic algorithm: NSGA-II," IEEE Trans. on Evolutionary Computation, vol. 6, pp. 182–197, 2002.
3. A. Zhou, B.-Y. Qu, H. Li, S.-Z. Zhao, P. N. Suganthan, and Q. Zhang, "Multiobjective evolutionary algorithms: A survey of the state of the art," Swarm and Evolutionary Computation, vol. 1, pp. 32–49, 2011.
4. X. Zhang, Y. Tian, R. Cheng, and Y. Jin, "An efficient approach to nondominated sorting for evolutionary multiobjective optimization," IEEE Trans. on Evolut. Comput., vol. 19, pp. 201–213, 2015.
5. K. McClymont and E. Keedwell, "Deductive sort and climbing sort: New methods for non-dominated sorting," Evolutionary Computation, vol. 20, pp. 1–26, 2012.
6. H. Wang and X. Yao, "Corner sort for Pareto-based many-objective optimization," IEEE Transactions on Cybernetics, vol. 44, pp. 92–102, 2014.
7. M. T. Jensen, "Reducing the run-time complexity of multiobjective EAs: The NSGA-II and other algorithms," IEEE Trans. on Evolut. Comput., vol. 7, pp. 503–515, 2003.
8. H. Fang, Q. Wang, Y.-C. Tu, and M. F. Horstemeyer, "An efficient non-dominated sorting method for evolutionary algorithms," Evolutionary Computation, vol. 16, pp. 355–384, 2008.
9. K. C. Tan, M. H. Lim, X. Yao, and L. Wang, Recent advances in simulated evolution and learning vol. 2: World Scientific, 2004.

Harmonic and Contra-Harmonic Mean-Centric JPEG Compression for an Objective Image Quality Enhancement of Noisy Images

G. Srinivas, P. Naga Srinivasu, T. Srinivas Rao and Ch. Ramesh

Abstract The operations of conveyed information across the Internet have soar exponentially over the past two decades. Image compression is a significant approach to shrink an image. JPEG is the core prevailing still image compression for bandwidth preservation. So images could be ensued and transmitted earlier. In this paper, the anticipated JPEG algorithms manifest finer conclusions compared to conventional JPEG compressed data in terms of image encoded bits on images might be corrupted with speckle, Poisson, and salt-and-pepper noise. The proposed JPEG compression algorithms are built on image smoothening operators mean, median, harmonic mean, and contra-harmonic mean that enhances speed while minimizing memory necessities by tumbling the number of encoded bits.

1 Introduction

A bunch of symbols are gathered by the encoder once after the input image $f(x, y)$ has been passed to it. And then the resultant encoded image is passed to the decoder after the transmission through the channel. Finally restructured image $f'(x, y)$ is generated

G. Srinivas (✉)
Department of IT, Anil Neerukonda Institute of Technology and Sciences, Visakhapatnam 531163, India
e-mail: gsrinivas.it@anits.edu.in

P. Naga Srinivasu
Department of CSE, Anil Neerukonda Institute of Technology and Sciences, Visakhapatnam 531163, India
e-mail: parvathanenins@gmail.com

T. Srinivas Rao
Department of CSE, GIT,GITAM University, Visakhapatnam 531162, India
e-mail: thamadasrinu_cse@gitam.edu

Ch. Ramesh
Department of CSE, Aditya Institute of Technology and Management, Tekkali, India
e-mail: chappa_ramesh01@yahoo.co.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_14

by the decoder. In lossless compression strategy, the output $f'(x, y)$ is exact the reproduction of $f(x, y)$. If not, there would be some level of misinterpretation is in the appearance of the reassembled image.

The JPEG is the acronym for Joint Photographic Experts Group which was named after the committee who had proposed the approach of compressing a raw image, is a noticeable lossy compression approach for images [1–5]. The information that the image is represented imprecisely with JPEG compression approach, but JPEG has a benefit that consumes minimal memory, and the data in the uncompressed image appears to be very alike it lags only in terms of the quality considerably. But the compressed images will roughly look same as the original images. The JPEG approach normalizes the giant frequencies of the image that the human eye cannot recognize. JPEG compression is the foremost approach for smoothing color/texture/tone conversion of the image.

1.1 Checking the PDF File

JPEG is one such straightforward approach for compressing the image that could be accomplished by the following:

1. The original image is being split into 8 × 8-pixel blocks. In case if the image size is not absolutely multiple of 8, then add zeros in empty pixels around the edges.
2. For each 8 × 8 sized block, the intensities of the pixels are acquired.
3. The Discrete Cosine Transform (DCT) is applied to each 8 × 8 block and the resultant value is obtained.
4. The DCT of each 8 × 8 block has to be multiplied by a normalized mask to make a number of values as zero.
5. Normalization reduces most of the high-frequency components. Next, is the mixed array of important 2-D normalized DCT coefficients by traversing in ZIGZAG fashion, categorizing them in a 1-D array. In 1-D array, there are two types of DCT coefficients: the first one is termed as direct current (DC) element, while other coefficient is called as alternating current (AC) elements. Variable-length Huffman coding is used to code AC components.
6. Decompression is achieved in a reverse order. By utilizing Huffman codes, it initially estimates the normalized DCT values by decoding the compressed bit stream. All the DCT values are then arranged in a 2-D array in a meandering fashion as explained previously. The decoded DCT values are acquired by multiplying them with normalization coefficients. Now an IDCT is executed on the denormalized DCT array. The decoding process generates an ensuing image block which will not be similar as respective original image block used during encoding.

Harmonic mean is a kind of aggregated average of a group of individual values. The harmonic mean of a group of h numbers could be defined as the division among h and the sum of reciprocals of the numbers. The harmonic mean of 'h' variables (v_1, v_2, v_3…,v_h) could be given by

$$\frac{h}{\frac{1}{v1} + \frac{1}{v2} + \frac{1}{v3} + \cdots + \frac{1}{vh}}.$$

Function complementary to the harmonic mean derives the Contra-harmonic mean. Contra-harmonic mean of 'C' variables (v_1, v_2, v_3…,v_c) is given as

$$\frac{v_1^2 + v_2^2 + v_3^2 + \cdots + v_c^2}{v_1 + v_2 + v_3 + \cdots + v_c}.$$

Mean is deliberated by summing up all the stated individual values and dividing the value by the number of data entities. The mean of 'h' variables (v_1, v_2, v_3…,v_n) is given as

$$\frac{v_1 + v_2 + v_3 + \cdots + v_h}{h}.$$

Median is the manner to identify the middle value. In case the total entities in the list are odd, the median will be the middle entry in the list after sorting the individuals in ascending order. When the total entities of the list are even the median is equal to the sum of two middle numbers divided by two.

2 Intended Adaptive JPEG Compression Approaches

If 8 × 8 blocks include plenty of dissimilitude in pixel intensity values, then obviously the figure of constructive DCT coefficients may increase considerably. Otherwise, hardly the initial DCT coefficients will be more notable while remaining are zeros. By superimposing filter over the image, the image gets smoothened and as a result the distinction between the pixel values of a block will be normalized [6–9].

The proposed JPEG algorithms are executed in three distinct ways:

1. Prior to separating the image into 8 × 8 blocks, the images adulterated with Poisson/Speckle noise are elaborated using a harmonic mean filter.
2. Further to segregate the noisy image 8 × 8 blocks, the image is accelerated towards the mean and median filters.
3. Before partitioning the noisy image into 8 × 8 blocks the image is convoluted with contra-harmonic mean.

2.1 Execution of Planned JPEG Algorithms

In this paper, the suggested JPEG compression approach is executed on images of sizes 256 × 256, 512 × 512, and 1024 × 1024. Approximation of calculated results authorizes that the proposed compression techniques had manifest qualitative results and are the best alternatives since they are proved to be superior in terms of image quality metrics like PSNR and MSE [8, 9].

Let Q_1 be the quantity of data units required to signify uncompressed information (original image) and Q_2 be the number of elements in the encoded dataset, where both Q_1 and Q_2 are characterized under same units (Fig. 1):

$$C_R = Q_1/Q_2.$$

When the uncompressed original raw image quantity $Q_1 \ll$ encoded data set $N2$,

C_R is the compression ratio that specifies the degree of compression and $I_E \rightarrow 1$ specifies the refined compression.

The reconstructed image is identical to the original raw image with lossless compression techniques as they not only obliterate redundancy data present in the image but also conserve the sensitive information present in the raw image. The original image will not be same as that of the decompressed image with lossy compression algorithms, so higher compression is attained with lossy compression-based algorithms. To classify the variation among the raw and decompressed image, either objective fidelity criteria or subjective fidelity criteria are used.

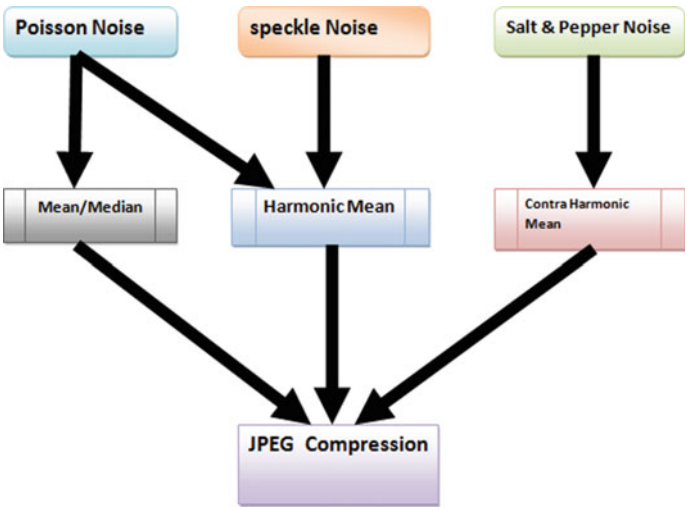


Fig. 1 Structure of planned JPEG algorithms

This paper exhibits the performances between the proposed approaches with the standard JPEG compression. The planned approaches illustrate enhanced results compared to the JPEG in terms encoded bits. This paper makes use of MATLAB tools to admittance the proposed algorithms and the images are downloaded from SIPI image database.

Algorithm 1: Harmonic mean-based JPEG algorithm
Step 1: Peruse the image.
Step 2: Apply speckle/Poisson noise.
Step 3: Apply harmonic mean.
Step 4: Standard JPEG compression

See Tables 1, 2, 3, 4, 5, 6, 7 and 8.

Table 1 Traditional JPEG-based compression over a 512 × 512 image corrupted with Poisson noise

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	288,528	292,370	290,948	280,512
RMS error	6.73	6.85	6.60	6.26
Compression ratio	7.26	7.17	7.2	7.47
PSNR	37.63	37.48	37.80	38.25
MSE	45.29	46.88	43.50	39.22

Table 2 Traditional JPEG-based compression over a 1024 × 1024 image corrupted with Poisson noise

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	758,082	1,224,942	1,050,327	1,263,542
RMS error	6.42	6.23	6.16	6.53
Compression ratio	11.06	6.84	7.98	6.63
PSNR	46.91	44.32	44.42	43.91
MSE	21.38	38.78	37.92	42.59

Table 3 Traditional JPEG-based compression over a 512 × 512 image corrupted with speckle noise

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	320,639	383,073	317,790	289,040
RMS error	7.17	7.77	7.06	6.49
Compression ratio	6.54	5.47	6.59	7.25
PSNR	37.08	36.38	37.20	37.94
MSE	51.35	60.37	49.90	42.11

Table 4 Traditional JPEG-based compression over a 1024 × 1024 image corrupted with speckle noise

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	1,381,120	1,200,240	1,067,788	1,378,967
RMS error	6.91	6.06	6.28	6.91
Compression ratio	6.07	6.98	7.85	6.08
PSNR	43.42	44.55	44.25	43.42
MSE	47.76	36.78	39.45	47.74

Table 5 Proposed JPEG through harmonic mean-based compression over a 512 × 512 images corrupted with Poisson noise

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	231,949	226,334	232,710	233,413
RMS error	6.98	5.96	6.26	6.01
Compression ratio	9.0284	9.2657	9.0119	8.98
PSNR	37.31	38.68	38.26	38.61
MSE	48.66	35.51	39.17	36.13

Table 6 Proposed JPEG through harmonic mean-based compression over a 1024 × 1024 images corrupted with Poisson noise

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	617,197	1,002,214	839,901	1,042,287
RMS error	4.10	6.42	5.60	8.12
Compression ratio	13.59	8.37	9.98	8.04
PSNR	47.94	44.05	45.25	42.01
MSE	16.84	41.26	31.31	65.96

Table 7 Harmonic based JPEG compression on images corrupted with speckle noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	346,283	1,684,888	342,234	313,258
RMS error	10.23	11.11	10.28	9.29
Compression ratio	6.05	5.08	6.12	6.69
PSNR	33.99	33.27	33.95	34.83
MSE	104.58	123.45	105.6	86.26

Table 8 Harmonic based JPEG compression on images corrupted with speckle noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	631,088	1,172,884	1,176,948	1,455,174
RMS error	4.42	8.15	8.48	11.21
Compression ratio	13.29	7.15	7.12	5.76
PSNR	47.29	41.98	41.24	39.21
MSE	19.58	66.45	71.95	125.74

Algorithm 2: Mean/median-based JPEG Algorithm
Step 1: Read the image.
Step 2: Apply salt-and-pepper noise.
Step 3: Apply the smoothening operators median and mean.
Step 4: Standard JPEG compression.

See Tables 9, 10, 11, 12, 13 and 14.

Table 9 JPEG compression on images corrupted with salt-and-pepper noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	1,733,288	341,790	1,728,735	369,682
RMS error	6.44	5.71	6.4	6.32
Compression ratio	5.76	6.13	5.69	5.67
PSNR	38.01	39.06	38.06	38.17
MSE	s41.50	32.58	40.97	39.96

Table 10 JPEG compression on images corrupted with salt-and-pepper noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	1,490,856	1,655,891	1,453,768	1,587,494
RMS error	6.23	6.73	6.33	6.38
Compression ratio	5.62	5.06	5.77	5.28
PSNR	44.31	43.65	44.18	44.11
MSE	38.83	45.23	40.01	40.66

Table 11 Median-based JPEG compression on images corrupted with salt-and-pepper noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	145,499	98,482	155,798	65,536
RMS error	2.18	1.24	2.36	0.55
Compression ratio	14.41	21.29	13.46	32
PSNR	41.13	47.29	41.49	59.39
MSE	20.20	4.89	18.60	0.30

Table 12 Median-based JPEG compression on images corrupted with salt-and-pepper noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	439,344	787,529	571,358	807,971
RMS error	1.61	2.90	2.12	2.79
Compression ratio	19.09	10.65	14.68	10.38
PSNR	47.67	45.09	47.55	46.78
MSE	17.92	32.45	18.43	22.02

Table 13 Mean-based JPEG compression on images corrupted with salt-and-pepper noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	201,050	189,485	200,507	203,671
RMS error	2.77	2.60	2.89	2.93
Compression ratio	10.431	11.06	10.45	10.29
PSNR	45.34	45.87	44.95	44.86
MSE	7.67	6.78	8.38	8.56

Table 14 Mean-based JPEG compression on images corrupted with salt-and-pepper noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	758,609	912,545	774,874	907,956
RMS error	2.78	2.93	2.71	2.9
Compression ratio	11.05	9.19	10.82	9.239
PSNR	51.33	50.86	51.54	50.97
MSE	7.73	8.59	7.35	8.38

Algorithm 3: Contra-harmonic mean-based JPEG algorithm
Step 1: Read the image.
Step 2: Apply speckle/Poisson noise.
Step 3: Apply contra-harmonic mean.
Step 4: Standard JPEG compression

See Tables 15, 16, 17 and 18.

Table 15 Contra-harmonic-based JPEG compression on images corrupted with Poisson noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	66,572	66,964	66,973	67,831
RMS error	0.34	0.28	0.60	0.41
Compression ratio	31.50	31.32	31.31	30.91
PSNR	63.60	65.27	65.29	62.00
MSE	0.11	0.08	0.08	0.17

Table 16 Contra-harmonic-based JPEG compression on images corrupted with Poisson noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	348,096	246,137	249,682	250,390
RMS error	1.15	0.27	0.27	0.33
Compression ratio	24.09	34.08	33.59	33.50
PSNR	59.01	71.51	71.47	69.80
MSE	1.32	0.07	0.07	0.11

Table 17 Contra-harmonic-based JPEG compression on images corrupted with speckle noise of size 512 × 512

Images	Elaine.512.tiff	8.512.tiff	7.1.03.tiff	7.1.01.tiff
No of bits required	62,578	57,386	62,736	65,456
RMS error	0.46	0.07	0.60	0.47
Compression ratio	33.51	36.44	33.42	32.03
PSNR	60.99	77.22	58.60	60.80
MSE	0.21	0.03	0.36	0.22

Table 18 Contra-harmonic-based JPEG compression on images corrupted with speckle noise of size 1024 × 1024

Images	7.2.01.tiff	5.3.02.tiff	1.4.06.tiff	1.4.02.tiff
No of bits required	261,944	261,780	261,526	252,702
RMS error	0.11	0.31	0.35	0.51
Compression ratio	32.02	32.044	32.07	33.19
PSNR	79.14	70.45	69.41	66.07
MSE	0.01	0.09	0.12	0.26

3 Results and Discussions

This paper spot the comparison between the proposed (Mean/Median)/Harmonic mean/Contra-harmonic mean-based approaches with the standard JPEG compression. The deliberated approaches embody enhanced results compared to the JPEG. Out of these proposed smoothening-based JPEG compressions the harmonic mean filter on images corrupted with on speckle noise in *Algorithm 1*, median filter on images corrupted with salt-and-pepper noise in *Algorithm 2*, and contra-harmonic mean filter on images corrupted with speckle noise encodes the images with fewer number of bits; as a result, the images will be conveyed with a high speed. The crucial implication in image processing is the measurement of image quality. Evaluation and assessing are obligatory for image quality in numerous image processing implementations. The refinement of human to boost the image quality is not adequate. To quantize the quality of the image we had to necessitate few auxiliary image quality metrics like Mean Square Error (MSE) and Peak

Signal-to-Noise Ratio (PSNR). The number of encoded bits required to characterize the compressed image is minimized with the harmonic mean filter on images corrupted with Poisson noise in *Algorithm 1*, median filter on images corrupted with salt-and-pepper noise in *Algorithm 2*, and contra-harmonic mean filter on images corrupted with speckle noise with *Algorithm 3* which results in high compression ratio than the standard JPEG compression.

4 Conclusion

In this paper, (Mean/Median)/Harmonic Mean/Contra-Harmonic Mean-based JPEG compression algorithm is gaged. The images compressed with the suggested approaches hold less encoded bits, and as a result transmission rate enhanced.The untried conclusion shows that a high compression can be achieved when the images corrupted with salt-and-pepper noise are compressed with mean and median-based JPEG compression technique, and the images corrupted with speckle or poison noise are corrupted with harmonic or contra-harmonic-based JPEG compression techniques which result in the images adulate with good renaissance image quality with projected techniques compared to JPEG compression.

References

1. R.C. Gonzalez and R.E. Woods “Digital Image Processing”, 2nd Edition Addison Wesley, USA ISBN 0-201-60078.
2. Olivier Egger and Wei Li, “VERY LOW BIT RATE IMAGE CODING USING MORPHOLOGICAL OPERATORS AND ADAPTIVE DECOMPOSITIONS,” IEEE International Conference on Image Processing Vol-3, PP No. 326–330, Nov-1994.
3. Ricardo L. de Queiroz, Member IEEE, “Processing JPEG-Compressed Images and Documents” IEEE TRANSACTIONS ON IMAGEPROCESSING,” VOL. 7, NO. 12, PP No: 1661–1672, DECEMBER 1998.
4. Ravi Prakash, IEEE Member, Joan L. Mitchell, IEEE Fellow, and David A. Stepneski, “Enhanced JPEG Compression of Documents,” IEEE International Conference on Image Processing Vol-3, PP No: 494–497, Oct-2001.
5. Sreelekha G. and P.S. Sathidevi, “An Improved JPEG Compression Scheme Using Human Visual System Model,” IEEE, PP No: 98–101, June 2007.
6. Ch. Ramesh, N.B.Venkateswarlu and J.V.R. Murthy, “Filter Augmented JPEG Compressions,” IJCA, Vol-60, No-17, PP No: 1–5, Dec-2012.
7. M. Krishna, G. Srinivas, and Prasad Reddy PVGD, “Image Smoothening and Morphological operator based JPEG compression,” JATIT, Vol. 85, No. 3, PP No: 252–259, March 2016.
8. M. Krishna, Prasad Reddy PVGD, G. Srinivas, and Ch. Ramesh, “A Smoothening Based JPEG Compression for an Objective Image Quality Enhancement of Regular and Noisy Images,” IJAER, Vol:11, No-6, PP No: 3799–3804, March 2016.
9. R.V.S.S. Lalitha, P. Naga Srinivasu “An efficient Data Encryption through Image via Prime order symmetric key and Bit shuffle Technique”, IC3T, Springer LNNS series,Nov 2016.

Design of Narrow-Band Bandpass Filter with Extended Stopband Using Open-Loop Triangular Resonators

Yatindra Gaurav and R.K. Chauhan

Abstract A narrow-band bandpass filter with high rejection performance and wide upper stopband is introduced by using two open-loop triangular resonator. The design is less complex and is easy in fabrication since no via or defected ground structure is used. Coupled resonator theory is used for coupling parasitic resonance of multiple degenerate modes of parasitic resonances operating close to fundamental mode in the proposed structure to improve the rejection performance of filter. A wide stopband is obtained on both side of narrow passband with selectivity. The filter proposed is designed and simulated in Agilent Advance Design System. A good agreement is found between the simulated and measured result.

1 Introduction

Planar and compact size of Microwave filters with resonators as fundamental element having narrow bandwidth and high performance are in high demand due to its importance in present scenario of various communication systems [1–8].

An effective approach is adopted by many researchers to minimize the size of filter is by reducing the size of resonator. There are number of approaches to reduce the size of resonator, one of them is by modifying physical structure, and the other one is by using additional structure to traditional resonators so that it generates additional modes [8–10]. A single resonator can be said as multi-electrical resonator when the additional structures are added to it having compact size and low insertion loss. In single multimode resonator a challenging part is the coupling of degenerate modes of parasitic resonances to fundamental modes operating close to it. A continuous effort is being given by many researchers to overcome it [11–18].

Y. Gaurav (✉) · R.K. Chauhan
Department of Electronics and Communication Engineering,
Madan Mohan Malaviya University of Technology, Gorakhpur, Uttar Pradesh, India
e-mail: ygaurav2000@gmail.com

R.K. Chauhan
e-mail: rkchauhan27@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_15

In this paper, a single narrow-band bandpass filter using cascaded open-loop triangular ring resonator loaded with coupled stubs is proposed. The dielectric material that is being used in designing the proposed filter is Rogers RT Duroid 6010 with dielectric constant as 10.2 and thickness as 1.27 mm.

2 Design of Single Narrow-Band Bandpass Filter

Open-loop triangular ring resonator is used in designing the filter because it has small size when compared to conventional resonators. Single multimode resonator is achieved by cascading two open-loop triangular ring resonator showing wide stopband on both the sides of passband.

Figure 1 shows the conventional design of open-loop triangular ring resonator. Different frequency responses with different position and sizes of perturbation can be obtained for bandpass filter. The coupling strength is based on the nature and extent of the field, which is further determined by the length and width of the sides of triangular ring resonator with the relative dielectric constant and its thickness. Open-loop resonators execute ion loss and better coupling when compared to closed-loop resonators since they are associated with both electric coupling and magnetic coupling.

Open-loop triangular ring resonator coupled in series with transmission line shows a passband centered at its resonating frequency in the s-parameter characteristics, see Fig. 2, the resonant frequency is given by

$$f_o = \frac{c}{2L\sqrt{\varepsilon_{\text{eff}}}} \tag{1}$$

where, C = speed of light, f_o = fundamental resonant frequency, L = length of microstrip line, and ε_{eff} = effective dielectric constant. A resonant frequency centered at 8 GHz is obtained in frequency response. A wide stopband is achieved on both side of passband. The insertion loss and return loss in passband is 1.1 and 18.7 dB. The selectivity at the passband edges is achieved. An upper stopband extends from 18.2 to 18 GHz with return loss less than 3 dB and maximum value of insertion loss as 29 dB is obtained, see Fig. 2.

A coupling associated with open-loop triangular ring is improved by loading coupled stubs, see Fig. 3. Coupled stubs improve the both, magnetic coupling and electrical coupling at the open-loop area, and its impact on frequency response is

Fig. 1 Structure of open-loop triangular ring resonator coupled in series with transmission line

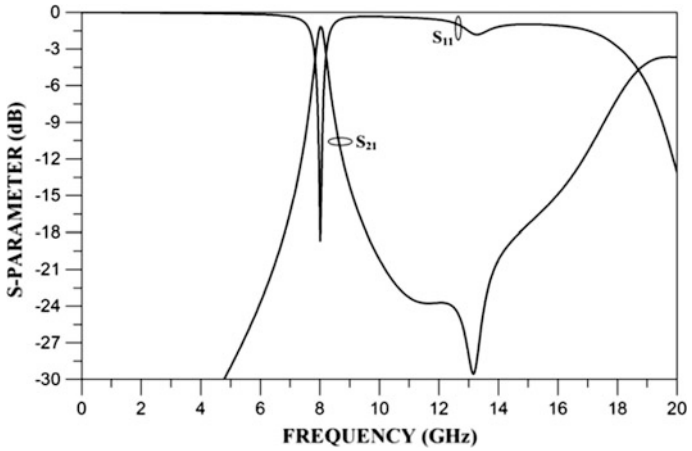


Fig. 2 Frequency response of open-loop triangular ring resonator coupled in series with transmission line

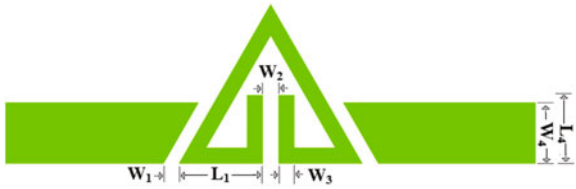


Fig. 3 Structure of open-loop triangular ring resonator loaded with stub

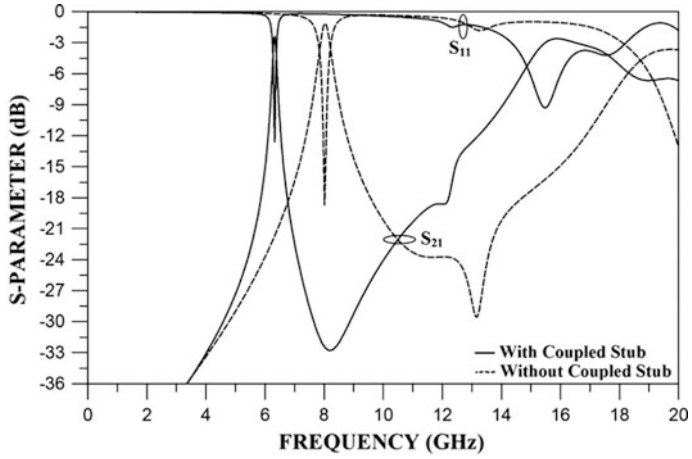


Fig. 4 Comparative frequency response of open-loop triangular ring resonator loaded with stub

shown in Fig. 4. The length of stubs and its coupling distance controls the center frequency of passband that is its resonance frequency. A shift of resonant frequency and higher harmonics is seen toward the lower frequency side, it is due to the degeneration of modes that generates the attenuation pole due to cross coupling. The resonant frequency is 6.3 GHz with insertion loss as 2.4 dB and return loss as 12 dB. A wide stopband is seen on both the sides of passband with selectivity, see Fig. 4. The loaded coupled stub length controls the center frequency of passband, see Fig. 5.

To improve the passband performance and rejection performance of the filter, an additional stub extended to port is coupled with the two adjacent coupled cascaded similar structure of open-loop triangular ring resonator, see Fig. 6. The addition of line stub that is coupled with the open-loop area of triangular ring improves both electrical coupling and magnetic coupling. Considering coupled resonator theory, improvement in coupling strength disturbs the field associated with the triangular ring inspiring the degenerate modes creating attenuation poles and transmission

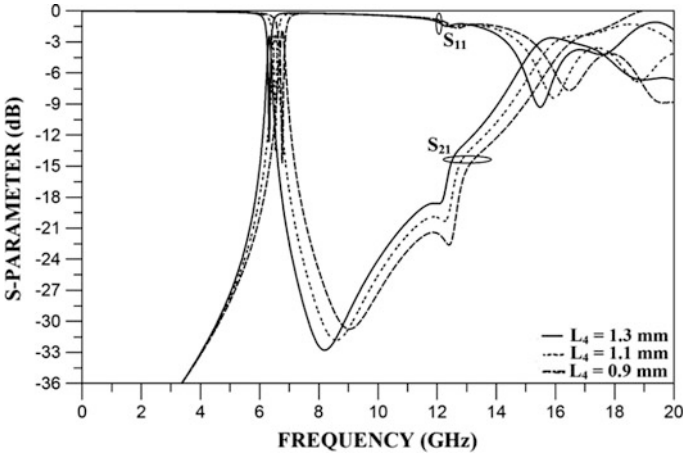


Fig. 5 Comparative frequency response of open-loop triangular ring resonator loaded with stub with varying stub length

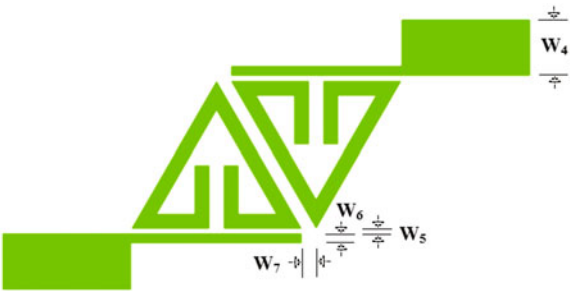


Fig. 6 Structure of proposed filter

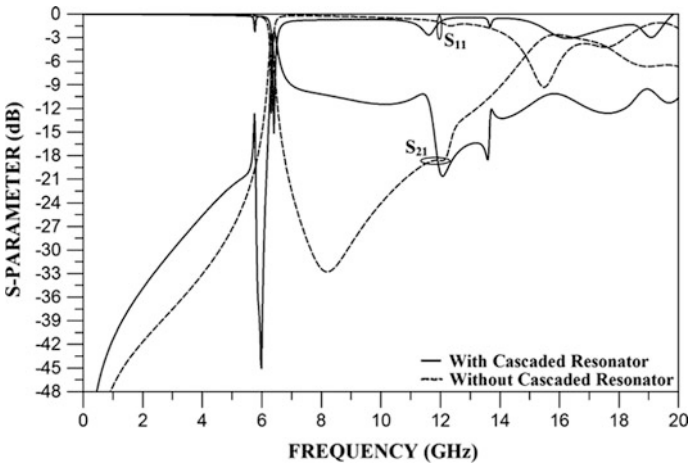


Fig. 7 Comparative frequency response of proposed filter with and without cascaded structure with extended stub at ports

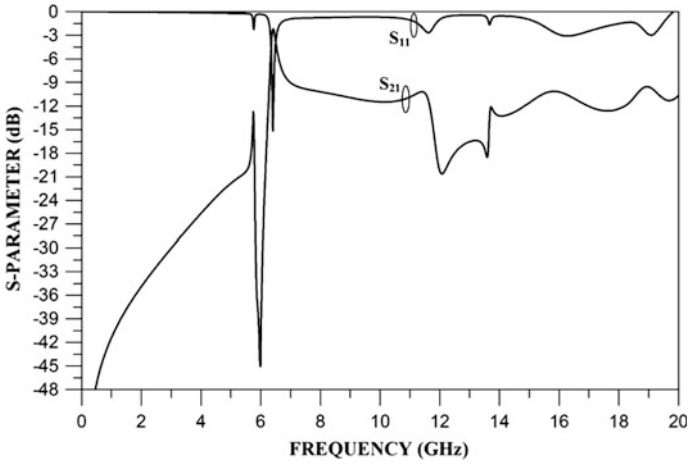


Fig. 8 Frequency response of proposed filter

zeros at the edges of passband. These degenerate modes of parasitic resonances operating close to fundamental frequency are coupled, improving the rejection performance of the filter with selectivity, see Fig. 7. Frequency response of proposed structure has single passband centered at 6.4 GHz. The insertion loss and return loss of passband is 2 and 15.2 dB. A wide upper stopband is obtained that

extends from 6.53 GHz with insertion loss more than 10.4 dB and return loss less than 1 dB, see Fig. 8.

3 Fabrication and Measurement

The optimized dimensions of the proposed design are as follows: $L1$ = 0.7 mm, $L2$ = 3.5 mm, $L3$ = 2.16 mm, $L4$ = 1.3 mm, $W1$ = 0.3 mm, $W2$ = 0.3 mm, $W3$ = 0.3 mm, $W4$ = 1.16 mm, $W5$ = 0.15 mm, $W6$ = 0.2 mm, and $W7$ = 0.3 mm. The

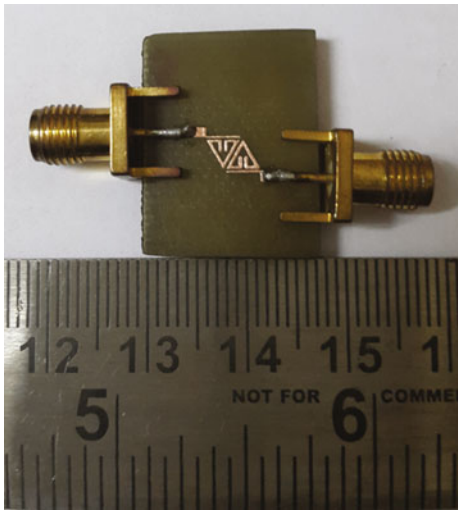


Fig. 9 Photograph of fabricated filter

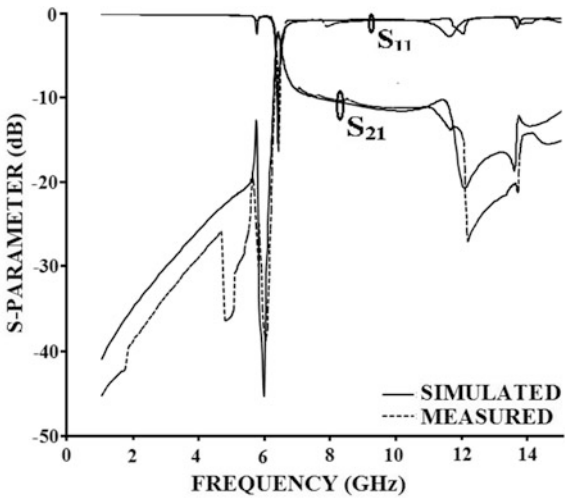


Fig. 10 Simulated and measured frequency response of proposed filter

overall size of the simulated filter is 5.56 mm × 3.63 mm. The photograph of the fabricated filter is shown in Fig. 9. The simulated and measured frequency response of proposed structure has single passband centered at 6.4 GHz. The simulated insertion loss and return loss of passband is 2 and 15.2 dB whereas its counterpart is 1.9 and 16.24 dB. A simulated wide upper stopband extends from 6.53 GHz whereas measured has 6.56 GHz. The simulated value of insertion loss and return loss in upper stopband is more than 10.4 dB and less than 1 dB whereas its counterpart is more than 11 dB and less than 0.85 dB. The 3 dB fractional bandwidth of the passband is 2.1%, see Fig. 10.

4 Conclusion

A compact and planar single narrow-band bandpass filter using two cascaded open-loop triangular ring resonator loaded with stub coupled with a line stub extended to ports is proposed. Coupled resonator theory is being used to convert multiple multimode resonators to single multimode resonator that is coupling of parasitic resonance of multiple degenerate modes operating close to fundamental frequency. Cascading of resonator is done to achieve the extended upper wide stopband and to remove the harmonics of high frequency. The proposed structure generates single narrow passband centered at 6.4 GHz with 3 dB fractional bandwidth of 2.1%. A wide upper stopband is obtained that extends from 6.53 GHz. A good rejection performance with selectivity across the passband is achieved making it applicable in various communication systems.

References

1. Chiou, Y.C. and J.T. Kuo.: Planar multiband bandpass filter with multimode stepped-impedance resonators, Progress In Electromagnetics Research. 114, pp. 129–144 (2011).
2. Huang, X.G., Q.Y. Feng and Q.Y. Xiang.: High selectivity broadband bandpass filter using stub-loaded quadruple-mode resonator, Journal of Electromagnetic Waves and Applications. 26, No. 1, pp. 34–43 (2012).
3. Wang, L. and B.R. Guan.: Compact and high selectivity dual- band bandpass filter using nested dual-mode defected ground structure resonators, Journal of Electromagnetic Waves and Applications. 26, No. 4, pp. 549–559 (2012).
4. Lee, J.R., Cho, J.H. and Yun, S.W.: New compact bandpass filter using microstrip λ/4 resonators with open stub inverter, IEEE Microwave and Guided Wave Letters. 10, pp. 526–527 (2000).
5. Mondal, P. and Mandal, M.K.: Design of dual-band bandpass filters using stub-loaded open-loop resonators, IEEE Trans. Microwave Theory Tech. 56, pp. 150–155 (2008).
6. Kuo, Y.T.: Analytical design of two-mode dual-band filters using E-shaped resonators, IEEE Trans. Microwave Theory Tech. 60, pp. 250–260 (2012).
7. Hong, J.S. and Lancaster, M.J.: Microstrip Filters for RF/Microwave Applications, John Wiley & Sons, Inc. (2001).

8. Sagawa, M., Takahashi, K. and Makimoto, M.: Miniaturized hairpin resonator filters and their application to receiver front- end MIC's, IEEE Trans. Microwave Theory Tech. 37, pp. 1991–1996 (1989).
9. Ma, K., Yeo, K.S., Ma, J.G. and Do, M.A.: An ultra-compact hairpin band pass filter with additional zero points, IEEE Microwave and Wireless Components Lett. 17, pp. 262–264 (2007).
10. Ma, K., Ma, J.G., Yeo, K.S. and Do, M.A.: A compact size coupling controllable filter with separated electric and magnetic coupling paths, IEEE Trans. Microwave Theory Tech. 54, No. 3, pp. 1113–1119 (2006).
11. Awai, I., Kundu, A. C. and Yamashita, T.: Equivalent- circuit representation and explanation of attenuation poles of a multimode dielectric-resonator bandpass filter, IEEE Trans. Microwave Theory Tech. 46, pp. 2159–2163 (1998).
12. Zhu, L., Wecowski, P. and Wu, K.: New planar multimode filter using cross-slotted patch resonator for simultaneous size and loss reduction, IEEE Trans. Microwave Theory and Tech. 47, No. 5, pp. 650–654 (1999).
13. Hong, J.S. and Lancaster, M.J.: Microstrip triangular patch resonator filters, IEEE MTT-S Int. Symp. Dig., pp. 331–334 (2000).
14. Zhu, L., Sun, S. and Menzel, W.: Ultra-wideband (UWB) bandpass filters using multiple-mode resonator, IEEE Microwave and Wireless Components Lett. 15, No. 11, pp. 796–798, (2005).
15. Ma, K., Leong, K.C. B., Jayasuriya, R.M. and Yeo, K.S.: A wideband and high rejection multimode bandpass filter using stub perturbation, IEEE Microwave and Wireless Components Lett. 19, pp. 24–26 (2009).
16. Shaman, H. and Hong, J.S.: A novel ultra-wideband (UWB)bandpass filter (BPF) with pairs of transmission zeroes, IEEE Microwave and Wireless Components Lett. 17, No. 2, pp. 121–123 (2007).
17. Hsieh, L.H. and Chang, K.: Compact elliptic-function low-pass filters using microstrip stepped-impedance hairpin resonators, IEEE Trans. Microwave Theory and Tech. 51, No. 1, pp. 193–199 (2003).
18. Bastioli, S., Tomassoni, C. and Sorrentino, R.: A new class of waveguide dual-mode filters using TM and nonresonating, IEEE Trans. Microwave Theory and Tech. 58, No. 12, pp. 3909–3917 (2010).

Series Fed Patch Antenna Array with CSRR Inspired Ground Plane

Chirag Arora, Shyam S. Pattnaik and R.N. Baral

Abstract In this paper, a series fed, Complementary Split Ring Resonator (CSRR) loaded, microstrip patch antenna array has been presented for 5.5 GHz Wi-Fi applications. The traditional unloaded antenna array resonates at 6 GHz with gain of 7.15 dBi and bandwidth of about 480 MHz. Whereas, when the ground plane under each patch of the same antenna array is loaded with CSRR, the resonant frequency gets shifted to 5.5 GHz, while gain increases to 9.8 dBi. The proposed antenna array has been designed on 1.48 mm thick FR-4 substrate and simulated in Finite Element Method (FEM) based HFSS electromagnetic simulator.

1 Introduction

Microstrip patch antennas are most commonly used planar antennas, as they have low profile, simple structure and low cost. However, they suffer from major drawbacks of low gain and narrow bandwidth, due to surface wave losses, dielectric losses and conductor losses [1]. Several approaches have been used to reduce these losses, such as use of high impedance surface [2], use of photonic bandgap structures [3], use of hybrid substrates [4], use of superstrates [5], etc. But use of all these techniques makes the antenna bulky, along with the difficulty in their fabrication.

C. Arora (✉)
Krishna Institute of Engineering & Technology, Ghaziabad, UP, India
e-mail: c_arora2002@yahoo.co.in

S.S. Pattnaik
National Institute of Technical Teachers' Training and Research, Chandigarh, India
e-mail: shyampattnaik@yahoo.com

R.N. Baral
IMS Engineering College, Ghaziabad, UP, India
e-mail: r.n.baral@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_16

After the realization of artificially designed left-handed metamaterials by Smith et al. [6] in 2000, researchers have tried various techniques to use their peculiar properties for performance enhancement of patch antennas. These techniques include the loading of traditional antennas with the single/double negative metamaterials in various ways, such as loading the patch with Split Ring Resonators (SRR) [7, 8], using metamaterial superstrates [9], etching metamaterial slots on ground plane of conventional microstrip patch antennas [10], etc. Incorporation of metamaterials with traditional antenna has manifold advantages, as these materials not only improve gain and bandwidth of patch antennas, but also produce subwavelength resonance [11], resulting in size reduction of conventional antennas, while retaining their 2-D planar structure. However, there are certain applications, like radars, where the gain and bandwidth improvement achieved by these techniques is still insufficient. In such applications, the arrays are designed by use of multiple patch antennas and quarter wave transformers, which can further be loaded with different shaped metamaterials to obtain the desired results. As per the best knowledge of the authors, till now, almost no attention has been paid towards the metamaterial loading of arrays. Therefore, to take the initiative, in [12–14] different methods have been adopted by the authors to integrate metamaterials with traditional patch antenna arrays for the upliftment of antenna performance parameters.

To extend the work in same direction, in this article, the authors have proposed a series fed, four element microstrip patch antenna array and then its performance is compared with the proposed metamaterial loaded array, which is designed by etching CSRR below the each patch of this conventional array. The novelty of this proposed array lies in the fact that its gain has improved and size has squeezed without any change in the dimensions of its conventional counterpart. Moreover, the 2D planar structure of the antenna has also been retained. This communication is methodically divided into four segments. The design of the traditional and proposed antenna array is discussed in Sect. 2. Section 3 presents the simulated results of designed array and ultimately, the article is ended with conclusions in Sect. 4

2 Antenna Array Design

Figure 1 depicts top view of a series fed traditional microstrip patch antenna array. This conventional antenna array is composed of four microstrip patches, each of dimensions $W = 11.9$ mm $\times$ $L = 15.6$ mm. The four patches are connected to each other with help of quarter wave transformers of dimensions $b = 7.55$ mm $\times$ $a = 0.52$ mm. The dimensions of patch and quarter wave transformer are calculated using transmission line equations [15–17]. FR-4 substrate of thickness $h = 1.48$ mm, loss tangent = 0.01 and dielectric constant of 4.3 is used to design this array and its feeding is done by a 50 Ω connector. Figure 2 shows the bottom view of the proposed array, which has been designed by etching a CSRR below each patch of the conventional array, shown in Fig. 1. Figure 3 presents the geometric sketch of the CSRR unit cell, used for loading the conventional array and its measurements

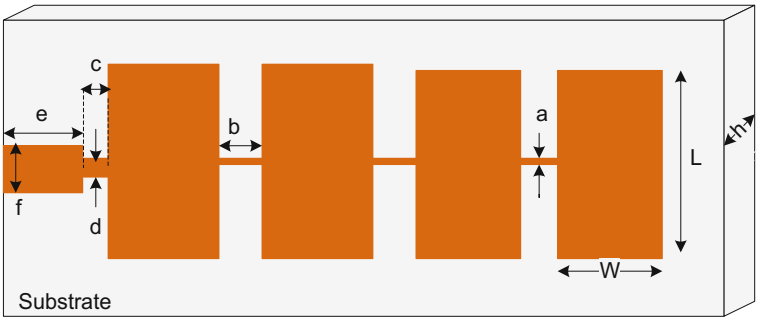


Fig. 1 Geometric outline of the traditional patch antenna array

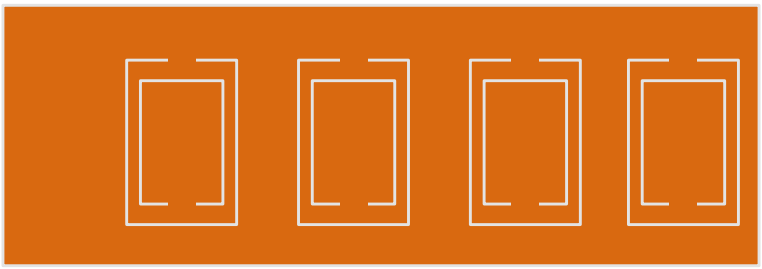


Fig. 2 Bottom view of proposed metamaterial loaded microstrip patch antenna array

Fig. 3 Geometry of metamaterial unit cell

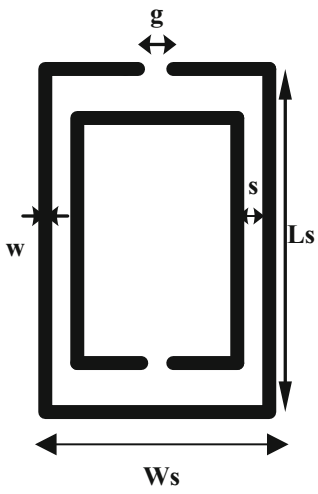


Table 1 Dimensions of CSRR

Parameters of CSRR	Dimensions (mm)
Length of outer ring (*Ls*)	15
Width of outer ring (*Ws*)	11
Split gap (*g*)	2.5
Width of slot (*w*)	1.5
Gap between two slots (*s*)	2

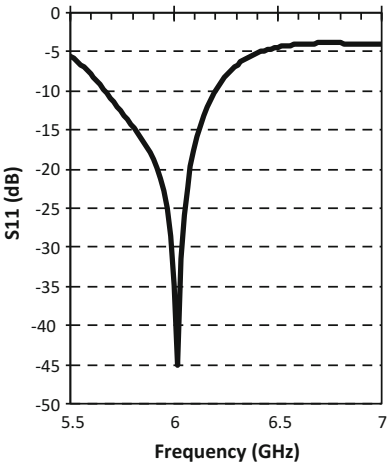


Fig. 4 S_{11} Characteristics of unloaded antenna array (simulated)

are presented in Table 1. This loading of the traditional antenna array has been done in such a way that two dimensional planarity of the proposed array is retained. The simulations are done using FEM based commercial electromagnetic software ANSYS HFSS.

3 Simulated Results and their Analysis

The simulated results of the conventional and designed metamaterial loaded patch antenna array are presented in this section. The return loss characteristics (S_{11}) of the conventional, series fed patch antenna array is presented in Fig. 4. As seen in Fig. 4, this conventional array resonates at 6 GHz with operating bandwidth of about 480 MHz. However, on etching the CSRR below each patch of this conventional array, the resonant frequency reduces to 5.5 GHz, while the bandwidth remains almost same and this is presented in Fig. 5.

The simulated elevation plane radiation patterns of traditional and CSRR loaded antenna array are shown in Figs. 6 and 7, respectively. As seen from these figures, the traditional antenna array resonates at 6 GHz with gain of about 7.15 dBi, whereas, the metamaterial loaded proposed antenna array resonates at 5.5 GHz with gain of 9.8 dBi. On etching the CSRR on ground plane, it interacts with the electric field and offers negative permittivity at resonant frequency.

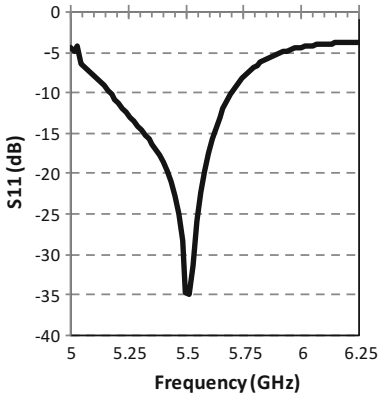


Fig. 5 S_{11} Characteristics of CSRR loaded antenna array (simulated)

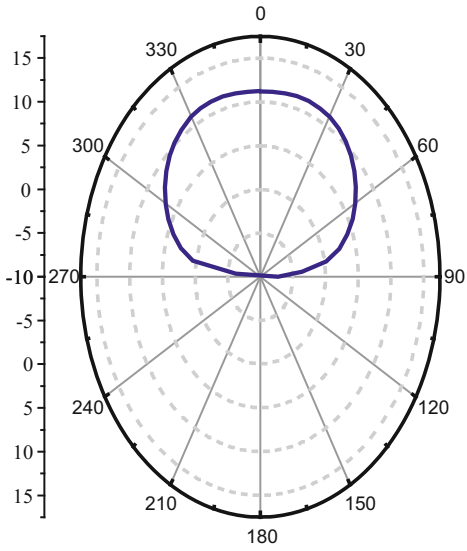


Fig. 6 Simulated elevation plane radiation pattern of traditional antenna array at 6 GHz

Most of the current gets concentrated around CSRR and the original current distribution on the patch gets destroyed. Thus, by selecting the optimized size of CSRR, the subwavelength resonance of the designed antenna array can be attained and thus, size miniaturization and gain enhancement can be obtained. Figure 8 shows the inset shot of top and underneath of the fabricated, proposed CSRR loaded microstrip patch antenna array.

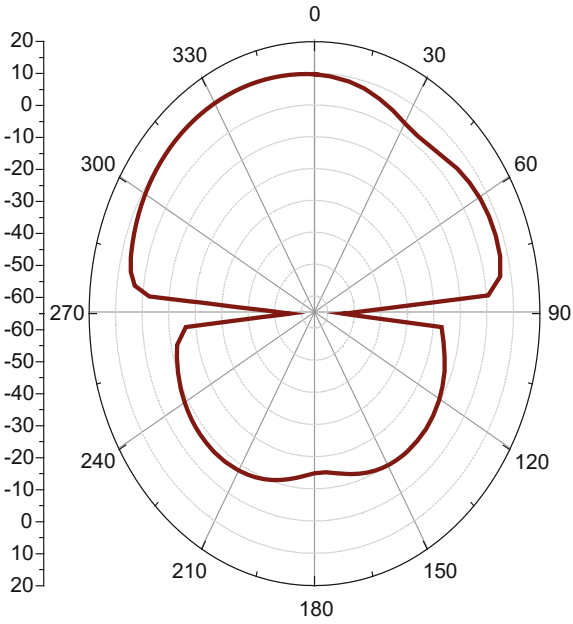


Fig. 7 Simulated elevation plane radiation pattern of CSRR loaded antenna array at 5.5 GHz

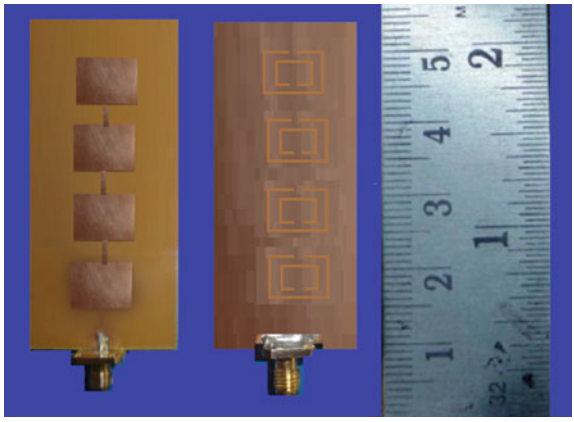


Fig. 8 Inset shot of top and bottom of fabricated proposed antenna array

4 Conclusions

In this communication, a metamaterial inspired microstrip patch antenna array has been proposed for 5.5 GHz Wi-Fi applications. As compared to its conventional counterpart, the size of the proposed CSRR loaded patch antenna array is reduced by 9.16% and gain has increased by 2.65 dBi. This design is novel as size miniaturization and gain improvement has occurred by maintaining the planar structure of the array and that too at no extra hardware cost and size. The designed

antenna array has been fabricated and the measured results will be published in the forthcoming research issues. In future, this array can be extended with more number of patch elements and different metamaterial structures can be used for loading purpose so as to obtain the desired performance, as required for different applications.

References

1. Waterhouse, R. B.: Microstrip Patch Antennas: A Designer's Guide. MA: Kluwer Academic Publishers, Boston (2003).
2. Wang, C., Yan, D. B., Yuan, N.C.: Application of High Impedance Electromagnetic Surface to Archimedean Planner Spiral Antenna. Microwave Optical Technology Lett. 49(1), 129–131 (2007).
3. Li, Z., Xue, Y. L., Shen, T.: Investigation of Patch Antenna Based on Photonic Band-Gap Substrate with Heterostructures. Hindawi Publishing Corporation. 2012, 1–9 (2012).
4. Albino, A. R., Balanis, C. A.: Gain Enhancement in Microstrip Patch Antennas using Hybrid Substrates. IEEE Antennas Wireless Propag. Lett. 12, 476–479 (2013).
5. Attia, H., Yousefi, L.: High-Gain Patch Antennas Loaded With High Characteristic Impedance Superstrates. IEEE Antennas Wireless Propag. Lett. 10, 858–861(2011).
6. Smith, D. R., Padilla, W. J., Vier, D. C., Nasser, S. C. N., Schultz, S.: Composite Medium with Simultaneous Negative Permeability and Permittivity. Phy. Review Lett.; 84(18), 4184–4187 (2000).
7. Joshi, J. G., Pattnaik S. S., Devi, S.: Geo-textile Based Metamaterial Loaded Wearable Microstrip Patch Antenna. International J. Microwave Optical Technology. 8(1), 25–33 (2013).
8. Gao, X. J., Zhu, L., Cai, T.: Enhancement of Gain and Directivity for Microstrip Antenna using Negative Permeability Metamaterial. AEU International J. Electronics Communications. 70(7), 880–885 (2016).
9. Razi, Z. M., Rezaei, P., Valizade, A.: A Novel Design of Fabry- Perot Antenna using Metamaterial Superstrate for Gain and Bandwidth. AEU International J. Electronics Communications. 69(10), 1525–1532 (2015).
10. Pandeeseari, P., Raghavan, S.: Microstrip Antenna with Complementary Split Ring Resonator Loaded Ground Plane for Gain Enhancement. Microwave Optical Technology Lett. 57(2), 292–296 (2015).
11. Alu, A., Bilotti, F., Engheta, N., Vegni, L.: Subwavelength, Compact, Resonant Patch Antennas Loaded with Metamaterials. IEEE Trans. Antennas Propag. 55(1), 13–25 (2007).
12. Arora, C., Pattnaik, S. S., Baral, R. N.: SRR Inspired Microstrip Patch Antenna Array. J. of Prog. in Electromagnetic Res. C. 58 (10), 89–96 (2015).
13. Arora, C., Pattnaik, S. S., Baral, R. N.: Microstrip Patch Antenna Array with Metamaterial Ground Plane for Wi-MAX Applications. In: Proceedings of the Springer Second International Conference on Computer and Communication Technologies. AISC, vol. 381, pp. 665–671, Springer, India (2015).
14. Arora, C., Pattnaik, S. S., Baral, R. N.: Metamaterial Superstrate for Performance Enhancement of Microstrip Patch Antenna Array. In: 3rd IEEE International Conference on Signal Processing and Integrated Networks (SPIN-2016), pp. 775–779, IEEE Press, India (2016).
15. Garg, R., Bhartia, P., Bhal, I., Ittipiboon, A.: Microstrip Antenna Design Handbook, Artech House, UK (2001).
16. Balanis, C.A.: Modern Antenna Handbook John Wiley & Sons, New York, USA (2011).
17. Pozar, D. M.: Microwave Engineering, John Wiley & Sons, New York, USA (2008).

Design of Dual-Band BPF Using Interdigital Structure Loaded Resonators

Arvind Kumar Pandey and R.K. Chauhan

Abstract This paper presents a second-order dual-band bandpass filter (BPF) with sharp selectivity, good insertion, and wide stop band. Two modified open loop resonators are coupled to achieve the dual pass band at frequencies 1 and 2 GHz. An Interdigital structure is loaded on the resonator to reduce size as well as to improve selectivity of the proposed filter. Stubs are used to remove harmonics in higher frequencies for wide stopband. The scattering parameter of filter shows insertion loss and return loss in both pass bands of the filter less than 0.4 dB and better than 10 dB, respectively. The geometry of filter is designed on Rogers_RO3010 with dielectric constant 10.2 and of thickness 1.27 mm. The performance of the proposed filter is found better and smaller in size than filters designed by simple open loop resonator. The geometry of proposed filter is planar that makes it fabrication-easy and cost-effective.

1 Introduction

The design concepts of dual-band and multiband BPF are reported in the literature to fulfill the requirements of modern communication system [1–8]. Multiband resonators are alternately cascaded to design dual and triple band planar filter [2]. Stepped Impedance resonator is used in various coupling topologies to design dual-band BPF [4–6]. But in most of the structure via is used in the geometry. In some structures multimode resonator are used to design dual-band BPF [7–9]. Transversal signal interference structure is used to create transmission zero in the pass band to achieve dual pass band of the filter [10]. Modified λ/4 resonator is used to design dual-band BPF using coupling of resonators [11]. The geometries of the

A.K. Pandey (✉) · R.K. Chauhan
Department of Electronics and Communication Engineering, Madan Mohan Malaviya University of Technology, Gorakhpur, Uttar Pradesh, India
e-mail: arvindmknk@gmail.com

R.K. Chauhan
e-mail: rkchauhan27@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_17

filter in most of the reported papers consist of via or defected ground structure (DGS).

In this paper, a simple and compact resonator is used to design a dual-band BPF by coupling of two resonators. The pass band of the filter covers 1 and 2 GHz with wide stop band. The effect of interdigital finger on open loop resonator is used to reduce size and improves performance of the filter.

2 Design of Dual-Band BPF

Open loop resonator with two rings on same base line is used to design in the proposed filter. The outer ring of the resonator resonates on lower frequency f_1 and inner ring resonates on higher frequency f_2. The geometry of resonator used in the proposed filter is shown in Fig. 1a [12].

The resonating frequency of open loop dual ring resonator coupled with transmission line shows bandstop behavior and is used to find out resonating frequency of the resonator, as shown in Fig. 1b. The s-parameter characteristic of the bandstop configuration shows resonating frequency of the resonator, as shown in Fig. 2. The resonant frequency of the resonator is given by [13].

$$f_o = \frac{c}{2L\sqrt{\varepsilon_{\text{eff}}}} \tag{1}$$

where, c = speed of light, f_o = fundamental resonant frequency, L = length of microstrip line, $\mathcal{E}_{\text{eff}}$ = effective dielectric constant. The two resonant frequencies of the resonator are centered at 1.5 and 3 GHz, respectively. The resonant frequency at 1.5 GHz is due to outer open loop ring and frequency at 3 GHz is due to inner open loop ring.

Higher order filter can be realized by using coupling of resonators [3]. In the proposed filter, two resonators are coupled to design second-order dual-band BPF. The geometry of the filter is shown in Fig. 3a. The input and output ports are directly connected to the resonators.

The response of the filter shows dual pass band of the filter, as shown in Fig. 3b.

To improve the response of the filter interdigital fingers are loaded on the resonator, as shown in Fig. 4a [13]. The interdigital finger couples electric energy

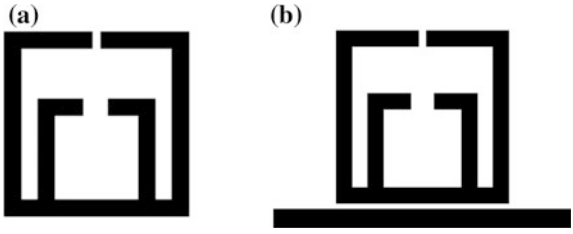


Fig. 1 **a** Geometry of open loop double ring resonator. **b** Stopband configuration

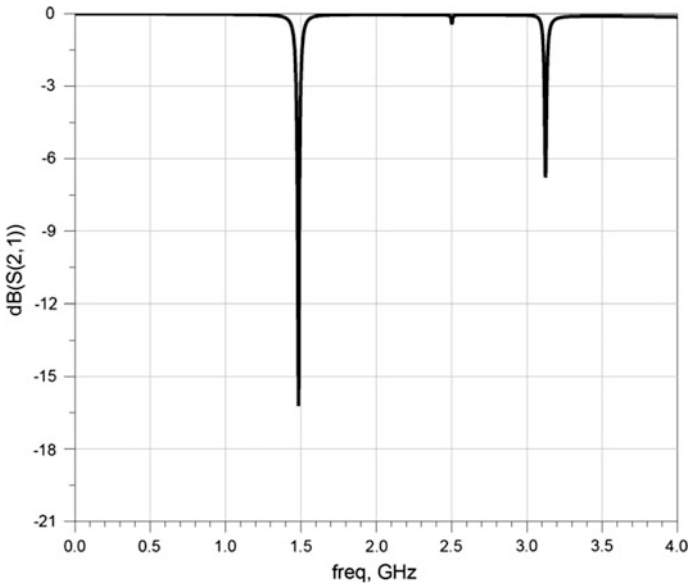


Fig. 2 Frequency response showing resonating frequency of resonator

by gap at the end of fingers and magnetic energy by the length of the finger. The interdigital fingers loaded on the resonators are coupled in such a way that electric and magnetic energy both are coupled and added and improves the insertion loss as shown in Fig. 4b.

The second-order filter is designed by using coupling of resonators and loaded by interdigital fingers. The pass band frequencies of dual-band filter are decreased on loading interdigital finger on the resonator. The decrease in frequency indicates the relative size reduction of the filter because of interdigital finger. The interdigital finger also creates transmission zero on both sides of the pass band that improves selectivity of the filter. Two stubs are loaded on the input and output ports to remove harmonics which improves the stopband. The geometry of proposed filter is shown in Fig. 5a. The dimensions of the proposed filter are length and width of outer loop is 11 mm, length and width of inner loop is 7 mm, width of lines in loop are 0.4 mm. Length and width of interdigital fingers loaded on outer ring are 9.7 and 0.4 mm, respectively. The length and width of fingers in inner loop are 5.7 and 0.4 mm. Gap width of open slot of outer loop is 0.5 mm and for inner loop it is 1.5 mm. The size of two open stubs are 7 and 8 mm. The dielectric constant and thickness of Rogers_RO3010, that is used to design filter, is 10.2 and 1.27 mm, respectively.

The frequency response of the proposed filter shows two pass bands at 1 and 2 GHz frequencies with good insertion loss and wide pass band, as shown in Fig. 5b.

From comparison between Figs. 3b and 5b the advantages of interdigital finger loaded on resonator can be seen. The resonating frequencies are shifted toward

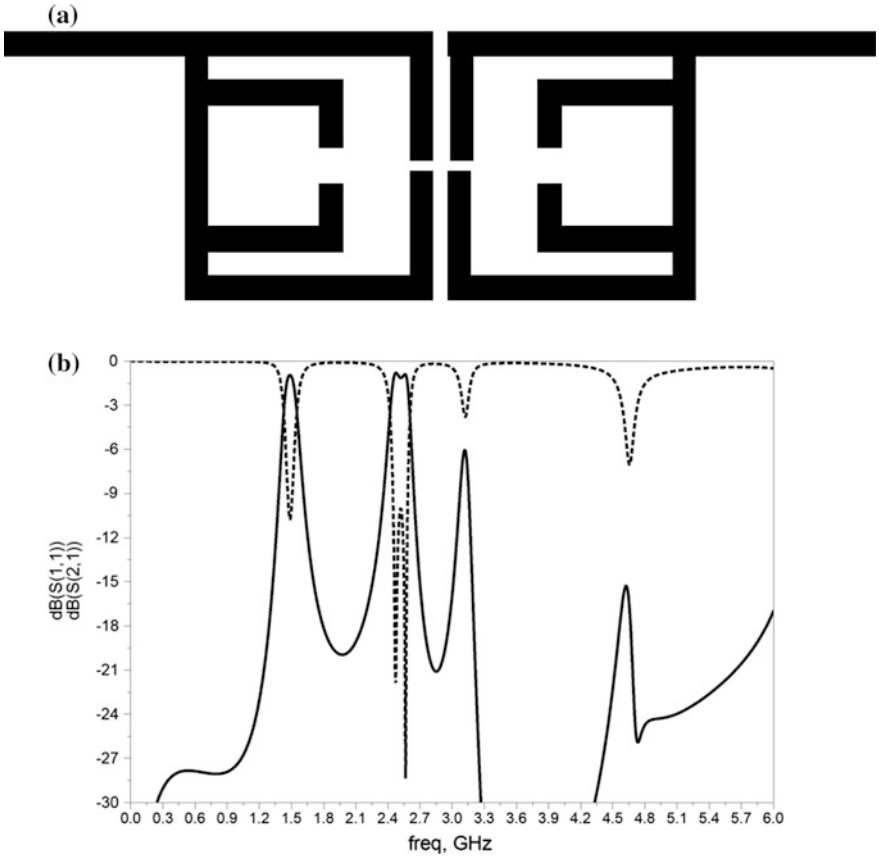


Fig. 3 **a** Second-order bandpass filter using two coupled resonators. **b** Frequency response of the bandpass structure

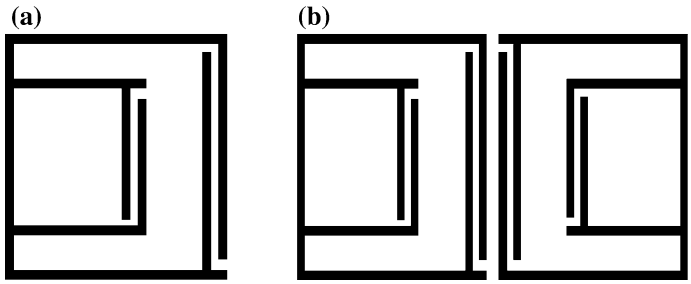


Fig. 4 **a** Interdigital finger loaded resonator. **b** Coupled interdigital fingers

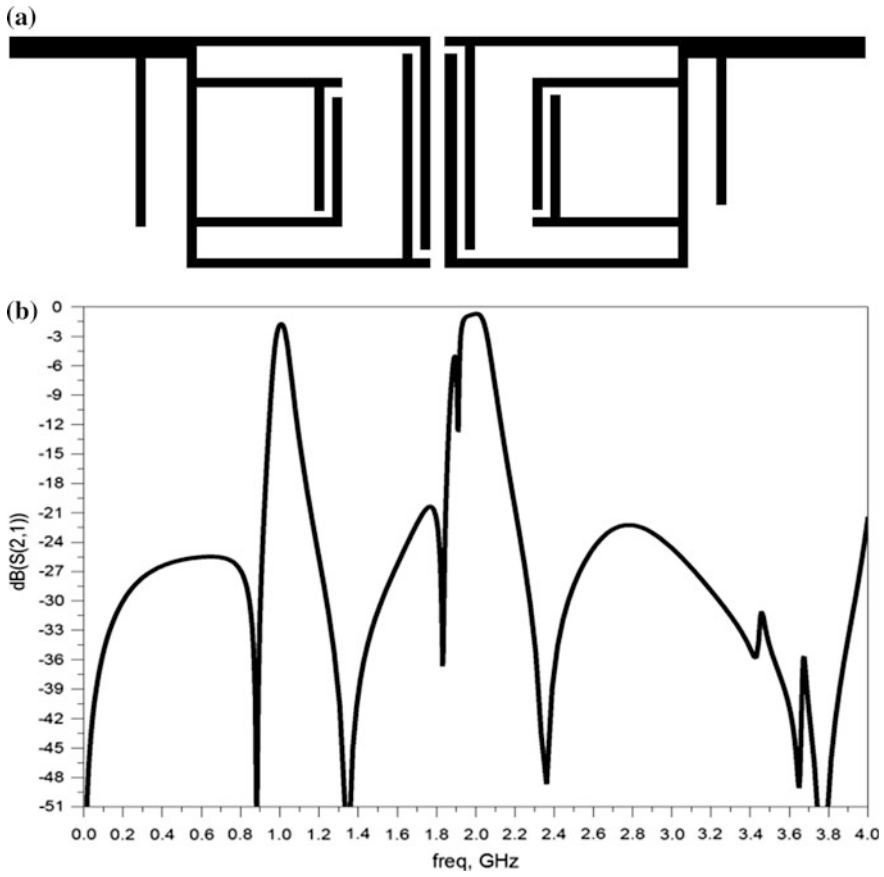


Fig. 5 **a** Geometry of proposed dual-band BPF. **b** Frequency response of the proposed filter

lower frequency that represents relative size reduction. The transmission zeros seen in Fig. 5b shows the better selectivity of the filter than simple open loop. The harmonics in high frequency are removed by using open stub.

3 Conclusions

A compact, planar, and simple second-order BPF with dual pass band is proposed in this work. The interdigital loaded two dual-band modified open loop resonators are coupled to design proposed filter. The interdigital finger loaded on the resonators improves the selectivity of the filter and insertion loss. Stubs are used to remove harmonics for wide stopband. The proposed filter passes frequencies 1 and 2 GHz with insertion loss less than 0.4 dB and return loss greater than 10 dB.

The selectivity is sharp and stopband is wide of the filter. The size of filter also relatively decreased as compared to simple open loop resonator. In the geometry of proposed filter via, DGS or any such structures are not used to make its structure planar for easy-fabrication and cost-effective.

References

1. J. S. Hong and M. J. Lancaster, Microstrip Filters for RF/Microwave Applications, New York: Wiley, 2011.
2. C. F. Chen, T. Y. Huang, and R. B. Wu, "Design of dual- and triple passband Filters using alternately cascaded multiband resonators," IEEE Trans. Microw. Theory Tech., vol. 54, no. 9, pp. 3550–3558, Sep. 2006.
3. J. –S. Hong and M. J. Lancaster, "Couplings of microstrip open-loop resonators for cross-coupled planar microwave filters," IEEE Trans. Microwave Theory Tech., vol. 44, pp. 2099–2109, Dec. 1996.
4. Alkanhal, M. A. S., "Dual-band bandpass filters using inverted stepped impedance resonators," Journal of Electromagnetic Waves and Applications, vol. 23, Nos. 8–9, 1211–1220, 2009.
5. Lee, C. H., I. C. Wang, and C. I. G. Hsu, "Dual-band balanced BPF using ¸λ/4 stepped-impedance resonators and folded feed lines," Journal of Electromagnetic Waves and Applications, vol. 23, Nos. 17–18, 2441–2449, 2009.
6. S. Fu, B. Wu, J. Chen, S.-J. Sun, and C.-H. Liang, "Novel second order dual-mode dual-band filters using capacitance loaded square loop resonator," IEEE Trans. Microw. Theory Tech., vol. 60, no. 3, pp. 477–483, March 2012.
7. C. H. Kim and K. Chang, "Independently controllable dual-band bandpass filters using asymmetric stepped-impedance resonators," IEEE Trans. Microw. Theory Tech., vol. 59, no. 12, pp. 3037–3047, Dec. 2011.
8. S. B. Zhang and L. Zhu, "Synthesis design of dual-band bandpass filters with stepped-impedance resonators," IEEE Trans. Microw. Theory Tech., vol. 61, no. 5, pp. 1812–1819, May 2013.
9. P. Mondal and M. K. Mandal, "Design of dual-band bandpass filters using stub-loaded open-loop resonators," IEEE Trans. Microw. Theory Tech., vol. 56, no. 1, pp. 150–155, Jan. 2008.
10. Jun Li, Shan-Shan Huang, and Jian-Zhong Zhao, "Compact Dual- Wideband Bandpass Filter Using a Novel Penta-Mode Resonator (PMR)," *IEEE Microw. Wireless Compon. Lett.,* vol. 24, No. 10, October 2014.
11. Zhi-Chong Zhang, Qing-Xin Chu, and Fu-Chang Chen, "Compact Dual-Band Bandpass Filters Using Open-/Short-Circuited Stub-λ/4 Loaded Resonators," *IEEE Microw. Wireless Compon Lett*., vol. 25, No. 10, October 2015.
12. Subash Varma Vegesna, "Frequency selective components for microwave and Terahertz applications," Submitted to the Graduate Faculty of Texas Tech University in Partial Fulfillment of the Requirements for the Degree of Doctor df Philosophy, May, 2014.
13. Inder Bahl, Lumped Elements for RF and Microwave Circuits, Artech House, INC., 2003.

Characterization and Control Strategies of a Magnetic Levitation System

Maher Alwajih and Shabana Urooj

Abstract The objective of this paper is to study and analyze the control strategies related to magnetic levitation systems (MLS). Major motto is to propose refinement in the mechanism of MLS towards effective stability of the system. In the proposed work, the prototype of the levitation system is acquired by calculating the proportional linear system parameters and implementing a suitable PID controller to accomplish a stable system. The PID parameters have been obtained for the controller and applied to a nonlinear system model for productive outcome. The results of linear and nonlinear systems are compared and hence use of PID controller is justified.

1 Introduction

Magnetic Levitation System (MLS); also known by term maglev in simple way, suspending an object in presence of 'only' magnetic field thereby counteracting the effects of 'g' and other acceleration by magnetic force (focuses on lifting force and stability). MLS is an unstable nonlinear system with open-loop pole at right of plane. Due to its nonlinearity and instability, it is a big challenge to acquire a stable controlled system for MLS. Magnetic levitation systems attract the attention of many researchers since it is generally applicable in many fields such as frictionless bearing, contactless melting, maglevs, wind tunnel models and vibrations isolation of sensitive equipment, etc. MLS have nonlinear dynamics and constitutes an open-loop unstable system and a feedback response control is necessary to stabilize the maglev system.

M. Alwajih (✉) · S. Urooj
Department of Electrical Engineering, School of Engineering,
Gautam Buddha University, Greater Noida, UP, India
e-mail: pre.mw2014@gmail.com

S. Urooj
e-mail: shabanaurooj@ieee.org

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_18

The system controller works on an approximate linear model which is built up by using standard linear control technique and perturbing the system dynamics around an operating point. A linear controller for this was modelled out and used by Wong in 1986. There, the nonlinear system equation was disconcerted about an operating source, which caused approximate linear model having pole in the open right half plane. Wong presented a compensator which proceeded in linear phase manner which was adequate enough to put the system at step responses of 1.5 mm about the operating point in stabilized manner [1]. Recently, several methods have been studied based on the models of linear and nonlinear systems to acquire stabilized system. Standard linear technique is grounded as linear model approximation found by variation of the dynamics of the system about the desired operating point. Since the model is valid for a small area of the operating point, it is expected that the proposed linear controller will work well in the same area. Proper use of PID (Proportional Integral Derivative) controller loop has been judiciously used for control feedback. These are easy to implement and provides stability to unstable linear systems.

Guess et al. successfully compared conventional MLS model and actual system incorporating the effects of non-modelled dynamics on stability of simulated system. Their implementation was successful in proving the effectiveness of PID controller on set point regulation as well as tracking a changing input [2]. Dolga and Dolga built a nonlinear model for MLS and proposed systems linearization principle in order to linearize the nonlinear model [3]. Ying-Shing Shiao in 2001 made a system linearized and phase-lead compensated with virtual pole cancellation to develop a controller for unstable nonlinear system. The system was able to maintain better stability in a levitated ball [4]. Shameli et al. presented a nonlinear design for calculation of the magnetic forces in MLS which, further was developed and was proposed for controlling method to regulate the position vectors of a MLS permanent magnet.

Stability analysis through Lyapunov method showed the stability in the controlling technique. It was reported that it had a precise position vector process across an operation range of 30 mm, which is a development over available control techniques in literature for greater gapped maglev systems [5, 6]. Suboptimal controller for linear time invariant system has been reported in [7]. In W. Barie et al. compared linear and nonlinear controllers for Maglev system and stated that the feedback linearization controller has better trajectory tracking.

This paper proposes a PID controller carried out in the form of a MLS model. The main reason of implementing the controller is to bring system behaviour under control. The system dynamic equation is discussed in Sect. 3. In Sect. 4 the resultant graphs show the response of the linear and nonlinear systems. Finally, the paper is concluded in Sect. 5 which briefly discusses the obtained results.

2 Magnetic Levitation System (MLS)

Maglev system considered in this research constitutes a ferromagnet ball which will be suspended in an electric potential environment which is generated due to magnetic field. Figure 1 shows the schematics of MLS.

Coil acts as electromagnetic actuator, while an optoelectronic sensor determines position of ferromagnetic ball. The coils current will generate electromagnetic force (EMF) to attract the ball. The ball is impacted by its gravity, consequently, the controller keeps manipulating the current till the EMF equalizes the gravity force [8]. Thus, the ball will levitate in stable equilibrium point. But it is a nonlinear, open loop, unstable system that demands a good dynamic model and a stabilized controller.

3 System Analysis

3.1 Nonlinear Model

A ferromagnetic ball with mass '*m*' is located below the electromagnet at a distance of '*x*'. The current '*i*' flows in the coil will generate EMF that attracts the ferromagnetic ball. Hence, the resultant force will be the difference between the EMF and gravitational force which will induce an up or down motion of the ferromagnetic ball. The photoresistor will be sensing the variation of positioning vector of the ball and will send a feedback signal to the controller and amplifier circuit to

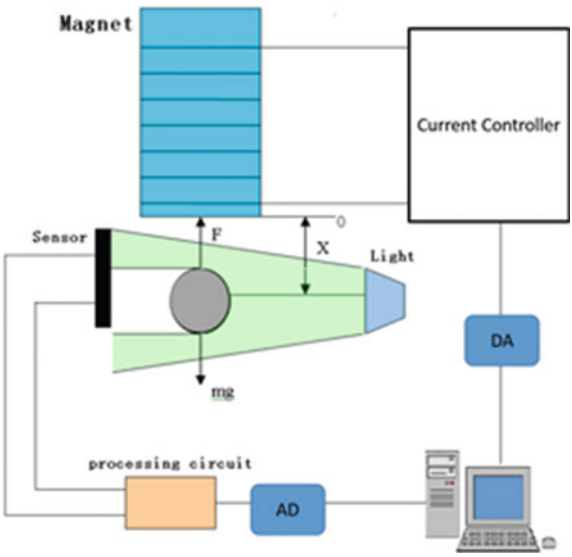


Fig. 1 Schematic diagram of magnetic levitation system

control the input current 'i'. Ferromagnetic ball is retained in a stable position nearby the equilibrium point.

The nonlinear model of maglev system can be obtained by the following equations as follows:

$$F = K\left(\frac{i}{x}\right)^2 \tag{1}$$

$$e = Ri + \frac{\mathrm{d}i}{\mathrm{d}t} \tag{2}$$

$$\frac{m\mathrm{d}^2x}{\mathrm{d}t^2} = F - mg \tag{3}$$

According to the Eqs. (1) and (3) which describe the mathematical system of the MLS, in addition to damping force denoted by the damping constant k_v and considering the initial values the nonlinear model can be defined by Eq. (4). The proposed Simulink schematic is shown in Fig. 2.

$$m\frac{\mathrm{d}x_2}{\mathrm{d}t^2} = i^2\frac{(x_0 - u)^2}{k_c} - k_v\frac{\mathrm{d}x}{\mathrm{d}t} - mg \tag{4}$$

where;

F magnetic force
i coil current
x distance between electromagnet and ball
K constant
e electric potential across the coil system
R coil resistance
m ferromagnetic ball mass

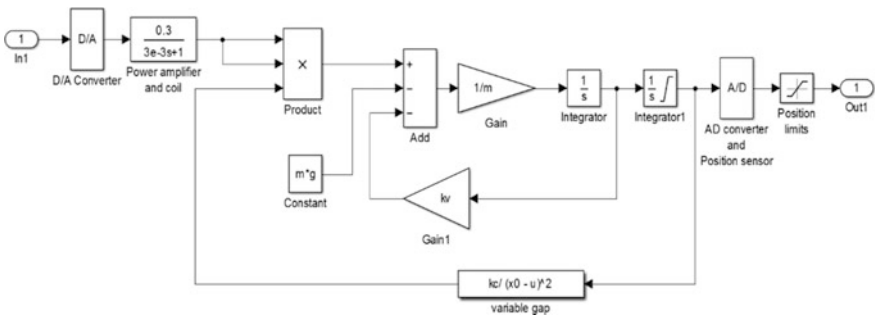


Fig. 2 Equivalent nonlinear system of magnetic levitation

g acceleration due to gravity
x_0 coil offset
k_v damping constant

Before applying the linear control theory, the nonlinearity of the system must be taken into account [9]. The system dynamic equation is linearized on the operating point. The linearized equations are obtained by using the linear terms from Taylor series expansion.

3.2 System Model Linearization

When the ball is in equilibrium point, the acceleration is 0 and from the Newton's law the composition of force on the ball is also 0. The magnetic force is equal to gravitational force of the ball;

$$F(i_0, x_0) - mg = 0 \tag{5}$$

$$F(i_0, x_0) = mg \tag{6}$$

The Taylor expansion of Eq. (1) at the equilibrium point (i_0, x_0) can be described as;

$$m\frac{\mathrm{d}_2 x}{\mathrm{d}t^2} = \frac{2Ki_0}{x_0^2}i - \frac{2Ki_0^2}{x_0^2}x \tag{7}$$

after applying Laplace transform

$$X(S)S^2 = \frac{2Ki_0}{mx_0^2}I(S) - \frac{2Ki_0^2}{x_0^2}X(S) \tag{8}$$

from the boundary Eq. (5) the transfer function for the open loop is as follows:

$$\frac{x(s)}{i(s)} = \frac{-1}{As^2 - B} \tag{9}$$

where

$$A = \frac{i_0}{2g}, \quad B = \frac{i_0}{x_2}$$

Since the open-loop system characteristic is as follows: $As^2 - B = 0$,

The system poles are as follows:

$$s_{1,2} = \pm\sqrt{\frac{B}{A}} = \pm\sqrt{\frac{2g}{x_0}} \tag{10}$$

4 Simulation Results

In order to verify the proposed linear and nonlinear system, the system was simulated using MATLAB and parameter values are presented in Table 1.

In Fig. 3, the output graph of the reference trajectory is shown. It shows the step changes between the two steady states. The graph depicts that the output of the nonlinear system model is controlled [10]. The output response of the linear system is shown in Fig. 4.

The experimentally proposed parameters for PID controller are performed in Simulink model using a feedback control structure with two state reference signals. The same reference signal is taken in both linear and nonlinear models of MLS.

Table 1 System physical parameters

Parameter	Value	Parameter	Value
M	22 g	x_0	20.0 mm
Iron core diameter	22 mm	Enamelled wire diameter	12.5 mm
N	2450 circles	K	2.314e−004 Nm^2/A^2
i_0	0.6105	K_f	0.25

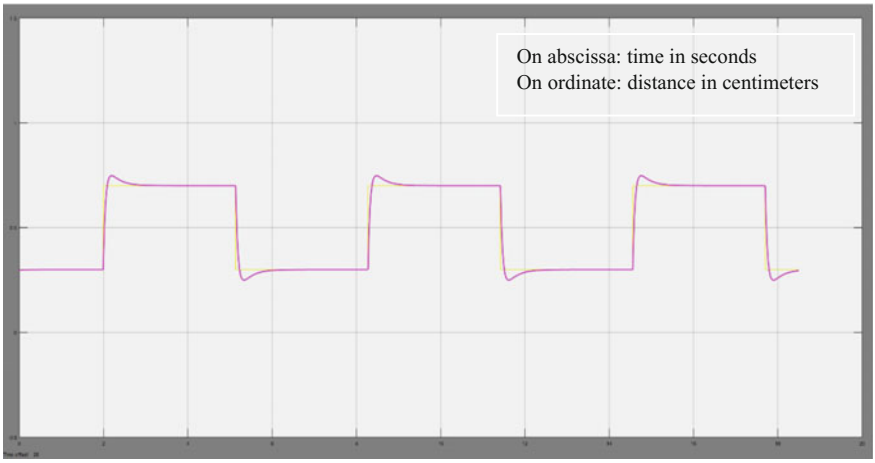


Fig. 3 Two levels of steady state response for nonlinear system model

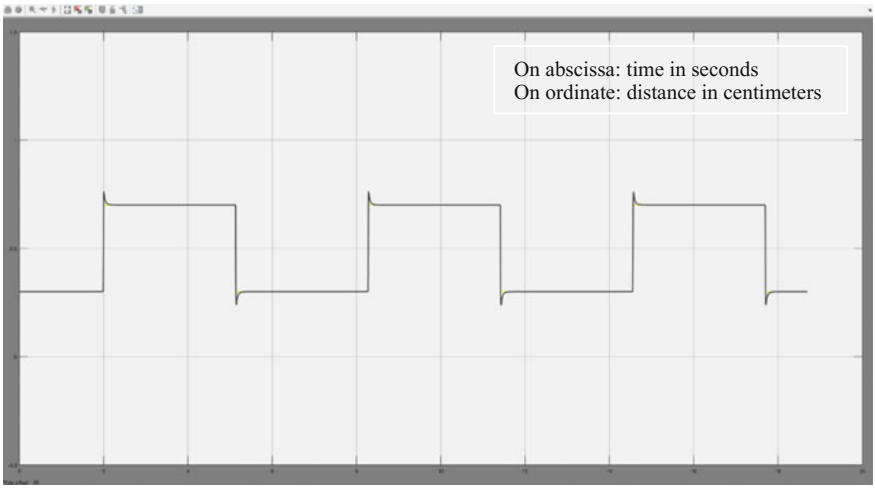


Fig. 4 Two levels of steady state response for the proposed linear system

It is well perceived that the same results are obtained for the both models and therefore it ensures that the linearized model is fairly equivalent to the nonlinear model.

5 Conclusions

In this script the suitable parameters for linear magnetic levitation have been found out successfully and a stable system was successfully implemented with suitable PID parameters. These parameters were then used for stabilization of a nonlinear system and it was found out that a nonlinear system can be partially stabilized with the parameters used in linear system for a PID controller.

References

1. T. Wong, Design of a magnetic levitation system - an undergraduate project, IEEE Transaction on Education, 29, 1986, 196–200.
2. Trent M. Guess and David G. Alciatore, Model development and control Implementation for a magnetic levitation apparatus, Proceedings of ASME Computers in Engineering Conference, Boston September 1995, U.S.A.
3. Valer Dolga, Lia Dolga "Modeling and Simulation of a Magnetic Levitation System" Annals of the Oradea University. Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007.
4. Y Shing Shiao, "Design and Implementation of a Controller for a Magnetic Levitation System" Proc. Natl. Sci. Counc. Roc(D) Vol. 11, No. 2, 2001. pp. 88–94.

5. Ehsan Shameli, Mir Behrad Khamesee, Jan Paul Huissoon, "Nonlinear controller design for a magnetic levitation device", Microsyst Technol 13:831–835, DOI 10.1007/s00542-006-0284-y, 2007.
6. W. Barie and J. Chiasoson, "Linear and nonlinear state-space controllers for magnetic levitation", International Journal of Systems Science, 27(1), 1996, 1153–1163.
7. Slotin J.J.E. and W. Li., Applied non-linear control. 1st Edition, Prentice Hall, New York. 1991.
8. Muhammad Shafiq and Sohail Akhtar. "Inverse Model Based Adaptive Control of Magnetic Levitation System", 5th Asian Control Conference. 2004.
9. Santanu Kumar Pradhan and Raghuwansh Singh, "Nonlinear Control of a Magnetic Levitation System using Feedback Linearization" IEEE International Conference on Advanced Communication Control and Computing Teclnologies (ICACCCT) 2014.
10. Shabana Urooj, M Khan, "Sub-optimal Controller for Airframe Model of Harrier AV8A VTOL Aircraft", South East Asian Journal of Mathematics and Mathematical Sciences, published in Vol. 6 No. 3, 2008.

Power Energy Management for Grid-Connected Hybrid Renewable Energy System in Yemen Using Fuzzy Logic

Adel Rawea and Shabana Urooj

Abstract Active development of green energy and the continuous major problems in Yemen power sector lead to serious issues related to the load demand and civilization of the country. This issue requires particular strategies to be incorporated to maintain necessities of electrical power among green energy resources and utility grid. This paper presents an algorithm for power management in grid-connected hybrid renewable energy system under a set of constraints, including the special country situations, weather conditions, and utility grid situations. To manage the flow of power between the different loads (first, second, and third load) and the multi-agents; (utility grid and green energy resources) fuzzy smart controller is used. Proposed techniques fuzzify all the inputs and perform fuzzification of the rules from fuzzy outputs before defuzzification stage. The proposed smart control strategy is able to sense the parameter's fluctuations in hybrid renewable energy generation, grid situations, load demand, and the state of charge (battery status). The suggested smart fuzzy algorithm based distribution of loads can operate well with fuzzy inputs according to the load priority. Therefore, it does not require any mathematical model and can deal with nonlinearity by combining the human heuristics into computer-assisted decisions.

1 Introduction

Renewable energy resources have gradually become a very important part of power energy production since the load demand requirements are increasing and the fossil fuel are affecting negatively on the environment [1]. The solar, wind, and geothermal energy are considered as the most anticipated options of the renewable

A. Rawea (✉) · S. Urooj
Department of Electrical Engineering, School of Engineering,
Gautam Buddha University, Greater Noida, UP, India
e-mail: adelrawea@gmail.com

S. Urooj
e-mail: shabanaurooj@ieee.org

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_19

energy resources among all the types of renewable energy [2, 3, 8]. Although these renewable energy resources are stimulating in many aspects, many problems are associated with this technique. The irregular nature of renewable energy resources is because of the unpredictable status. Moreover, increasing capital cost for some types of the green energy sources are the core barriers to their utilization [3].

Besides, there is a particular problem in Yemeni power sector and barriers in using clean energy which is represented in the sabotage of utility grid [1]. A grid-connected hybrid renewable energy system [4] can enhance the power availability, operational efficiency of the system, and participate in solving a part of the problem in the energy sector [5, 6]. The idea of using supporting energy sources (green energy) and (DG) requires particular algorithm according to the country's situation to be incorporated into their operations. It offers better services of the individuals, as well as manages the energy flow to loads.

This paper suggests a power management algorithm using fuzzy logic controller for grid-connected hybrid renewable energy system to manage the power energy flow among the green energy resources, storage units, utility grid, and loads.

The block diagram of the proposed grid-connected hybrid renewable energy system is illustrated in Fig. 1.

The hybrid renewable energy can be used to supply the load into the DC/DC and DC/AC units or to charge the storage units into the charge controller [7]. Likewise, the storage units can be used to supply the necessary loads while the grid power and hybrid systems are off; therefore, the power energy flow needs an effectual

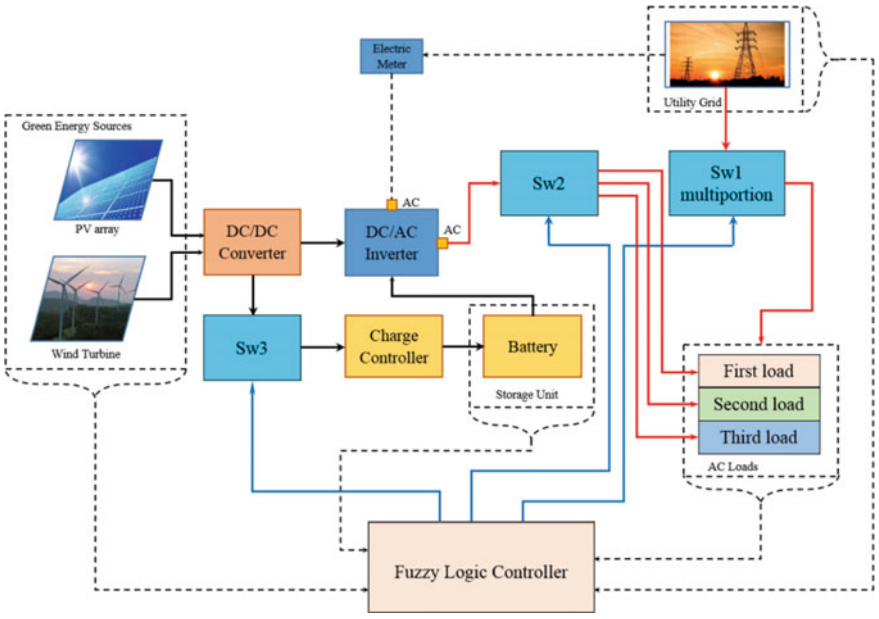


Fig. 1 The proposed grid-connected hybrid renewable energy system

management algorithm to be able to sense the fluctuations in the hybrid renewable energy generation, load demands, and the state of charge of the storage units to make the right decisions for continuous supply of the loads in accordance to the priority of the loads [8].

2 Motivation of Paper

The motivation of this paper is to manage the power flow using fuzzy logic control algorithm since FLC does not require mathematical models; as in traditional control systems it can present performing well in real-time applications. The objectives include selecting the important loads to continue serving the people during specific condition of Yemen (Fig. 2).

3 Research Methods

In this script, to simulate fuzzy logic controller, the modeling has been done by using MATLAB/Simulink.

Fuzzy logic is widely used in control systems and the modern techniques. 'Fuzzy' means that the inference involved can deal with cases which cannot be represented as 'true/false' but relatively as 'partial true' or 'partial false' [9]. Although alternative methods and many techniques like genetic algorithm and neural network can present as well as fuzzy logic in the same cases, but fuzzy logic has an advantage that the problem results can be expected in a form relevant to understand the problem as the human perceptions, so to add their knowledge in controller design [10].

All of these have been made easy to automate tasks which are achieved successfully by humans. Fuzzy logic consists of three following important steps [2];

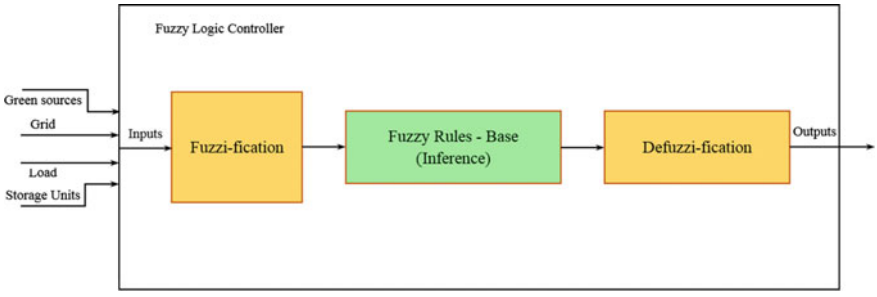


Fig. 2 Proposed fuzzy logic controller for grid-connected hybrid energy system

- **Fuzzification**: At this stage, the crisp data are converted to fuzzy data-based membership function (MFs).
- **Inference Process**: At this stage, the membership functions are combined with rules to promote the fuzzy output.
- **Defuzzification**: It includes using various mechanisms to value each related output and add them to a lookup table.

The fuzzy logic controller suggests Mamdani Inference with its standard settings, i.e., MIN-MAX method of the centroid for defuzzification process and aggregation [11].

3.1 Fuzzification

The input variables green-sources, grid status, battery-SOC, and load demand are changed into semantic variables with suitable membership functions as follows:

Figure 3 illustrates the green resource power which is divided into range of membership functions (No-P, Low-P, Medium-P, and High-P) in (kW) Capacity.

The membership function in Fig. 4 defines the grid status which are 0(not available power) and 1(available power) at the current time.

Figure 5 shows the battery-SOC which consist of membership function levels (low, medium, medium–high, and high) according to its available charged capacity (in %) throughout the operation times.

Figure 6 illustrates the membership function of the load demand profile which is divided into (first load, second load, and third load) according to load demand (kW) at any instance of time (Fig. 7).

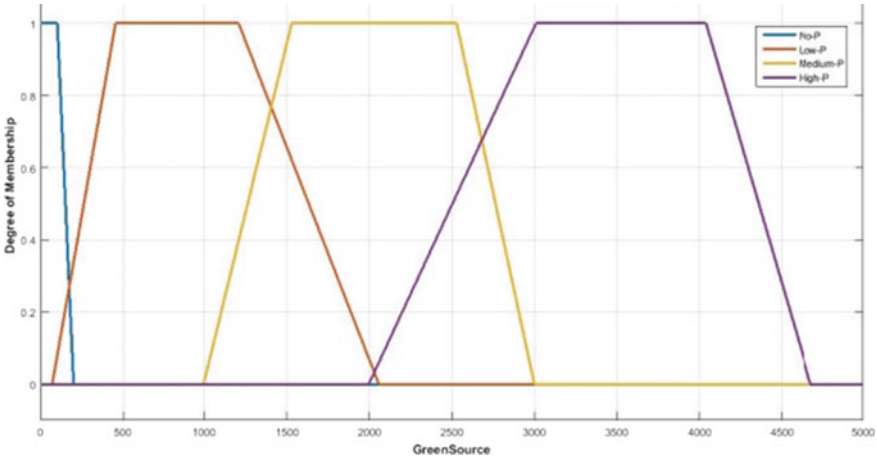


Fig. 3 Membership function of green resources

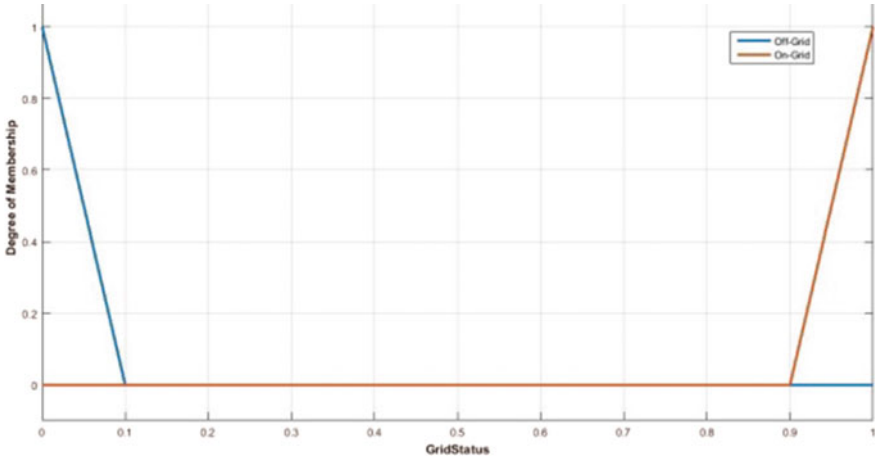


Fig. 4 Membership function of grid status

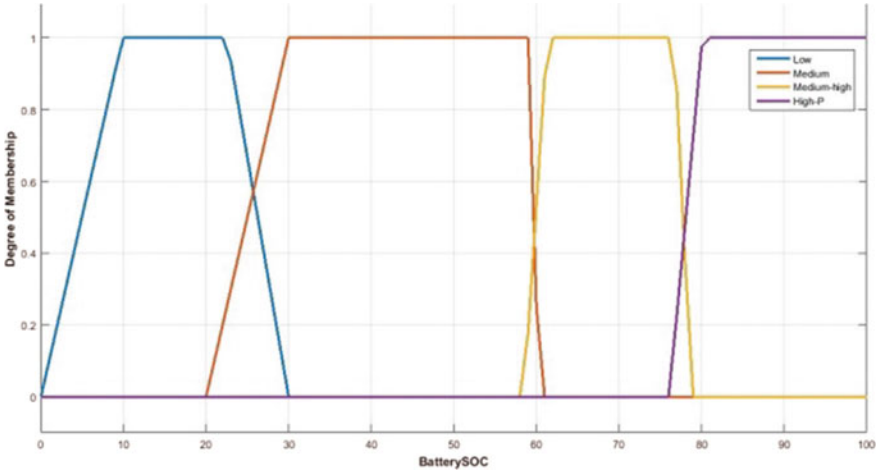


Fig. 5 Membership function of storage unit status

3.2 Fuzzy Inference Process

The process of inference involves all of the sections that are described in membership functions, logical operations [12], and IF-THEN rules which are applicable as follows;

The fuzzy logic controller maps the outputs to inputs using IF-THEN rules, where (IF rules—part) illustrates the inputs variables and the (THEN rules part) illustrates the outputs variables. In this paper, the fuzzy inputs variables are

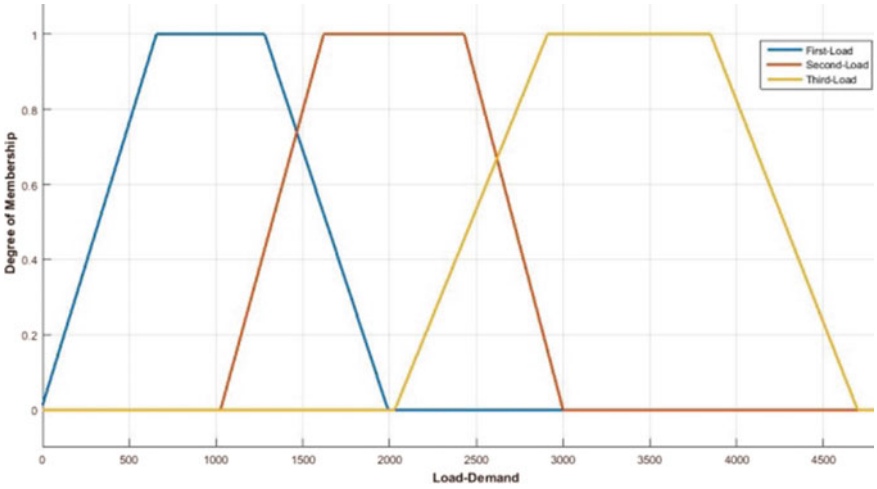


Fig. 6 Membership function of load demand

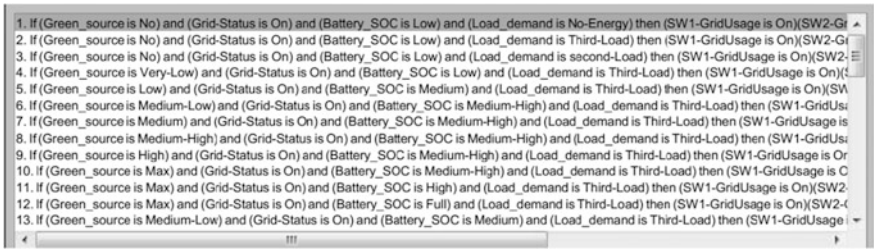


Fig. 7 IF-THEN rules

green-source, grid status, battery-SOC, and load demand, and the fuzzy outputs variables are SW1-GridUsage, SW2-GreenUsage, and SW3-BatteryCharge as shown in the Fig. 8.

3.3 Defuzzification

The combined output fuzzy sets are the inputs of the defuzzification process and the output is a suitable decision. There are several defuzzification methods and the centroid calculation method is the most desired defuzzification method [13].

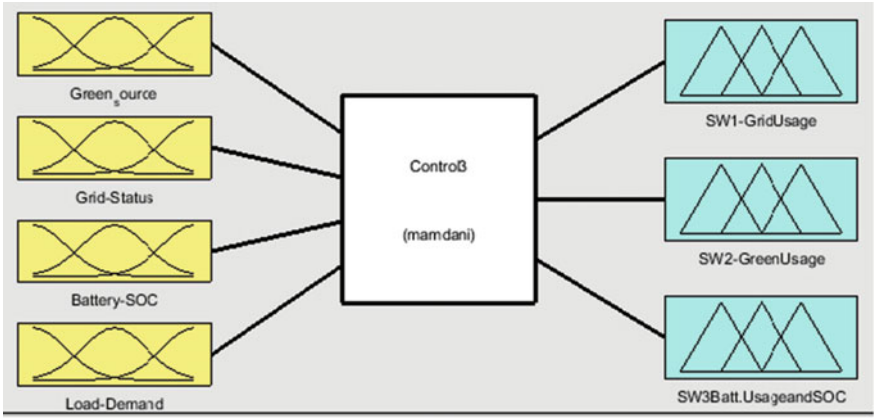


Fig. 8 Proposed fuzzy logic control block

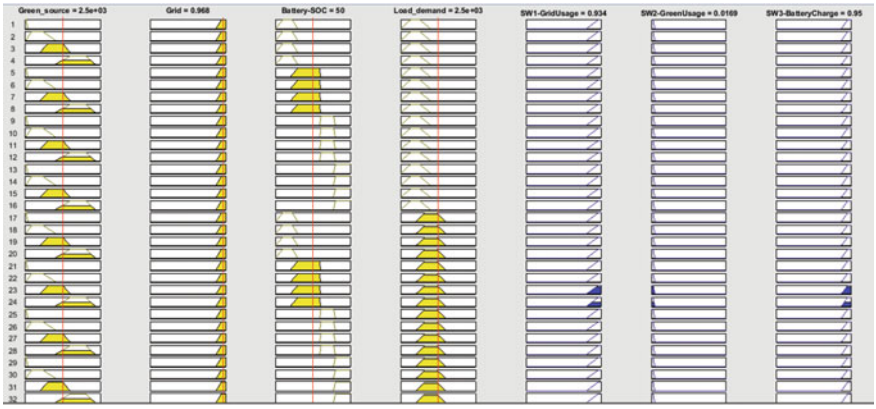


Fig. 9 Simulations results of the rules

4 Results

The designed fuzzy logic controller has four inputs variables and three outputs variables which are shown in Fig. 8. Min-Max methods and centroid for defuzzification have been performed by using MATLAB/Simulink and the simulation result of the rules are shown in Fig. 9 which has been illustrated in two cases (the grid availability is ON and the grid availability is OFF).

5 Conclusions

This paper proposes strategy to manage the flowing power between the multi-agent (utility grid, storage unit, and green resources) and the load, in grid-connected system with variable levels under the set of switches through the rule-based fuzzy controller. It has the benefits of operation using fuzzy inputs, which is not requiring mathematical/numerical model and can handle nonlinearity in a better way [14].

The developed control approach is based on the rules and it is able to sense the changes in green power generation, load demands, and battery status in order to make suitable decisions according to load levels and grid availability [15, 16].

Four fuzzy inputs variables are considered to manage the shortage of the power energy without taking tariff variable into consideration. Tariff variable is evaded due to lack of adequately obtained ability of the utility grid. In conditions when the adequate availability of the utility grid became sufficiently good, the tariff variable can be added to the fuzzy inputs variables in order to promote the use of green energy and reduce the consumption of the utility grid power [17].

References

1. A. Rawea and S. Urooj, "Remedy of Chronic Darkness & Environmental effects in Yemen Electrification System using Sunny Design," vol. 7, no. 1, pp. 5–10, 2017.
2. F. S. Tidjani et al., "Optimization of Standalone Microgrid Considering Active Damping Technique and Smart Power Management using Fuzzy Logic Supervisor," vol. 3053, no. c, 2016.
3. R. B. Roy, E. Basher, and R. Yasmin, "Fuzzy Logic Based MPPT Approach In A Grid Connected Photovoltaic System," vol. 1, no. 1.
4. D. Arcos-Aviles, J. Pascual, L. Marroyo, P. Sanchis, and F. Guinjoan, "Fuzzy Logic-Based Energy Management System Design for Residential Grid-Connected Microgrids," IEEE Trans. Smart Grid, vol. 3053, no. c, pp. 1–1, 2016.
5. S. Leonori, E. De Santis, A. Rizzi, and F. M. F. Mascioli, "Optimization of a Microgrid Energy Management System based on a Fuzzy Logic Controller," pp. 6615–6620, 2016.
6. F. E. I. Gao and L. Wang, "Information Modeling and Evaluation Method of EPON System for Grid-Connected Distributed Energy Resources," no. Ciced, pp. 10–13, 2016.
7. A. Rawea, S. Urooj, "Hybrid Energy (Off-Grid) System Solutions for Yemeni Remote Areas using Sunny Design Web," 2017.
8. K. Manickavasagam, "Intelligent Energy Control Center for Distributed Generators Using Multi-Agent System," pp. 1–8, 2014.
9. H. Yin, W. Zhou, M. Li, and C. Zhao, "An Adaptive Fuzzy Logic Based Energy Management Strategy on Battery/Ultracapacitor Hybrid Electric Vehicles," vol. 7782, no. c, pp. 1–12, 2017.
10. N. Hashmi and S. A. Khan, "Power Energy Management for a Grid-Connected PV System using Rule-Base Fuzzy Logic," 2015.
11. A. Rawea and S. Urooj, "Design of Fuzzy Logic Controller to Drive Autopilot Altitude in Landing Phase."
12. C. Vega, "Fuzzy Logic Con ntroller Design for Batt tery Energy Management in a Grid Connected Elect," pp. 2014–2019, 2014.

13. L. Zhu, J. Han, D. Peng, and T. Wang, "Fuzzy logic based energy management strategy for a fuel cell/battery/ultra-capacitor hybrid ship," pp. 107–112, 2014.
14. S. Njoya Motapon, L. A. Dessaint, and K. Al-Haddad, "A Comparative Study of Energy Management Schemes for a Fuel Cell Hybrid Emergency Power System of More Electric Aircraft," Ind. Electron. IEEE Trans., vol. PP, no. 99, p. 1, 2013.
15. P. Patel and J. Shrivastava, "Modelling & Performance Analysis of Hybrid Renewable Energy Resources Using Fuzzy Logic Controller," vol. 5, no. 5, 2016.
16. Shabana Urooj, A Hussain, Narayani, "Biodiesel Production from Algal Blooms: A Step towards Renewable Energy Generation & Measurement", International Journal of Measurement Technologies & Instrumentation Engineering. 2(3), 60–71 July-September 2012. IGI Publishing Hershey, PA USA. DOI:10.4018/ijmtie.2012070106.
17. Shabana Urooj, Narayani, "Non-Conventional Forms of Renewable Energy and their future prospects; A Review", INDIACom 2012, ISSN 0973-7529; ISBN 978-93-80544-03-8 February 2012.

Classification of Mammograms Using Sigmoidal Transformation and SVM

Vikrant Bhateja, Ananya Tiwari and Aman Gautam

Abstract Preprocessing and enhancement of mammograms is necessary to improve the visual quality and detectability of the anomalies present in the breasts. In this work, a sigmoidal transformation technique has been applied for enhancement (preprocessing) of mammograms. Gray-level co-occurrence matrix (GLCM) has been used for computation of textural features. Finally, Support Vector Machine (SVM) is used as a classification tool for sorting the mammogram into normal or abnormal. The accuracy, sensitivity, and specificity of the classifier are deployed as the performance parameters. The proposed approach has reported considerably better accuracy in comparison to other existing approaches.

1 Introduction

Breast cancer has been the second most common causes of death among middle-aged women according to the World Health Organization (WHO). It occurs when an uncontrolled multiplication of cells occur in the vicinity of breast tissues. Cancer is one of the most dangerous forms of diseases known to mankind. This is so because the cause of this disease is unknown and it can only be cured not prevented. The detection of anomalies in mammograms is done by skilled radiologists. However the diagnosis done does not always bring precise outcomes [1]. Thus, early detection of breast cancer can be carried out with the help of computer based analysis programs for better diagnosis. These computer programs are known

V. Bhateja (✉) · A. Tiwari · A. Gautam
Department of Electronics and Communication Engineering,
Shri Ramswaroop Memorial Group of Professional Colleges (SRMGPC),
Lucknow 226028, Uttar Pradesh, India
e-mail: bhateja.vikrant@gmail.com

A. Tiwari
e-mail: absoluteananya@gmail.com

A. Gautam
e-mail: gautamaman543@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_20

as computer-aided detection/diagnosis (CAD) systems. CAD system is used as a 'second reader' by the radiologists' to have an unbiased opinion regarding the detected anomaly. Mammography has proved to help the radiologist in the detection procedure and thus reducing the probability of false detections. Mammograms are digital images of breast tissues which the radiologists use to detect cancer with the help of CAD systems. Enhancing a mammogram helps the CAD system to diagnose the ROI with greater efficiency [2]. There are various modules of a CAD system such as preprocessing, features extraction, and classification. Some of the earlier works regarding the enhancement and classification of mammograms using CAD system are discussed below. Tang et al. [3] applied discrete wavelet transform (DWT) which is a multi-resolution enhancement technique over the mammograms. The enhancement method was same for every wavelet coefficient at every level due to which the enhancement response was not prominent. Aarthi et al. [4] performed *k*-means clustering method for features transformation followed by classification using SVM classifier. The authors did not use any procedures to enhance the mammograms; due to which the accuracy of their work was 80%. Subashini et al. [5] used a technique to suppress the pectoral muscle present in the mammogram with the help of histogram thresholding. For classification they have used SVM classifier with an accuracy of 95.33%. A new set of preprocessing mechanisms such as nonlinear polynomial filters [6, 7] and nonlinear unsharp masking [8] have also been utilized recently. Singh and Sing [9] proposed a three-class classification of MLO and CC views of mammograms using SVM classifier. Liu and Tang [10] integrated SVM with recursive feature elimination (SVM-RFE) with a normalized mutual information feature selection (NMIFS) for classification. However, the work presented by these authors has not shown any enhancement of mammograms at the preprocessing stage due to which the accuracy is low. Based on the above discussion on previous works, it can be inferred that the fall in classification performance of SVM classifier has been majorly due to lack of enrichment of mammograms during preprocessing. This is necessary as the choice of nonlinear enhancement approach [6–8] has shown to improve the contrast and edges of ROI; which may optimize the diagnostic capability of the CAD system. Also by using a proper synthesis tool on mammograms the formulation of decision criteria for classification is simplified which further improves the performance of SVM. In the proposed methodology, the effect of enhancement of mammograms over the classification accuracy has been shown. Therefore, sigmoidal transformation algorithm is used for preprocessing which enhances the tumorous region while clamping down the background region in the mammograms. For extraction of textural data from the ROI, four GLCM features are computed. For final classification into two subclasses, SVM classifier is used which formulates a decision rule during its training session; this rule is then used to classify the test images. The upcoming subsections detail the explanation of the methodology, analysis, and discussions of results along with conclusions.

2 Proposed Methodology: Preprocessing, Features Extraction and Classification of Mammograms

The CAD system in the present study consists of various modules such as preprocessing, features extraction, and classification. The input mammograms are first synthesized at preprocessing stage after which the detected ROI is obtained. These ROI are sent to a features extraction stage which calculates some textural data regarding the detected regions. The textural data gives information regarding the contrast, entropy, homogeneity, and energy of the ROI which helps the classifier to form a pattern of selection and thus classification. The training and testing of mammograms are practiced through these features with the help of SVM classifier; which sorts the input mammogram into either normal or abnormal class. Block diagram shown in Fig. 1 depicts the proposed methodology.

The first module as per Fig. 1 involves preprocessing stage in which the visual customization of mammograms is performed which transforms the image in such a way that the suspicious regions are clearly visible. Sigmoidal transformation function has been used for enhancement whose mathematical expression is as shown in Eq. (1)

$$y(x) = a[\text{sigmoid}\{k(x-b)\} - \text{sigmoid}\{-k(x+b)\}], \tag{1}$$

where the parameters a, b, and x have their original meanings as mentioned by Gautam et al. [11]. Equation (1) performs sigmoidal enhancement in contrast of the mammograms so that the detection procedure is less cumbersome. The next modules are features extraction and classification. Different classes of anomalies show different characteristics, thus it is necessary to compute the textural properties of ROI(s) obtained from mammograms. For this purpose, GLCM features extraction technique have been accommodated. It is a technique in which each pixel's intensity is compared with its neighboring pixel in four possible directions (0°, 45°, 90°, and 135°) of an image (Fig. 2) [12]. The features extracted are in the form as shown in Table 1.

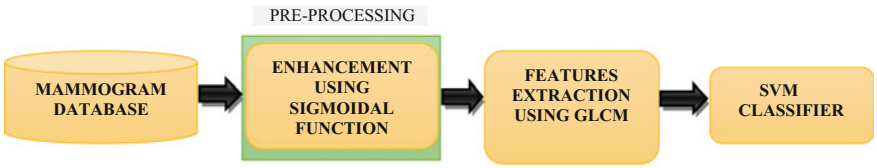


Fig. 1 Block diagram of proposed methodology

Fig. 2 GLCM pixels [12]

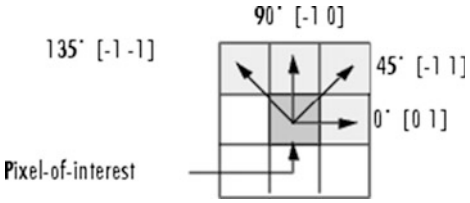


Table 1 GLCM features values at different angles [12]

Features/orientation	0°	45°	90°	135°
Contrast	0.1152	0.1446	0.1140	0.1540
Correlation	0.9723	0.9652	0.9725	0.9629
Energy	0.1789	0.1694	0.1793	0.1665
Homogeneity	0.9424	0.9277	0.9430	0.9320

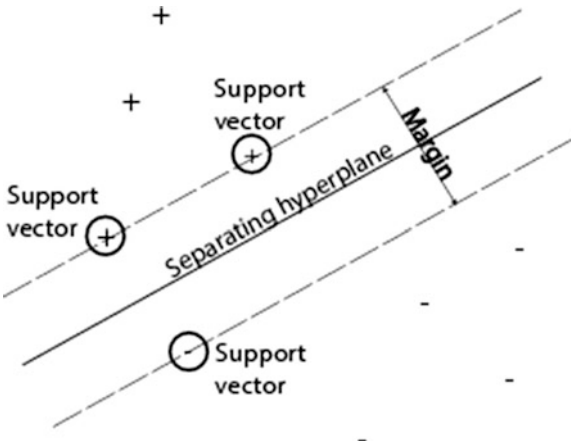


Fig. 3 Decision hyper-plane structure of SVM classifier [13]

These four features are fed to the SVM classifier for final diagnosis. SVM classifier is well known for its efficiency to classify a given dataset into two sub-groups. During its training session, SVM forms a hyper-plane or decision threshold plane depending upon the training dataset which sets criteria for classification as shown in Fig. 3.

This figure represents the linear classification mechanism where the optimal hyper-plane segregates the textural features into two groups [13]. When a test image is send as an input to the system, the textural features obtained are compared with those of the classifier's trained dataset. SVM sorts the input data into either of the two classes depending upon which side of the hyper-plane does the input data lies.

3 Results and Discussions

In proposed methodology, the digital mammograms are taken from MIAS database [14] which provides a classified set of images for cancer anomalies. During simulations, these mammograms are normalized by performing RGB to Gray conversion followed by enhancement process using sigmoidal transformation as discussed in the previous section.

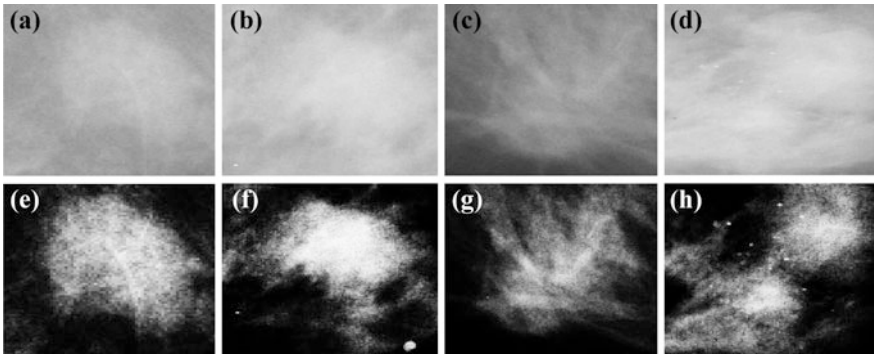


Fig. 4 **a–d** Original ROIs of mammograms: roi#1, roi#2, roi#3, roi#4, **e–h** corresponding enhanced ROIs: Eroi#1, Eroi#2, Eroi#3, Eroi#4

The results of enhanced mammograms using the proposed sigmoidal transformation function are shown in Fig. 4. Herein, Fig. 4a, b (roi#1, roi#2) shows original ROIs from glandular mammograms. After enhancement operation as shown in Fig. 4e, f (Eroi#1, Eroi#2) the background get suppressed and contrast is improved thus focused ROIs are clearly visible. Similarly Fig. 4c (roi#3) shows ROI from a fatty mass and Fig. 4d (roi#4) is from a dense mass with corresponding contrast improved enhanced ROIs in Fig. 4g (Eroi#3) and Fig. 4h (Eroi#4) respectively. The following parameters [15] are calculated measures the performance of the classifier:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{2}$$

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{3}$$

$$\text{Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}} \tag{4}$$

TP and TN stands for True Positive and True Negative respectively, which determines the number of cancerous cases that have been classified as such (TP) and the number of non-cancerous cases that have been classified as such (TN). FP and FN stands for False Positive and False Negative respectively, which is the count of the classification of cancerous cases into non-cancerous ones (FN) and non-cancerous into cancerous ones (FP). Specificity of a classifier measures the ability to detect non-cancerous cases correctly whereas sensitivity of a classifier measures the ability to detect cancerous cases correctly. Accuracy is the ability to detect cancerous and non-cancerous masses which are identified as such. The accuracy of the proposed approach is reported to be 93.18% with a sensitivity score of 95.83% and specificity of 90%. From Table 2, it can be observed that the

Table 2 Results of classifier performance evaluation

Parameters	Original ROIs	Enhanced ROIs
Training set (abnormal = 20, normal = 10)	30	30
Testing set (abnormal = 24, normal = 20)	44	44
True positive (TP)	5	23
True negative (TN)	3	18
False positive (FP)	17	2
False negative (FN)	19	1
Accuracy (%)	18.18	93.18
Specificity	0.15	0.9
Sensitivity	0.208	0.958

Table 3 Performance comparison of proposed methodology with other approaches

References	Classification accuracy (%)
Li et al. [16]	86.92
Zhang et al. [17]	92.10
Proposed methodology	93.18

accuracy of the classifier for original ROI(s) is very low. This is due the fact that the image acquisition procedure for mammogram is done using low dose of X-ray which introduces noise in the image and the overall contrast of the mammogram obtained is of low quality. The obtained results of the proposed methodology are notably better in comparison to the reported works in [15, 16] as illustrated in Table 3. The results proclaim an improvement in the classification system performance and are quite promising.

4 Conclusion

In the proposed work, a sigmoidal transformation function has been incorporated for the enhancement of mammograms followed by features extraction using GLCM features which is finally used for classification using SVM classifier. From the results obtained, it can be concluded that by applying proper enhancement techniques over mammograms, classification accuracy can be improved. The proposed approach has shown better performance than the other compared methodologies. The proposed nonlinear sigmoidal transformation technique improves the overall contrast of the ROI which further elevates the accuracy of the system. The sigmoidal transformation approach for enhancement of mammograms can also be modeled with different classifiers for multiple-class classification. Also, SVM classifier can further be used to classify the abnormal mammograms into malignant and benign.

References

1. Jain, A., Singh, S., Bhateja, V.: A Robust Approach for Denoising and Enhancement of Mammographic Breast Masses, In: International Journal on Convergence Computing, vol. 1, no. 1, pp. 38–49, Inderscience Publishers (2013).
2. Bhateja, V., Urooj, S., Misra, M.: Technical Advancements to Mobile Mammography using Non-Linear Polynomial Filters and IEEE 21451-1 Information Model, In: IEEE Sensors Journal, vol. 15, no. 5, pp. 2559–2566, Advancing Standards for Smart Transducer Interfaces (2015).
3. Tang, J., Liu, X., Sun, Q.: A Direct Image Contrast Enhancement Algorithm in the Wavelet Domain for Screening Mammograms, In: IEEE Journal of Selected Topics in Signal Processing, vol. 3, no. 1, pp. 74–80, IEEE (2009).
4. Aarthi, R., Divya, K., Komala, N., Kavitha, S.: Application of Feature Extraction and Clustering in Mammogram Classification using Support Vector Machine, In: International Conference on Advanced Computing (ICoAC), pp. 62–67, IEEE (2011).
5. Subashini, T. S., Ramalingam, V., Palanivel, S.: Automated assessment of breast tissue density in digital mammograms, In: Computer Vision and Image Understanding, vol. 114, no. 1, pp. 33–43, Elsevier (2010).
6. Bhateja, V., Misra, M., Urooj, S., Lay-Ekuakille, A.: A Robust Polynomial Filtering Framework for Mammographic Image Enhancement from Biomedical Sensors, In: IEEE Sensors Journal, vol. 13, no. 11, pp. 4147–4156, IEEE (2013).
7. Bhateja, V., Misra M., Urooj, S.: Non-Linear Polynomial Filters for Edge Enhancement of Mammogram Lesions, In: Computer Methods and Programs in Bio-mediicne, vol. 129C, pp. 125–134, Elsevier (2016).
8. Bhateja, V., Misra, M., Urooj, S.: Human Visual System based Unsharp Masking for Enhancement of Mammographic Images. In: Journal of Computational Science (2016).
9. Singh, D., Singh, M.: Classification of Mammograms using Support Vector Machine, In: International Journal of Signal Processing, Image Processing and Pattern Recognition, vol. 9, no. 5, pp. 259–268, IJSIP(2016).
10. Liu, X., Tang, J.: Mass Classification in Mammograms Using Selected Geometry and Texture Features, and a New SVM-Based Feature Selection Method, In: IEEE Systems Journal, vol. 8, no. 3, Sept. 2014.
11. Gautam, A., Bhateja, V., Tiwari, A., Satapathy, S. C.: An Improved Mammogram Classification Approach Using Back Propagation Neural Network, In: Data Engineering and Intelligent Computing, Advances in Intelligent Systems and Computing 542, vol. 35, pp. 1–8, Springer (2017).
12. Mohamed, H., Mabroukb, M. S., Sharawy, A.: Computer Aided Detection System for Micro Calcifications in Digital Mammograms, In: Computer Methods and Programs in Biomedicine, vol. 116, no. 3, pp. 226–35, April 2014.
13. Hastie, T., R. Tibshirani, and J. Friedman. The Elements of Statistical Learning, second edition. Springer, New York, 2008.
14. J Suckling et al. (1994) "The Mammographic Image Analysis Society Digital Mammogram Database" Exerpta Medica. International Congress Series 1069, pp. 375–378.
15. Rouhi, R., Jafari, M., Kasaei, S., Keshavarzian, P: Benign and malignant breast tumors classification based on region growing and CNN segmentation, In: Expert Systems with Applications, vol. 42, no. 3, Elsevier (2015).
16. Li, Y., Chen, H., Wei, X., Peng, Y., Cheng, L.: Mass Classification in Mammograms based on Two-Concentric Masks and Discriminating Texton, In: Pattern Recognition, vol. 60, pp. 648–656 (2016).
17. Zhang, Y. D., Wang, S. H., Liu, G., Yang, J.: Computer-aided diagnosis of abnormal breasts in mammogram images by weighted-type fractional Fourier transform, In: Advances in Mechanical Engineering, vol. 8, no. 2, pp. 1–11, 2016.

An Approach for the Preprocessing of EMG Signals Using Canonical Correlation Analysis

Deeksha Anand, Vikrant Bhateja, Ashita Srivastava and Deepak Kumar Tiwari

Abstract EMG signals are generally contaminated by various kinds of noises in a heterogeneous way. Among these various noises, major issue is the proper removal of Additive White Gaussian Noise (AWGN), whose spectral components overlay the spectrum of EMG signals; making its analysis troublesome. This paper presents an approach for AWGN removal from the EMG signal using Canonical Correlation Analysis (CCA). In this approach, CCA is first performed on the noisy EMG signals to break them into various canonical components followed by Morphological Filtering. Herein, a square-shaped structuring element is deployed which filters the canonical components. After that, the outcomes of the proposed methodology are contemplated with the approaches adopted in CCA-Gaussian filtering and CCA-thresholding. Outcomes of simulations show that the preprocessing approach used in this work suppresses AWGN from EMG signal while preserving the original content.

1 Introduction

Electromyogram (EMG) is an electrical revelation originated as a result of muscle contraction. The procurement of a pure EMG signal forms a major issue for proper analysis and utilization of the signal [1]. At low contraction level, the surface EMG

D. Anand (✉) · V. Bhateja · A. Srivastava · D.K. Tiwari
Department of Electronics and Communication Engineering,
Shri Ramswaroop Memorial Group of Professional Colleges (SRMGPC),
Lucknow 226028, Uttar Pradesh, India
e-mail: deeksharoma2012@gmail.com

V. Bhateja
e-mail: bhateja.vikrant@gmail.com

A. Srivastava
e-mail: srivastavaashita95@gmail.com

D.K. Tiwari
e-mail: srmdeepaktiwari57@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_21

signal is usually contaminated by three categories of noises: PLI, Baseline Wander, and AWGN [2]. AWGN originates as a consequence of many recording electrodes and their electrode skin contact area, which is nowadays a more challenging issue. Several preprocessing approaches have been developed in past for the removal of AWGN from EMG signals [3]. Among these, the most common technique is Gaussian filtering for suppression of AWGN. However, Gaussian filter also eliminates useful biomedical information from this signal. Hence, effective removal of AWGN without deteriorating the signal quality is a challenging task in preprocessing of EMG signals. Amirmazlaghani and Amindavar [4] introduced an approach of EMG noise suppression based on statistical modeling of wavelet coefficients using GARCH Modeling; but GARCH model often fails to capture highly irregular phenomena. Aschero and Gizdulich [5] carried out noise removal using Modified Wiener Filtering. However, this approach can only handle processes with additive, unimodal noise. Sobahi [6] propounded an approach of wavelet-based filtering of the EMG signals which targeted every AWGN component according to a thresholding rule. In continuation to previous work, Veer and Agarwal [7] proposed a method of preprocessing the EMG signals based on Daubechies wavelet analysis. This approach was suitable for classification of EMG signals; however, proper selection of wavelets is an important task which acts as constraint. In addition, for fine analysis; such approaches become computationally intensive. The noise removal approach by Zhang and Zhou [8] was based on Ensemble Empirical Mode Decomposition (EEMD) which overcomes the 'mode-mixing' issue occurred in Empirical Mode Decomposition (EMD). But, this approach has poor stability as small variation in input can produce large differences in the output signal. Recently, Harrach et al. [9] proposed a technique of Canonical Correlation Analysis followed by noise intensity ratio thresholding for AWGN elimination. But, the technique has been performance limited as it hampered the diagnostic quality of the EMG signal. In this paper, EMG preprocessing approach based on Canonical Correlation Analysis (CCA) followed by morphological operations is used for suppression of AWGN. CCA has a major benefit that the estimated canonical components are ranked in accordance to their value of correlation coefficients and morphological filters are used to retain the form of the original EMG signal. After that, the signal fidelity assessment parameter, i.e., Signal-to-Noise Ratio (SNR) is evaluated for the validation of the considered approach. The rest of the paper has been sectioned as follows: Sect. 2 reports the proposed AWGN removal approach. Section 3 comprises of the results section which shows the simulation results and discusses the analysis in detail whereas Sect. 4 concludes the work.

2 Proposed AWGN Removal Methodology

The proposed preprocessing approach combines the CCA algorithm with morphological filtering to remove AWGN from the corrupted EMG signal. Initially, the unprocessed EMG signal is fed to the CCA module where the signal decomposition via CCA takes place which breaks the EMG signal into estimated canonical components. These components are then filtered by morphological operations (opening and closing) to get the denoised signal. At the end, the signal fidelity assessment is conducted using SNR as the performance metric.

2.1 Canonical Correlation Analysis

Canonical Correlation Analysis (CCA) is a mathematical multivariate technique which utilizes the correlation coefficient to assess the amount of relationship between two set of linearly combined variables. CCA is a technique that makes use of Blind Source Separation (BSS) algorithm [10] for the sake of segregating contaminated signals. In this technique, first, the combination of variables from both the sets is estimated; further for governing the amount of resemblance between them, correlation coefficient is utilized. These pairs of combinations are called canonical variables or variates and the analog between them is called canonical correlation. The total amount of canonical variates is same as the minimum of variables in both sets [11].

We assume a multidimensional random variable $X = [X_1, X_2, \ldots X_n]$ (n equals the quantity of sensors) is the outcome of combination of obscure source signals $S = [S_1, S_2, \ldots S_n]$. X and S are related by matrix

$$X = A.S, \tag{1}$$

where A denotes mixing matrix and the goal here is to get the source matrix S by calculating the mixing matrix. It is done by bringing the de-mixing matrix W in a way that,

$$Z = W.X, \tag{2}$$

where the matrix Z closely equates the matrix S by a multiplying factor. Let Y be the lagged sketch of the matrix X in a way that $Y(k) = X(k-1)$, where k denotes the sample count. By removing the mean value of the variables X and Y, CCA acquires two basis vectors one for X and other for Y in a way that the correlation between them is maximized. Consider the linear combinations given below

$$x = (w_{x_1}x_1 + \cdots + w_{x_k}x_k) = w_x^T X \tag{3}$$

$$y = w_{y_1}y_1 + \cdots + w_{y_k}y_k = w_y^T Y \tag{4}$$

CCA gets the vectors w_x and w_y that maximizes analog ρ in x and y by the following expression:

$$\rho = \frac{w_x^T C_{xy} w_y}{\sqrt{\left(w_x^T C_{xx} w_x\right)\left(w_y^T C_{yy} w_y\right)}}, \tag{5}$$

where C_{xx} and C_{yy} represent the auto-covariance matrices of X and Y, C_{xy} represents the cross covariance matrix of X and Y, and w_x and w_y are the corresponding weight vectors. Initially, the first variates calculated using the CCA algorithm are found maximally correlated with each other. Similarly, second variates are calculated that are correlated exceptionally with each other but disassociated with the first pair of variates. So, the total variates are deducted iteratively [12]. As a result, all these variates are supposed as the sources which have maximum autocorrelation and are disassociated with one another. Thus, on employing CCA technique on the AWGN corrupted EMG signal, the sources (deduced canonical components) are arranged in a way that the source at the top has the largest autocorrelation value and the source at bottom has the lowest autocorrelation value.

2.2 Morphological Filtering

Morphological filtering signifies nonlinear transformation method mainly employed for the purpose of locally changing the structural properties of a signal using the basic applications of set theory. In this technique, each examined signal can be seen as a set which is in Euclidean space. Morphological filters are those set functions that modify the linear representation of the signal and describes its geometrical shape quantitatively. An important type of morphological operations, i.e., opening and closing can be used for detailed extraction of the signal. Proper selection of structuring element constitutes a very important step for extracting the features from the original EMG signal. Also, structuring element's size should be precisely selected as its inaccurate choice may distort the adjoining wave of the EMG signal [13]. In the proposed approach, square shaped structuring element of width 4 is chosen as shown in Fig. 1. AWGN is eliminated by the help of morphological functions constituting high-pass as well as low-pass filter properties. Therefore in the proposed methodology, opening and closing operations for the effective elimination of AWGN have been used. The respective expression of opening and closing operations is given by

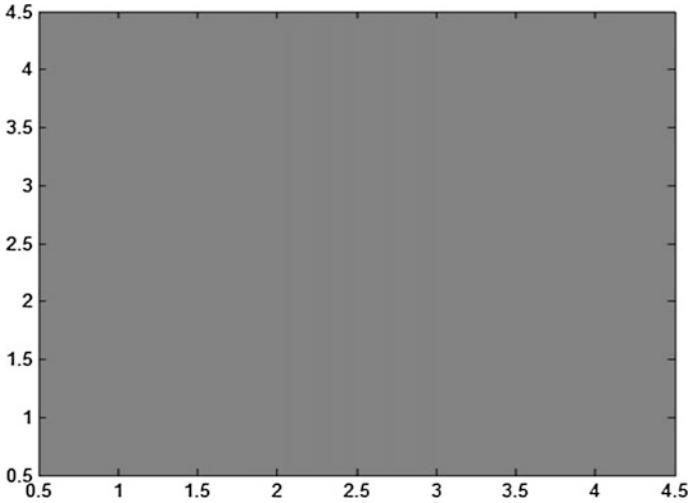


Fig. 1 Square structuring element

$$A \circ B = (A \Theta B) \oplus B \tag{6}$$

$$A \bullet B = (A \oplus B) \Theta B \tag{7}$$

where: A denotes the matrix of decomposed canonical components, B represents the structuring element and $\oplus$ and Θ denotes the dilation and erosion respectively.

Opening, i.e., erosion succeeded by dilation and closing, i.e., dilation succeeded by erosion is performed on the decomposed canonical components from the AWGN corrupted EMG signals. After that, an average of the output of opening and closing operation is evaluated to obtain the filtered EMG signal.

3 Results and Discussions

In the proposed approach, the EMG signals have been acquired from The UCI Machine Learning Repository [14] which includes 10 normal and 10 aggressive physical actions measuring the distinct human activities. In the simulation process, the EMG signals were first decomposed into their corresponding sources using the CCA algorithm. After the decomposition process, the decomposed canonical components were filtered using morphology. Proper selection of structuring element is a very necessary task in morphological operation so here 'Square' shaped structuring element of width '4' has been used which is giving the correct output. Figure 2. demonstrates the results obtained using the proposed approach along with the outputs of the other approaches (CCA-Thresholding and CCA-Gaussian).

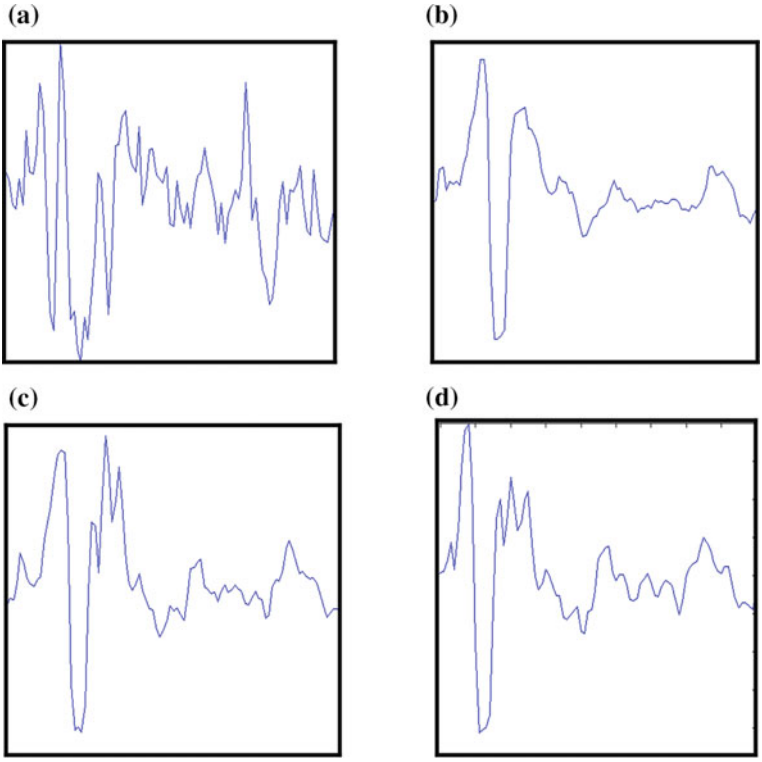


Fig. 2 **a** Corrupted EMG signal (Pushing 3). **b** CCA-thresholding output signal, **c** CCA-Gaussian output signal. **d** Proposed technique output

Figure 2a shows an original EMG signal (Pushing 3) in which AWGN is present. From Fig. 2b, it is observed that the AWGN component has been removed using CCA-Thresholding algorithm but it is accompanied with change in the characteristic of the original signal. Figure 2c shows the output of the CCA-Gaussian approach in which some of the AWGN Components have been removed but still it is present in various portion of the signal. But, there is an improvement in the output of the proposed approach over the other two approaches. In this, AWGN has been removed significantly from the original EMG signal which is clearly seen in Fig. 2d. The noisy EMG signal along with the corresponding output which is filtered using the proposed approach has been shown in Fig. 3a, b respectively.

Furthermore, SNR has been used as performance metric to evaluate and validate the proposed approach. SNR values of the AWGN removed EMG signal using the proposed approach have been compared with the CCA-Thresholding and CCA-Gaussian approaches and shown in Table 1.

Signal-to-noise ratio is a parameter which evaluates the improvement in the signal quality relative to noise. The SNR value of the approach which has been

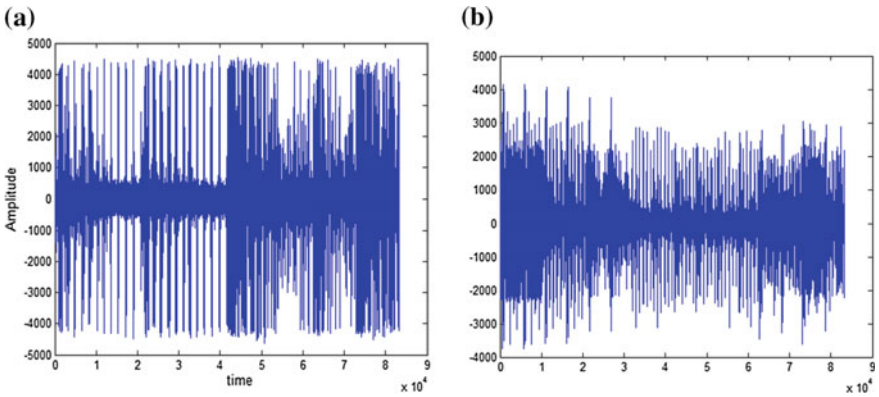


Fig. 3 **a** Corrupted EMG signal (Pushing 3). **b** Proposed approach filtered EMG signal

Table 1 Comparison of SNR (in dB) of other existing approaches used for AWGN removed signal with the proposed approach

EMG signal Ref. No.	Original	CCA-thresholding [5]	CCA- Gaussian	Proposed approach
S1	−53.5585	−25.9195	−30.4589	−17.3018
S2	−54.9072	−22.7579	−24.1077	−19.9077
S3	−51.4548	−23.0094	−18.4568	−16.9144
S4	−51.8611	−22.4099	−21.0319	−16.4957
S5	−52.2966	−22.4412	−20.0167	−19.6798

proposed is reported to be −17.3018 for signal (S1) which is much better as compared to CCA-Thresholding and CCA-Gaussian. Similar results are obtained for other signals also. This proposed approach certainly outshines over the other two approaches.

4 Conclusion

This paper introduced a novel technique for the elimination of AWGN from EMG signals based on CCA algorithm which is followed by morphological filtering [15]. CCA algorithm effectively decomposes the EMG signal into its source components while morphological filtering successfully removes the AWGN present with minimum distortion of the original EMG signal. The performance of this approach was compared with CCA-Thresholding and CCA-Gaussian Filtering based approaches. The proposed approach achieved better results than the other two approaches in terms of suppression of AWGN in the EMG signal. The proposed approach outperforms the existing CCA-Thresholding and CCA-Gaussian based approaches in terms of SNR values.

References

1. Luca, C. D. J., Adam, A., Wotiz, R., Gilmore, L. D., Nawab, S. H.: Decomposition of Surface EMG Signals, Journal of Neurophysiology, vol. 96, pp. 1647–1654, (2006).
2. Tiwari, D. K., Bhateja, V., Anand, D., Srivastava, A.: Combination of EEMD and Morphological Filtering for Baseline Wander Correction in EMG Signals, International Conference on Micro-Electronics, Electromagnetics and Telecommunications, Springer LNEE, pp. 1–8, (2017).
3. Reaz, M. B. L., Hussain, M. S., Yasin, F. M.: Techniques of EMG Signal Analysis: Detection, Processing, Classification and Applications, Biological Procedures Online, vol. 8, no. 1, pp. 11–35, (2006).
4. Amirmazlaghani, M., Amindavar, H.: EMG Signal Denoising via Bayesian Wavelet Shrinkage based on GARCH Modeling, In: IEEE International Conference on Acoustics, Speech and Signal Processing, pp. 469–472, IEEE (2009).
5. Aschero, G., Gizdulich, P.: Denoising of Surface EMG with a Modified Wiener Filtering Approach, Journal of Electromyography and Kinesiology, vol. 20, pp. 366–373, (2010).
6. Sobahi, N. M.: Denoising of EMG Signals based on Wavelet Transform, Asian Transactions on Engineering, vol. 01, no. 05, pp. 17–23, (2011).
7. Veer, K., Agarwal, R.: Wavelet Denoising and Evaluation of Electromyogram Signal using Statistical Algorithm, International Journal on Biomedical Engineering and Technology, vol. 16, no. 4, pp. 293–305, (2014).
8. Zhang, X., Zhou, P.: Filtering of Surface EMG using Ensemble Empirical Mode Decomposition, Journal of Medical Engineering and Physics, vol. 35, no. 4, pp. 537–542, (2014).
9. Harrach, M. A., Boudaoud, S., Hassan, M., Ayachi, F. S., Gamet, D., Grosset, J. F., Marin, F.: Denoising of HD-sEMG Signals using Canonical Correlation Analysis, Medical & Biological Engineering & Computing, vol. 55, no. 3, pp. 375–388, (2017).
10. Naik, G. R., Kumar, D. K., Arjunan, S. P.: Pattern Classification of Myo-Electrical Signal during Different Maximum Voluntary Contractions: A Study using BSS Techniques, Measurement Science Review, vol. 10, no. 1, pp. 1–6, (2010).
11. Hassan, M., Boudaoud, S., Terrien, J., Marque, C.: Combination of Canonical Correlation Analysis and Empirical Mode Decomposition Applied to Denoising the Labor Electrohysterogram, IEEE Transactions on Biomedical Engineering, vol. 58, pp. 2441–2447, (2011).
12. Sweeney, K., McLoone, S., Ward, T.: The Use of Ensemble Empirical Mode Decomposition with Canonical Correlation Analysis as a Novel Artifact Removal Technique, IEEE Transactions on Biomedical Engineering, vol. 60, pp. 97–105, (2013).
13. Verma, R., Mehrotra, R., Bhateja, V.: An Improved Algorithm for Noise Suppression and Baseline Correction of ECG Signals, Springer, vol. 199, pp. 733–739, (2013).
14. Frank, A., Asuncion, A.: UCI Machine Learning Repository, University of California, School of Information and Computer Science, Irvine, Calif, USA, (2010).
15. Qiang, L., Bo, L.: The Muscle Activity Detection from Surface EMG Signal using the Morphological Filter, Applied Mechanics and Materials, vol. 195, pp. 1137–1141, (2012).

Big Data Analytics and Security: A Big Choice and Challenge for the Generation

Gebremichael Girmay and D. Lalitha Bhaskari

Abstract The concept of big data comes into concern when challenges have been identified in digital capacity, velocity, and type of the data gathered. The domain of data source is diverse: social networking, mobile phones, sensors, satellites, and different types of organizations. The data is collected/generated at high rate, and its type is complex (structured, unstructured, and semi-structured). Big data analytics, which is the process to reveal hidden patterns and secret correlations that is to predict and capture insights from this overwhelming data, forced standard technologies to be upgraded or replaced by big data technology, and has a multitude benefits and applications. In this paper, the benefits and particularly the challenges of privacy and security in big data are dealt and solutions are suggested. Parallel to capturing insights from such massive and mixed data which also is sourced from huge varieties of IoT devices, the principles of big data pose advanced security solutions.

1 Introduction

As our world is now in a new age of information existence, huge aspects or matters necessary to our life are becoming dependable on automated computing technologies. Particularly private and government organizations, institutions, and enterprises of all categories are highly characterized by whether they are equipped and integrated with information computing technology. Almost for most of these organizations, the pending issue within the current and coming decade(s) is that of storing huge size (or binary voluminous) of data to be collected, the mix type of

G. Girmay (✉) · D.L. Bhaskari
Department of Computer Science & Systems Engineering, AUCE(A),
Andhra University, Visakhapatnam, India
e-mail: micgirmay@gmail.com

D.L. Bhaskari
e-mail: lalithabhaskari@yahoo.co.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_22

data format sourced from countless IT devices, locations and vendors, the throughput or rate at which these data are piped, analyzed and gain valuable insights-all together these and other concerns are coined by the engulfing term *Big Data*.

Big data can lend new benefits but also raises issues with respect to management, technological setup, and analytical process, privacy, and security threats. In other words, new brands of algorithms and programs have to be designed and developed to handle big data, as well a firm policy and plan in compliance with this new era is required to protect and safeguard all sort of data processing.

A number of global and local enterprises have already envisioned and implemented big data setup. Apache Hadoop, MapReduce, and others are the prominent platforms available for performing big data analytics that apply parallelism and distributed algorithm on clusters or nodes.

The essential works done and being tackled (by companies, researchers, IT stakeholders, throughout the world) under the big data era are to mention some, big data analytics, big data security analytics, big data privacy, big data forensics.

2 Big Data and Big Data Analytics

Big Data—refers to the voluminous data sets that are too complex to manage and process using the existing or regular database management tools.

As articulated by industry analyst Doug Laney, big data spans three dimensions: Volume, Velocity, and Variety.

Volume—The size of data is excitingly very large and will continue to increase enormously, measured as terabytes, petabytes, exabytes, zettabytes, and so on. Some of the issues emerging include how to determine relevance within large data volumes and how to use analytics to create value from relevant data.

Variety—Data collected is of different types of formats, i.e., structured (such as numeric data in traditional databases), unstructured (e.g., Videos), and semi-structured. The domain of data source is diverse: Internet, social media, business organizations, sensors and mobile phones, space, health centers, defence, weather forecasting, etc. Managing, merging, and governing different varieties of data are something many organizations still tied with.

Velocity—Data is streaming in at unprecedented speed and must be dealt with in a timely manner. Reacting quickly enough to deal with data velocity is a challenge for most organizations.

Figure 1 generalizes the meaning of the three Vs. However, the 3Vs is replaced to more number of Vs, in some research papers and articles, example 4Vs, 5Vs, even up to 11Vs. Some of these terms are veracity, value, variability, verification, validity, volatility, and visibility. The orders of priority for these terms also vary among the articulators who want to escalate the Vs. What we can generalize from this is that big data is really a manifold issue and that needs a more automated and customized solution.

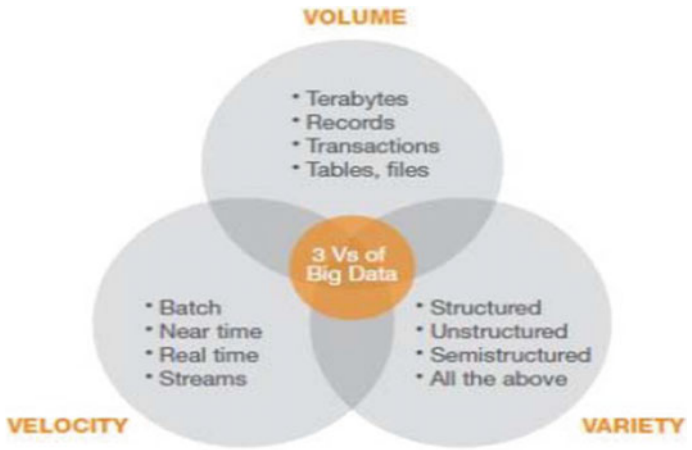


Fig. 1 The three Vs of Big Data [1]

Big data analytics—is the process of collecting, arranging, and analyzing huge data sets to reveal hidden patterns, correlations and other helpful information and deep insights that is important to take enhanced decisions. As the concept of big data has been around for years; many organizations now understand that if they capture all the data that streams into their businesses, they can apply analytics and get significant value from it [2]. Using big data algorithms which lend high-performance data mining, predictive analytics, and optimization enables to continuously derive innovation and make the best possible decisions.

That is, implementing big data analytics companies can make more informed business decisions that cannot be achieved solely by conventional business intelligence (BI) processing architectures and tools. With big data analytics, data scientists and others can analyze not only huge volumes but also complicated set of data that conventional analytics solutions cannot touch. That is the data size is now in exabytes or zettabytes (1ZB = 10^{21} bytes = 10^{3} exabytes = 10^{6} petabytes = 10^{9} terabytes = 10^{12}gigabytes), which is the mix of structured and unstructured data type, and as mentioned in the previous section, the domain of data source is diverse and includes transaction data, web server logs and Internet clickstream data, social media content and social network activity reports, text from customer emails and survey responses, mobile-phone call detail records and machine data captured by sensors connected to the Internet of Things.

The processing pipeline can be organized into the following phases [3]:

- Data Acquisition and Recording
- Information Extraction and Cleaning
- Data Integration, Aggregation, and Representation
- Query Processing, Data Modeling, and Analysis
- Interpretation.

3 The Potentials and Challenges of Big Data

Big data has a number of potential benefits. In the first place, with the right setup of analytics platforms, an enterprise can collect a large enough variety of data at expected slot of time. The big data analytics platform itself endows scalability, fault-tolerant, high speed, better efficiency, reduced latency, by merely using moderately computing devices in the mappers and reducers nodes, for example.

Then comes the predictive power owed by big data analytics, example weather forecasting, healthcare, retail, smarts cities, future business decisions to earn high profits by examining their customer dreams, and more advancements. In general, the analysis of big data is often valuable to companies and to consumers, as it can guide the development of new products and services, predict the preferences of individuals, help tailor services and opportunities, and guide individualized marketing. Due to these and other benefits, the world is really forced to conceive and implement big data analytics.

The benefits of big data themselves are either challenges or result in challenges. Broadly, the challenges in big data environment include analysis, capture, curation, search, sharing, storage, transfer, visualization, and information privacy and security, and the architectures, methods and platforms that support for these scenarios.

For most organizations, big data analysis is a challenge. Consider a large company which is well established with the pre-big data technologies and platforms such as the conventional Business Intelligence (BI). Here, on behalf of the company, one can pose several challenges with regard to the transition to big data environment. Can this company resolve this challenge by reshuffling of the resources (including professional workers), or should the data warehouse be replaced with big data analytics tools and established from scratch? For sure additional investment is required, keeping in mind necessity of huge storage, the complexity of data types (structured and unstructured), applications and operations used to find patterns and deep insights through the analytics; that is big data requires high-performance analytics and thus the benefits be gained.

As outlined in [4], three alternatives of implementation are possible to migrate from the current conventional platform to big data platform. These alternatives are: *Revolutionary*, *Evolutionary*, and *Hybrid*.

The challenges regarding big data privacy and security are the main topic of this paper and are discussed in subsequent sections.

4 Big Data and the IoT

Big Data and IoT are two crucially influenced digital techno-analytical eras. The Internet of Things (IoT) is defined in [5] as "IoT is a term used to describe the ability of devices to communicate with each other using embedded sensors that are linked through wired and wireless networks". Therefore, within IoTs there are

thousands of types of sensors that act as a source of data by sensing and colleting from their intended function and transmit through the Internet networking system. These devices include everything from computers, smartphones, tablets, headphones, wearable devices, car, digital cameras, and almost anything else we can think of that can embed sensor(s). These devices are to be connected and use the Internet to transmit, compile, and analyze data. The IoT applications are tremendous, for example in transportation, retail, agriculture, weathercasts, security, and so forth.

Data generated from the IoT will grow exponentially as the number of connected nodes increases. Gartner predicts that the number of "connected things" will reach 25 billion by 2020 [6].

So, what is the relation between big data and IoT? Yes as discussed in previous sections, big data has the capability of storing the data at rest and the data at motion which are sourced from IoT as well. At the same time it is the task of big data analytics to dig out the hidden insights from the real values, and use it for better business, commercial or political decisions. Therefore, IoT and big data are two critically related projects, as if there are two sides of the same coin.

5 Privacy and Security Challenges with Big Data

Privacy is considered a purely legal issue [7, 8]. Security is the process of actions to make practical the privacy laws and legislations planed to protect user's data and information.

When we focus on privacy and security of data or big data in general, there are many issues to be raised. For example

- how an organization should secure the big data infrastructure (hardware and software),
- how the data is collected, accessed and used,
- which of the data is sensitive,
- what is the users/customers perception on the data or information they exchange,
- who is the responsible to handle these and other issues, etc.?

Security and privacy of potentially sensitive data, information, and IT infrastructure as a whole is always a challenging concern in all level and type of IT and related enterprise systems. The issues are worsen specially as enterprises move into the big data environment; this is because the architecture and platform (e.g. open source framework with distributed data processing across clustered computer environment as in HDFS) used, the type of data (structured, unstructured and hybrid), the millions or billions of data source (devices, vendors, customers), and the rate at which these data are flooding in and out, can result in several forms of vulnerability, one of which is the security and privacy vulnerability.

It is difficult enough to judge whether the data or information shared among millions of IT users is originated and uploaded for free or whether it is abused for monetization or moral satisfaction or dissatisfaction. To more elevate the issues regarding privacy, data from overwhelming sources are fastly circulating our universe, that is if a sensitive personal data is seized or breached in one location, there is a great chance of dissemination of that item and appearing in almost all locations of the world as instantly in real time or near-real time, and hence it is essential to locate and identify the real location of privacy breach to regulate the multi-source and multi-branch fountain of illegal acting, hence guarding the big data environment.

The big question here for researchers, legislatures, regulators is how to provide optimistic guarantee, for single or group of users, for their data privacy, of being secluded from the presence or view of others. As an example of privacy challenges, as referenced in [9], "the dilemma facing regulators is how they can regulate the collection, storage and trading of personal data on the internet, when all of these activities, and the corporations themselves, operate across multiple continents and jurisdictions". This and other phenomenon can force us to abstract that privacy and security breach in this new era of data management is not a simple issue, rather it potentially affects a much larger number of people in the globe which extends to economical, political and cultural intricateness as well.

One thing, organizations and other stakeholders of this issue, have to accept by default is that security and privacy threats are advancing in parallel to the current advancement in big data technological and operational management. The world of IT is now in a period of advanced persistent threats (APTs), or intelligence threat and thus organizations must take advantage of new technologies to protect the whole big data platform.

5.1 General Approach for Big Data Privacy and Security Solutions

As part towards the solution, the research designs, legislations, and regulations regarding privacy in big data environment have to be outlined, structured and implemented at several levels(for their inevitable reasons and backgrounds, in varity of orders), at

- user/individual level,
- institutional/organization level, and
- global level.

The vendors of data are now a day not only the licensed organizations, in other words individual users are not only consumers but also producers of huge amount of variety of data formats and transmitters of data at high speed automated IOTs. Some of the privacy issues to put as a burden on individuals may be summarized as:

awareness—about multitude types and ways of data stealers/disturbers; **trust**—to use or not to use network systems/apps; and **responsibility**—no to blame others on careless handling personal data. These and the other privacy techniques used at personal and organization level helps to avoid the collection of *personally identifiable information*.

Organizations share huge amount of data, information, technology and so forth, locally/globally, for the sake of enhanced business operations, for example. Hence the existence of one organization is critically dependent on other ones when we consider IT security in general, because if there is a vulnerable infrastructure in either of these parts then the security breach will be reflected in one or the other way in some or all the cooperating systems. Therefore it is a mandatory to have common/global IT security resolutions, regulations, legislations, and frameworks of transparency and guidelines.

Since big data is a relatively new concept; it is hard to say there is a list of best practices that are widely recognized by the security community. Of course, the principles of big data are the key to advanced security intelligence [10]. Anyway, several concerned intellectuals and practitioners have listed out a number of general security considerations and recommendations that can be applied to big data.

Methodology (**approaches**)—As a best overall practice, it will be helpful to sketch and clarify the roadmap of tackling big data threats. First, the *Big Data asset taxonomy* and the *Big Data treats taxonomy* have to be identified, then, followed by mapping the threats to big data asset taxonomy. Big data assets taxonomy can be categorized as data, infrastructure, analytics, security and privacy techniques, and roles. Similarly, big data threats taxonomy can be classified as organizational, legal, eavesdropping, nefarious, and unintentional damage, etc.

The security and privacy techniques, i.e., security-related assets have to be outlined, example as in [11, 12], which are categorized into four aspects of big data ecosystem, as *infrastructure security*, *data privacy*, *data management*, and *integrity and reactive security*. These can be further break down into several levels of aspects. This, of course, summarizes the challenges pointed out in preceding paragraphs. As threat asset taxonomy is vast one can select a specific weak point (example, intrusion detection) and provide intended solution with the help of taxonomy roadmap, algorithms, technologies and applications, that apply to big data platform.

Some of the basic big data security consideration includes

- Data anonymous,
- Data encryption,
- Cryptographically enforced access control and monitoring,
- Policy and compliance, and
- Governance frameworks.

Of course not all data is same and not all coming in data is to be stored. Sensitive data/information has to be anonymized or encrypted, compressed and stored in a

way of disparate. Authentications and authorizations are to be more efficient that may include voice, image or some kind of patterns taking into account scalability, time (low and high latency), according to the big data ecosystem.

As a matter of consequence, knowledge of machine learning, AI, advanced cryptography, etc., is highly required to support effective analytical models that identify potentially fraudulent transactions, identity theft, and malwares in general. This will help to look for solutions to improve or change the security posture from a reactive to a predictive model.

5.2 *Big Data Security Technologies and Applications in Use*

Of course dozens of security packages or tools have been in test and introduced as practical application this day, though they are not full-fledged security solutions towards the new era of security intelligence of data acquisition and analysis. Some of the leading big data security analytics tool vendors include Cybereason, IBM, RSA and Splunk. For example, Splunk/ELK, HP ArcSight feature (called Correlation Optimized Retention and Retrieval (CORR) Engine) serve as a foundation for threat detection, security analysis, and log data management as pointed out in [13].

Some of the existing or conventional applications for handling security include security incident event management (SIEM), and intrusion detection system (IDS). These may not compete for all type of data analysis capability (batch, near-time, and real time) within large business organization. They basically target on real threats and vulnerabilities in small and medium organizations.

For instance, the target of traditional SIEM is mainly for batch systems. SIEM tools basically accomplish their intended security function based on centralized collected security log data from different type of security controls, OS and other software used by an enterprise. That is their basic function is to collect, analyze, and report security breach issues based on logs and events, though some of the SIEM products may have the task of stopping attacks on the way. These SIEM are blamed for important big data issues such as scalability, incident response, though some recent SIEM tools can comply for that.

Big data security analytics (BDSA) is a specialized application of the more general concept of big data. Some of the key features that distinguish big data security analytics from other information security domains include scalability, reporting and visualization, persistent big data storage, information context, breadth of functions [14]. Real time is the newest business of concern. That is big data security analytics tools are designed to collect, integrate, and analyze large volumes of data based on context and correlation fashion, in near-real time, which requires several additional advancements.

6 Conclusion

In this paper, the definition of big data has been explained based on the 3Vs dimension followed by the benefits acquired from big data analytics. Accordingly the world is migrating towards big data environment due to the all round advancement in IoT, data size, data format, data type, latency, and the taxonomy. Though big data environment is a must to adapt, several challenges are facing researchers, data scientists, and organizations. Among these big data challenges are the big data privacy and security issues. Some tools, methods, and procedures are being in use already, though yet to reach the optimistic satisfaction. In general, tackling privacy and security issues in big data is a mandate of data generators, reservoirs, disseminators, and users as a whole. This issue may not as simple as in the traditional data and information management. This is because the multi-dimensional taxonomy of big data environment necessitates implementation of this concern at several levels of the big data ecosystem and using advanced and appropriate securing algorithms.

References

1. Big Data Analytics, https://www.researchgate.net/profile/Sachchidanand_Singh3/publication/261456942_Big_Data_analytics.
2. Big Data Analytics: What it is and why it matters, http://www.sas.com/en_us/insights/analytics/big-data-analytics.html.
3. Big Data Whitepaper: Challenges and Opportunities with Big Data, www.purdue.edu/…/assets/pdfs/BigDataWhitePaper<….
4. Dr. Arvind Sathi: Big Data Analytics: Disruptive Technologies for Changing the Game. First Edition, MC Press Online, LLC (2012).
5. Big Data: Seizing Opportunities, Preserving Values.
6. Driving Real-Time Insight: The Convergence of Big Data and the Internet of Things. Oracle White Paper (July 2016).
7. Rebecca Herold: What Is The Difference between Security and Privacy? (2002).
8. Wikipedia: Information Privacy, https://en.wikipedia.org/wiki/Information_privacy.
9. The Guardian: Little Privacy in the Age of Big Data, https://www.theguardian.com/technology/2014/jun/20/little-privacy-in-the-age-of-big-data.
10. A Randy Franklin Smith Whitepaper: Top 5 Truths about Big Data Hype and Security Intelligence.
11. José Moura, Carlos Serrão: Security and Privacy Issues of Big Data.
12. Cloud Security Allniance: Top Ten Big Data Security and privacy Challenges. (2012).
13. Slashdotmedia: 10 Ways to Build a Better Big Data Security Strategy. IT Manager's Journal (January 2014).
14. Dan Sullivan: Introduction to Big Data Security Analytics in the Enterprise.

A Prototype for Image Tamper Detection with Self-generated Verification Code Using Gödelization

P. Raja Mani and D. Lalitha Bhaskari

Abstract Smart gadgets like mobile phones, camcorders, handy digicams, and the availability of sophisticated photo editing tools have eased the process of forgeries in this digital era. The forged digital images are increasing at a rapid rate and so are the legal issues attached with them. As the technology is increasing, the methods adopted for creating digital forgeries and cyber crimes are posing a great threat to the security, integrity, and authenticity. Several researchers have proposed many techniques for detecting and identifying such illegal issues like image tampering, image forgery. The paper addresses this problem of image tamper detection by embedding a unique verification code generated from the image using Gödelization technique which acts as in-camera fingerprint of the image. It works for color images. This is a very simple method to implement which needs very low computation and memory space.

1 Introduction

In today's fast changing gadget era, smart phones have occupied a major part. It has turned to be a basic necessity in human life rather than a luxury. Smart phones with in-built cameras which are handy play a key role in digital forensics. With the ease in usage, it has become a fashion to click photos and selfies irrespective of occasion and share on social medias like Facebook, Twitter, Whatsapp, etc. With tremendous availability of images and easy accessible photo editing applications, resampling the images has become a common practice. The motto behind these manipulations need not always be to forge but to enhance the look and feel. But when they are manipulated to an extent which vicissitudes the image there raises an issue which

P. Raja Mani (✉)
GITAM University, Visakhapatnam, Andhra Pradesh, India
e-mail: rajamani09@gmail.com

D. Lalitha Bhaskari
AUCE(A), Andhra University, Visakhapatnam, Andhra Pradesh, India
e-mail: lalithabhaskari@yahoo.co.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_23

has to be arbitrated. Every image captured by a camera has a unique property which can be regarded as a fingerprint. Each and every image has its own fingerprints. In general, fingerprints are classified into intrinsic fingerprints and extrinsic fingerprints. Intrinsic fingerprints are features of the image where as extrinsic fingerprints are watermarks or signatures. The proposed method addresses the problem of image tamper detection by embedding a unique verification code (VC). VC is generated from the image using Gödelization technique which acts as in-camera fingerprint and this technique works for color images.

2 Related Work

2.1 Image Manipulation Techniques

Most of the image manipulation techniques can be categorized as content-changing manipulations and content-preserving manipulations. Content-changing manipulations focuses on image tampering like splicing, copy-move, resampling in which the image content is reshaped arbitrarily according to semantic content. Content-preserving manipulations concentrates on manipulations like contrast enhancement, blurring, compression.

Digital forgery detection techniques are classified into Active and Passive Methods.

(i) **Active Methods** are also known as non-blind methods. In these methods original image or its identity representation called watermark or digital signature is needed for comparison. The watermark can be text, image or any self generated unique code. Hash or digital signature generated by the camera can be treated as examples. Active Methods address content-changing manipulations. These methods are simple, robust, and easy to implement which gives accurate results of image tamper detection.

(ii) **Passive Methods** are blind methods which do not need any embedded information in the image. These methods use Wavelets, DCT, Feature extraction which are computationally complex to be robust. DCT is based on frequency content. It gives perfect results for images that have high frequency complexity [1]. But extensive testing is needed to get perfect results. The advantage of DWT is that it has multi-resolution characteristics [2]. The major drawback of this method is that the computational requirement is very high as compared to other methods. Feature extraction is the most commonly used blind technique. It is a complex procedure and requires a lot of computational efforts. The performance of feature-based detectors [3] is accurate only when the objects to be matched have a same color or a distinguishable corner or edge. Furthermore, the feature-based algorithms do not perform as good as expected when images are subjected to variations in color's distribution, scale, illumination, rotation.

2.2 Gödelization Technique

Gödelization [4, 5] is a process of converting a positive integer greater than 1 into a sequence called gödel number sequence (GNS). GNS of a number is the product of primes. According to it, GNS of 220 is calculated as GNS (2, 0, 1, 0, 1) which can be encoded as $2^2 \times 3^0 \times 5^1 \times 7^0 \times 11^1$. So now, 220 is encoded as 20101. This process is applied for diagonal pixels of the image. Every diagonal pixel is converted into a Gödel Number Sequence. Thus the obtained GNS are concatenated to form a gödel string (GS), where GS = GNS(1,1)$GNS(2,2) $….$GNS(n, n), n is size of the image and $ is a delimiter. This Gödel String is nothing but a unique signature generated from the image and this technique can be embedded as a post-processing operation in a camera after capturing and before generating the image.

3 Proposed Methodology

3.1 General Image Acquisition Model

The general Image Acquisition Model [6–8] in an image capturing device is shown in Fig. 1. Let S be the scene to be captured where the light passes through the lens, optical filter, Color Filter Array (P), and Color Sensors which acquires the color of the scene at an appropriate pixel location and produces the scene S_P. After obtaining S_P the intermediate pixel values are interpolated using the neighboring pixel values to obtain $S_P^{(I)}$. Now the red, blue, and green color components undergo basic post-processing operations like color correction, white balancing, gamma correction, denoising, lens distortion removal, etc. Based on the file format supported by capturing device, the image may be compressed to reduce storage space and produces the image I at point A.

With this general Image Acquisition Model in view, the proposed methodology incorporates Generation of verification code (VC) and Embedding of VC in the image which helps in increasing the authenticity as well as robustness of the resultant image. The detailed process is explained in the following section.

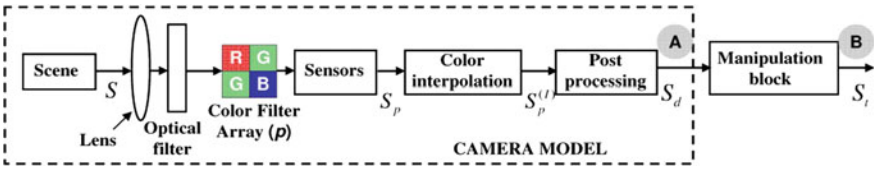


Fig. 1 General Image Acquisition Model [6–8]

3.2 *Prototype Design Incorporated in Image Acquisition Model*

Each camera model/make uses a different set of algorithms for CFA, color interpolation, and post-processing operations. According to the proposed model, after the basic post-processing operations we add two more operations called verification code (VC) generation and VC embedding as shown in Fig. 2. Gödelization technique as explained in Sect. 2.2 generates the VC of the image. The VC is unique and acts as a best in-camera fingerprint. Finally the VC is embedded in LSB+1 column plane of the image. LSB+1 column plane is chosen for embedding as it embeds the VC into the image without distorting the image and making VC perceptually invisible in the image. These operations leave some traces of intrinsic finger prints of the image I and generate the image I_{VC}. This prototype detects any post camera operations done to an image accidentally or maliciously. Even minor changes done to the image is easily detectable.

When a scene is captured by a camera and image is formed, the proposed technique is applied as a post-processing operation after which the final image I_{VC} is produced. The VC generated during post-processing is stored in Verification Code Index file along with its length as shown in Table 1. It also contains the image file size, image dimensions, date taken. The model for image tamper detection is explained in two phases. The first phase as shown in Fig. 2 describes generation of VC and embedding it into image to produce I_{VC} and is clearly explained in the following section. Figure 4 in Sect. 3.4 explains second phase, the process of extracting VC and detection of image tamper.

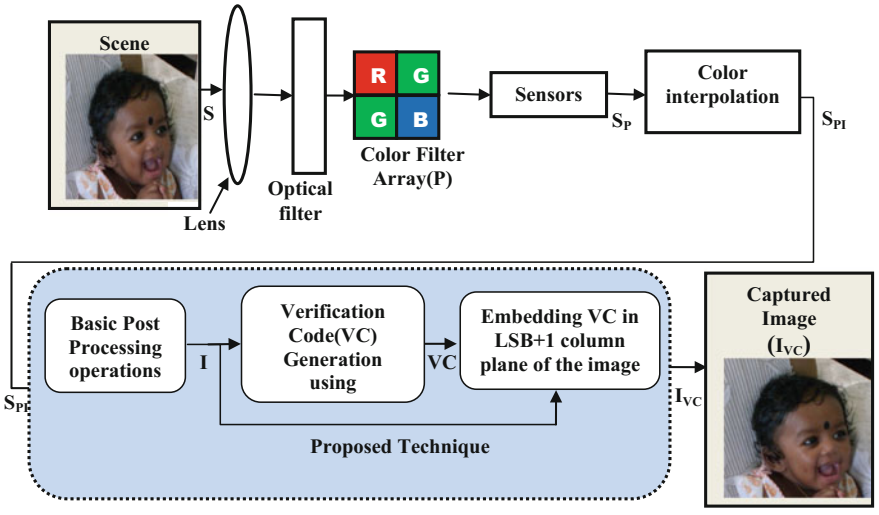


Fig. 2 Image acquisition model incorporated with proposed technique

Table 1 Verification code index table

Image	Size	File size (kb)	Date taken	VC Length (bits)
Sofa.png	160 × 160	30.1	04/12/2009	12,024
Bullets.png	180 × 180	78.8	10/19/2010	19,200
Baby.png	256 × 256	115	05/21/2008	27,408
Park.png	256 × 256	83	03/08/2014	30,632
Resort.png	256 × 256	86	03/08/2014	28,496
Aqua.png	256 × 256	98	03/19/2016	23,848
Temple.gif	256 × 256	119	06/08/2015	33,688
Ganesh.png	308 × 308	185	30/04/2016	40,832
Cycle.png	360 × 360	201	01/02/2015	26,808

'0100000000000000000001$0100000000000000000001$0210001$0010000000000000001$03
00000001$0200000000000001$0200000000000001$000000000000000000000000000000000
000000001$00102$03000001$000000000000000000000000000000001$0112$03101$011
00000001$000000000000000000000000000000000000000001$001101$010011$....

Fig. 3 Verification code of baby image

3.3 Embedding Self-generated Verification Code

The first phase comprises of generating a verification code using Gödelization technique and embedding it in the image. It is explained in the following steps.

Embedding Self-Generated Verification Code

Input: Image (I)
Output: Image embedded with verification code (I_{VC})
Step 1: Capture a Scene by an image Capturing device. Let the image be I.
Step 2: Compute GNS for the intensity values of diagonal pixels as explained in Sect. 2.2 to obtain GNS(I (i, j)) where $i == j$.
Step 3: The verification code (VC) is obtained by concatenating GNS of all diagonal pixels. VC = GNS_{i1}‖ GNS_{i2}‖ GNS_{i3}‖….. GNS_{ij} where $i == j$.
Step 4: Now the VC is embedded in LSB + 1 column plane of image I to obtain the final image I_{VC}.

Figure 3 shows the VC of Baby image. The verification code generated for each and every image is stored in a file along with its details like location of the image file, image format, image dimensions, file size, date of creation, and length of verification code. The Verification code Index Table in Table 1 gives some of these details.

3.4 *Extraction of Verification Code and Image Tamper Detection*

According to the proposed method, once the image is captured it introduces VC as an intrinsic fingerprint in I_{VC}. This image may undergo further processing accidently or maliciously. Let us assume this post camera manipulated image as test image (TI).

The second phase of the proposed method estimates the intrinsic fingerprints of TI to justify whether the image has been processed after it has been captured by the digital camera or mobile camera. Figure 4 shows this process. The various steps involved are as follows.

Extraction of Verification Code and Image Tamper Detection
Input: Test Image (TI) **Output:** Tampered/Untampered **Step 1**: Let the test image be TI. **Step 2**: Extract the bits at LSB + 1 position in column plane. **Step 3**: Compute the Verification code of TI, denoted as TI_{VC}. **Step 4**: Compare the verification codes of TI_{VC} and I_{VC} to judge the image is tampered or not. **Step 5**: The deviation of the verification code from the original indicates the manipulation of the image after it is captured by the camera.

4 Results

The proposed scheme is tested on a dataset of over 50 color images of various formats like jpg, gif, png, tiff. The quality of the image produced using the proposed method is measured in terms of PSNR. It is around 49.90 dB, which is highly acceptable and the distortion is imperceptible to HVS. Table 2 presents some test cases of untampered images with their PSNR and MSE. The markings in the images of Table 3 clearly show the images are tampered.

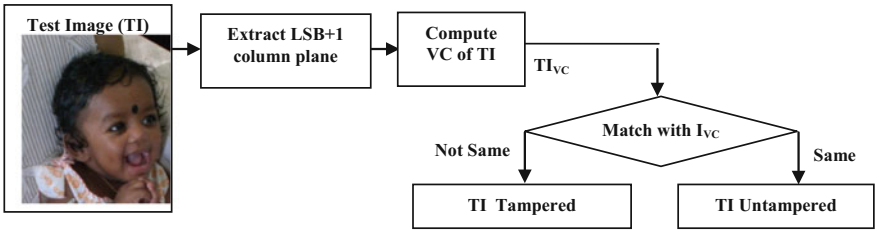


Fig. 4 Verification code extraction and image tamper detection

Table 2 PSNR and MSE analysis of untampered images

Name of the Image	Image with verification code	Test image	PSNR	MSE
Park.png			49.9008	0.6652
Ganesh.png			49.0120	0.81635

Table 3 PSNR and MSE analysis of tampered images

Name of the image	Image with verification code	Test image	PSNR	MSE
Baby.png			36.6097	14.1941
Cycle.png			14.4416	2.33836e +04
Bullets.png			26.9125	1.32381e +02

5 Observations and Conclusions

From the test cases shown in Tables 2 and 3, it is observed that the PSNR of the untampered images is around 49 dB and MSE is around 0.6 where as for tampered images PSNR has completely dropped down and MSE has raised. It indicates that the Verification code, acts as in-camera fingerprint and is able to detect clearly minor to major post camera manipulations. The VC generated using Gödelization technique is unique to every captured image. When a scene is captured I_{VC} is generated. If the same scene is captured again this time the capturing device

generates I_{VC1}. In this scenario, if one of the images is treated as Test Image (TI), we can assure that the images are perceptually the same and do not need any kind of testing.

This method is very simple to implement which needs low computation and memory space. The results are very accurate for lossless image formats. There are some false positive cases for lossy image formats like jpeg. This technique can be implemented as a prototype to generate in-camera fingerprints of the image to detect post camera manipulations which can further be used in analysis of image tampering.

References

1. Zhouchen Lin, Junfeng He, Xiaoou Tang, Chi-Keung Tang, "Fast, automatic and fine-grained tampered JPEG image detection via DCT coefficient analysis", Pattern Recognition 42 (2009) 2492–2501.
2. P. Raja Mani, D. Lalitha Bhaskari, "A Secured Approach for Watermark Embedding using Key based Gödelization Technique under Spatial and Frequency Domains", IJCA (0975–8887) Volume 95–No. 19, June 2014.
3. D.N.D. Harini, D. Lalitha Bhaskari, "Image retrieval System Based on Feature extraction and relevance Feedback", Proceedings of ACM by Intl. Conf CUBE 2012, Pune Sep 3–5,2012,978-1-4503-1185, pp 69–73, DOI 10.1145/2381716.2381731.
4. D. Lalitha Bhaskari, P. S. Avadhani, A. Damodaram, "A Combinatorial Approach for Information Hiding Using Steganography And Gödelization Techniques" in the Journal of IJSCI(International Journal of Systemics, Cybernetics and Informatics), pgs 21–24, ISSN 0973-4864.
5. P. Raja Mani, D. Lalitha Bhaskari, "Gödelization and SVD Based Image Watermarking under Wavelet Domain", Proc. of Int. Conf. on Front. of Intell. Comput., AISC 199, pp. 675–681, Springer-Verlag Berlin Heidelberg 2013.
6. J. Adams, "Interaction between color plane interpolation and other image processing functions in electronic photography," in Proc. SPIE Cameras Systems for Electronic Photography Scientific Imaging, San Jose, CA, Feb. 1995, vol. 2415, pp. 144–151.
7. J. Adams, K. Parulski, and K. Spaulding, "Color processing in digital cameras," IEEE Micro., vol. 18, no. 6, pp. 20–30, Nov./Dec. 1998.
8. A. Swaminathan, M. Wu, and K. J. R. Liu, "Non-intrusive component forensics of visual sensors using output images," IEEE Trans. Inf. Forensics Security, vol. 2, no. 1, pp. 91–106, Mar. 2007.

Suspicious URLs Filtering Using Optimal RT-PFL: A Novel Feature Selection Based Web URL Detection

Kotoju Rajitha and Doddapaneni Vijayalakshmi

Abstract The crucial and criminal activities in Internet occurs due to malicious or suspicious websites. Therefore, it turns to be an challenge approach to keep away the end users from moving on to the malicious websites. In this paper we propose a technique called optimal RT-PFL to classify the malicious URLs from non-malicious URLs detected in the websites. Here the data set should be encoded into both the lexical as well as the host-based features related to the URL in order to generate the feature components. Certain features is extracted by the feature extraction process. Optimal features of URLs is selected based upon the proposed feature selection approach namely Gray Wolf Optimizer based Rough Set Theory algorithm. This proposed algorithm can productively identify minimal attribute reduction from the highly efficient dataset which in turn improves the classification systems performance. The chosen URL should be admitted towards the classifier to foresee whether the admitted URL is benign or it is malicious. The classification of URLs depends on the newly proposed particle filtering based fuzzy logic approach. The subsequent classifiers gains higher accuracy by identifying huge amount of malicious URLs from the malevolent sites.

1 Introduction

Any data to be searched on a PC should be identified by entering its filename also uniform resource locators (URLs) is utilized to trace out any necessary website. Any user can recover a web page by writing a URL onto the browsers address bar or alternatively by clicking right URL into the address bar the user can obtain the required website. Example for this is https://mail.google.com/mail/#inbox. It takes after the standard rule <protocol><hostname><path> [1]. Feature selection gives a

K. Rajitha (✉) · D. Vijayalakshmi
Mahatma Gandhi Institute of Technology, Hyderabad, India
e-mail: charuk.rajitha@gmail.com

D. Vijayalakshmi
e-mail: vijayadoddapaneni@yahoo.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_24

path to distinguish the unavoidable features and also by eliminating (excess) ones held in the dataset [2]. The goal of feature selection is attribute reduction from a highly dimensional dataset, enhancing the performance of prediction, and great information knowledge gain for various applications of machine learning [2, 3].

In this paper, we have introduced Gray Wolf Optimizer based Rough Set Theory algorithm as well as the Particle Filtering based Fuzzy Logic approach. Certain optimal features are extracted from the entire generated features. After obtaining the minimal reduced features (attributes) of URL, classification should be done with the optimized minimal features using proposed particle filtering based fuzzy logic approach. Finally, at the implementation of this approach, malicious URLs is filtered out from original non-malicious URLs.

The contribution of this paper is as follows:

- Here we present a Gray Wolf Optimizer based Rough Set Theory algorithm in order to select the minimal attributes from the extracted features.
- Classification is done with the help of particle filtering based fuzzy logic approach. From this malicious (suspicious) URL can be isolated from the original URL. About 90–95% accuracy can be obtained for the identification of malicious URLs.
- Hereby we will evaluate the simulation results of the proposed approach, analyzed, and contrasted the outcomes together with the similar as well as with the existing approaches.

The rest of this paper is accompanied by the upcoming sections. Segment 2 relates our work with existing works. Problems behind existing works are provided in zone 3. Proposed methodologies behind this paper are portrayed in zone 4. Results behind this work are examined in Sect. 5. This paper gets finished up with zone 6.

2 Related Works

A few examination works have been done in suspicious URL identification. In this segment, we contribute our proposed work with the existing works. Chen et al. [4] have proposed social network services (SNSs) which were growing in demand. Interaction with companions develops a social organization that can be utilized to impart data to companions. These existing works when compared with proposed work it showed malicious URLs were detected without any security.

Emery et al. [5] have proposed a binary version of the novel Gray Wolf Optimizer (GWO) to choose a subset of optimal feature for the purpose of classification. Gray Wolf Optimizer (GWO) was the most recent bio-roused advancement methods, which recreate the Gray Wolves hunting procedure. After examining these works with the proposed methodology it was verified that the existing work shows limited performance.

Chung et al. [6] have examined the fuzzy logic framework a well-known instrument for displaying nonlinear frameworks. These existing works when contrasted with the proposed work it was detected that classification of malicious URL was a tedious process.

Li et al. [7] have examined the decision tree classification over the dynamic research field onto the application of machine learning. A new reduction of attributes technique in view of Rough Set approach was developed for information of multi-label. Decision tree classification when contrasted with the proposed methodology it was verified that it focused only on the reduction of attributes.

3 Problem Definition

From the existing work several disadvantages has been detected they are as follows:

- The third-party user can hack the websites with the help of malicious URLs.
- One of the unauthorized users may embed the fake URLs to the original URL content on the website.
- Transformation of malicious contents to the website. Classification and identification of malicious URL from original URL is a complex process.
- To resolve this issue classification and selection of URLs is carried out using Rough Set based Gray Wolf Optimizer algorithm as well as the Particle Filtering based Fuzzy Logic approach.

4 Suspicious URLs Filtering Using Optimal RT-PFL

4.1 Overview

In this paper, we propose Suspicious URLs Filtering Using Optimal RT-PFL: A Novel Feature Selection based Web URL Detection. To implement this feature selection algorithms and classifier approaches the data set of URL should be encoded into both the lexical as well as host-based features thus to develop its feature components. The features of lexical approach incorporate path token, host name, domain name, final path tokens, topmost level domain, and different incidental lexical features. The features behind host-based approach [1] incorporate geographic data WHOIS data, geographic membership included in the blacklist, association speed, and also the properties of domain name space (DNS). From the URL data set, optimal features of URL should be extracted. Now from the extracted features it is necessary to find the minimal attributes thus for the reduction of the optimal extracted features. For this purpose feature selection algorithm of Gray Wolf Optimizer based Rough Set Theory algorithm is used. After obtaining the minimal

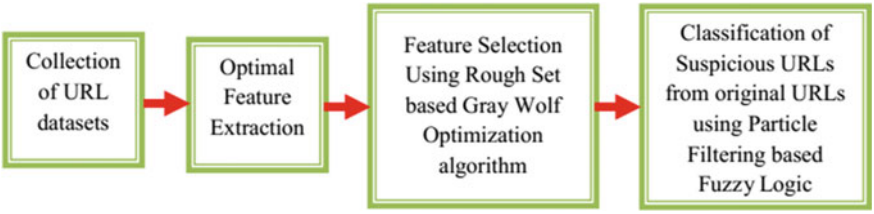


Fig. 1 Schematic diagram of proposed method

reduced features (attributes) of URL, classification should be done with the optimized minimal features using proposed (PFL) Particle filtering based Fuzzy Logic approach. Finally, at the implementation of this approach, malicious URLs is filtered out from original non-malicious URLs. Our proposed method supports the user to identify the malicious and non-malicious URLs. Thus it enhances the security of the websites and makes it more convenient to use the sites by the knowledge of non-suspicious URLs. Figure 1 describes the flow diagram of proposed method.

4.2 Collection of URL Datasets

Uniform resource locators (URLs), commonly referred to as "Web Links," turns to be an essential means in which clients find resources located into the Internet. The data set has been provided to repository of UCI machine learning. Gathering of URLs from various sites ought to be accumulated within the repository of UCI [1].

4.2.1 Lexical Features and Host-Based Features

Lexical feature is referred to as the URLs textual. Some of the properties are the length of the whole URL, domain name length, and in addition the quantity of dots used in the notion of URL.

Host dependent features denote "where" this malicious websites is facilitated, "who" oversaw this malicious websites and "how" this websites are controlled.

4.2.2 Optimal Feature Extraction

Certain features of URL should be extracted to identify suspicious URLs which have been included by the unauthorized third party. In order to promote feature extraction, every URL is divided into three segments: they are domain, protocol, and path [3]. Table 1 demonstrates the types of features. Tokens were generated by partitioning a region based upon the values, "?", "/", "=", ".", as well as "". For instance, the domain {2} that relates to "mail.google.com" alludes to the "mail" token.

Table 1 Example for feature extraction

Feature group	No of features
Domain {2}	7,933
Path tokens (all)	100,401

4.2.3 Feature Selection Using Gray Wolf Optimizer Based Rough Set Theory Algorithm

Assume DT $= (U, A = \mathrm{CU}^{D})$ DT as a Decision Table where as $U = \{x1, x2 \ldots x_n\}$ denotes objects to the non-empty finite set, C is notified as condition attributes (features) of the non-empty finite set, D is defined as Decision attribute.

Pseudo code for Gray Wolf based Rough set Theory Algorithm

Input: Decision Table $DT = (U, A = CU^{D})$ Where $C = \{1,2.....m\}$; C is represented as Condition Attributes;

D is represented as Decision Attributes;

$U = \{x1, x2....x_n\}$ Finite sets of non empty objects

Output:

$s \subseteq c$; $\| s$ Referred to as reduction of best minimal attribute;

Initialize arbitrarily: a, C, A

Search attributes position

$X(j,i)(j = 1..noofsearch\ agent, i = 1...\mathrm{dim}ension)$

Estimate the search agents Fitness

Initialize $X3, X1andX2$ position

for $t = 1$ generate max iterations do

for every search agent i do

for recent search feature position j do

Position $X(j,i)$ update

if $X(j,i) \geq 0.5$ then

$b(j,i) = 1$

Else

$b(j,i) = 0$

end if

end for

end for

Update a, C, A; Measure the main function $i(b)$ for entire search agents

Update $X3, X1andX2$;

end for

Return b

It is necessary to find the minimal attributes thus for the reduction of the optimal extracted features. For this purpose feature selection algorithm of Gray Wolf Optimizer based Rough Set Theory algorithm is used. Rough sets are utilized to reduce the attributes with huge achievement. The Gray Wolf optimization (GWO) detects optimal features (attributes) that relate to the complex search domain through the communication of people belongs to the population. The outcomes demonstrate that GWO is more appropriate for reduction of an attribute using rough set theory. Reduction of features (Attributes) is one of the main contributions to the exploration of Rough Set based theory.

4.2.4 Classification

After obtaining the minimal reduced features (attributes) of URL, classification should be done with the optimized minimal features using proposed (PFL) Particle filtering based Fuzzy Logic approach. Finally, at the implementation of this approach, malicious URLs is filtered out from original non-malicious URLs. Figure 2 shows the strides of feature classification. The particle filtering (PF) is

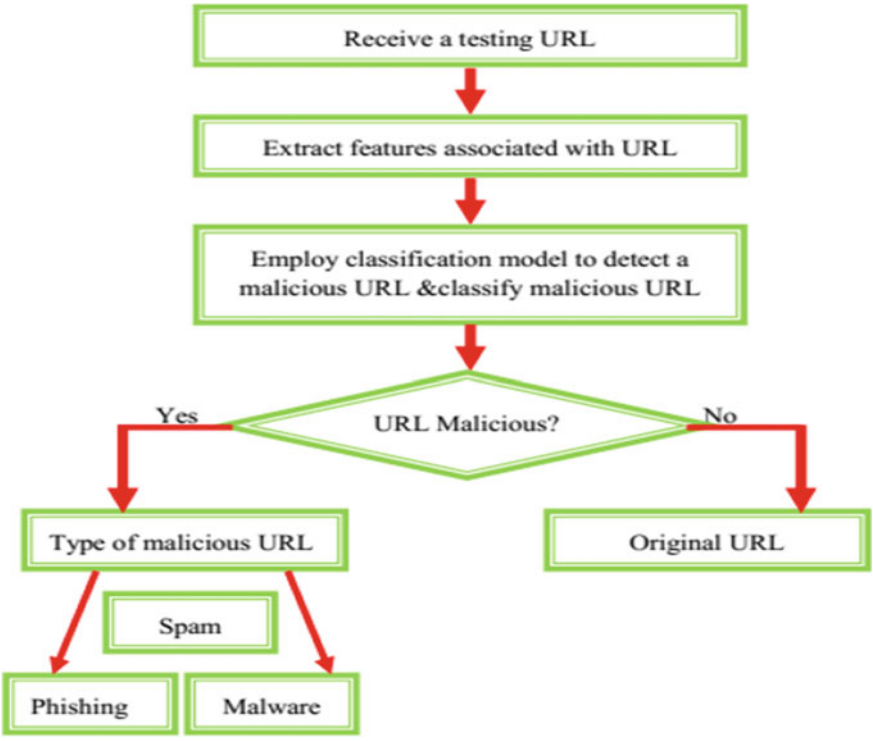


Fig. 2 Strides of feature classification

Table 2 Isolation of suspicious URLs

Rule	Domain and URL identity	Layer 2	Layer 3	Final suspicious rate
1	Genuine	Legal	Legal	Very legitimate
2	Genuine	Legal	Uncertain	Legitimate
3	Genuine	Legal	Fake	Suspicious
4	Genuine	Uncertain	Legal	Suspicious
5	Doubtful	Legal	Legal	Legitimate
6	Doubtful	Legal	Uncertain	Suspicious
7	Doubtful	Legal	Fake	Suspicious
8	Doubtful	Uncertain	Legal	Suspicious
9	Fraud	Legal	Legal	Suspicious
10	Fraud	Legal	Uncertain	Suspicious
11	Fraud	Legal	Fake	Suspicious
12	Fraud	Uncertain	Legal	Suspicious
. . . 27	Genuine	Legal	Legal	Very legitimate

associated with state x_n thus to acquire the condition of the following stride x_{n+1}. Website suspicious fuzzy patterns consist of 3 layers. The main layer includes just URL and Domain Identity conditions and URL. Second Layer includes Encryption and Security conditions Java Script and Source Code. The final third layer includes Content Style and Page Style, Social Human Factor conditions, Address Bar conditions. The base rule includes entries of $3^3 = 27$ and the result of base rule is the suspicious website measure of fuzzy groups (Uncertain, Legal or it is Fake) (Table 2).

By extracting the malicious URLs the efficiency of the system is improved and the user can easily identify the malicious URLs when it is interrupted in the original Website content.

5 Results and Discussion

The performance of feature selection: Figure 3a shows the performance of feature selection approach. When it is contrasted with the existing algorithms our proposed optimal RT-PFL provides about 95% in accuracy, sensitivity, and specificity. *The performance of Classification*: From Fig. 3b it is inferred that when compared with the existing classification approaches our proposed optimal RT-PFL provides higher accuracy, sensitivity, and specificity of about 98%. *Time complexity*: Figure 3c shows the time complexity of the proposed work. When compared with the existing

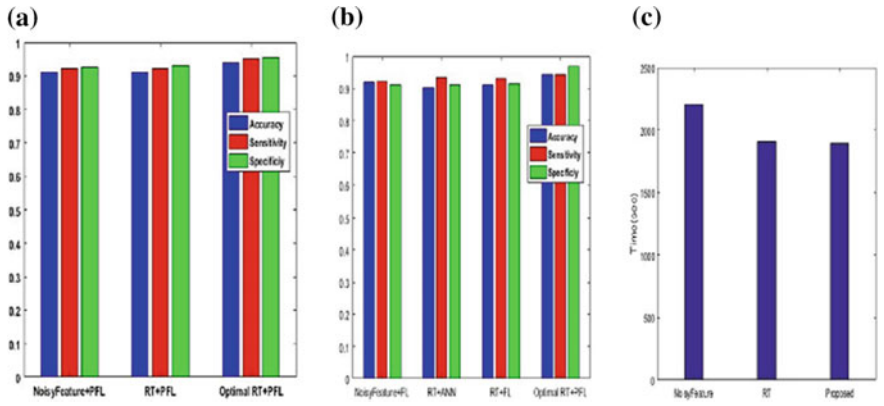


Fig. 3 **a** Feature selection, **b** classification, **c** time complexity

approach our proposed optimal RT-PFL shows minimum time delay than the existing work due to optimal identification of malicious URLs in diminished duration by the establishment of proposed RT-PFL approach.

6 Conclusion

In this paper, we proposed a technique called as optimal RT-PFL to classify the malicious URLs from non-malicious URLs detected in the websites. Optimal features of URLs was selected based upon the proposed feature selection approach namely Gray Wolf Optimizer based Rough set theory algorithm. It can efficiently find minimal attribute reduction from the high-dimensional dataset that enhances the performance of the classification system. The classification of URLs depends on the newly proposed (PFL) Particle Filtering based Fuzzy Logic approach. By this proposed method the performance of the system can be enhanced by the elimination of malicious URLS that affects the websites. Users can easily identify suspicious URLs which gets collapsed with the original URL of the website content.

References

1. Sayamber et al., "Malicious URL Detection and Identification" International Journal of Computer Applications, Vol no. 17, 2014.
2. Ma Justin et al., "Beyond blacklists: learning to detect malicious web sites from suspicious URLs" Journal on Knowledge discovery and data mining, pp. 1245–1254, 2009.
3. Mansoori et al., "On fuzzy feature selection in designing fuzzy classifiers for high-dimensional data" Journal on Evolving Systems, pp. 1–11, 2015.

4. Chen et al., “Feature set identification for detecting suspicious URLs using Bayesian classification in social networks” Journal on Information Sciences, Vol no. 289, pp. 133–147, 2014.
5. Emary et al., “Binary grey wolf optimization approaches for feature selection” Journal on Neuro computing, pp: 371–381, 2016.
6. Chung et al., “Particle Filtering Approach to Membership Function Adjustment in Fuzzy Logic Systems” Journal on Neuro computing, 2016.
7. Hua Li et al., “Binary PSO with mutation operator for feature selection using decision tree applied to spam detection” Journal on Knowledge-Based Systems pp: 22–31, 2014.

A Decision Tree Approach to Identify the Factors Affecting Reliability for Component-Based System

Rajni Sehgal, Deepti Mehrotra and Manju Bala

Abstract Component-based systems are frequently used in software development. Software reliability is the need of the hour as the lack of it could result in significant costs to the supplier regarding dis-satisfied customers, loss of market share, rework caused by rejected and returned systems, and the costs to customers of faulty systems that fail to meet their mission goals. There are a number of metrics available in the literature. The metrics considered in this study are traditional metrics like Chidamber and Kemerer (CK) metrics as well as metrics used for component-based software (CBS). Dimension reduction approach is used for finding the factors that will affect the system most. The proposed decision tree has been developed through empirical evaluation. In this paper, Rapid Miner is used to segregate important metrics from a bunch of metrics.

1 Introduction

Software reliability can be defined as a failure-free operation of the software in a particular environment for a specified amount of time for a specific purpose. With an increase in dependability on software, software quality has become an indispensable characteristic. It is often related to software quality, and while checking the reliability, we ensure that our end product is of high quality meanwhile in the process we can manage our resources efficiently. Software reliability is important since it provides us with information related to efficiency prediction (i.e., the amount of time required for a program to execute is known and thus other work in

R. Sehgal (✉) · D. Mehrotra
Amity School of Engineering and Technology, Amity University, Noida, Uttar Pradesh, India
e-mail: rsehgal@amity.edu

D. Mehrotra
e-mail: dmehrotra@amity.edu

M. Bala
I.P College for Women, University of Delhi, Delhi, India
e-mail: manjugpm@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_25

hand can be managed accordingly), system failure and protection from data loss. Reliability prediction allows us to gauge the probable reliability of the software. It not only yields the probable and feasible reliability of the software but also assess the proximity of system designs to the desirable designs and implementation decisions. Reliability predictions include outcomes like some faults to be expected during the development life cycle, failure rate prediction [1]. It also gives us the benefit of associating predicted failure rate and use the comparison to reform techniques used in the development of the software. There are some metrics for calculating software reliability. It can be divided into product, project, process and fault and failure metrics. Product metrics are used in the development of various system documents (SRS, design documents). Project metrics focuses on higher reliability achieved through a better development process, risk management process, configuration management process. A fault is defined as a defect in the program which occurs due to an error in the code and results in the failure of the software under defined environment. The fault and failure metrics looks upon the faults which are determined after the release of the software. This data extracted from the user is further operated to calculate the software reliability (Mean Time between Failure or other techniques). But along with these metrics come their limitations; The component-based system (CBS) architecture disintegrates the system design into further components which include unambiguous interacting interfaces, methods, attributes, etc. The elementary objective is to reuse the components in hand. It is cost efficient, more reliable, easy to deploy and needs less development time. Before CBS were in use the project circled the object; this system was called Object-Oriented System. The software development is broken down into three stages namely: analysis, design, and implementation. Analysis phase involves regular operations which are; learning user requirements, required SDLC model, etc. The design phase can be broken down in two subparts: System design and Object design. The idea of required architecture of the software is laid out in system design whereas in object oriented design the model is developed from the approach developed in analysis phase and during system design. In the implementation phase, the developed model is brought down into code in the aimed language. Decision trees provide us with flowchart with root and nodes. Each node represents a class label. Decision trees are often used as classifiers because they do not need any parameter settings and have higher efficiency.

2 Related Work

Various author finds that various parameters affected the reliability of a component-based system like coupling, cohesion, component packet density, weighted method per class; some of them are discussed here. Sehgal et al. [2] Predicts the fault for foreground and background of an application which based on component-based software development using Halstead Metrics. Tripathi et al. [3] finds that coupling is a parameter which affects the reliability at most. For this they

have proposed a model which is based on reliability block diagram. Shatnawi and Li [4] discovered that Metrics like CBO, RFC, WMC, DIT, and NOC metrics are the error predictor metrics from the classes. Shin and Williams [5] finds the impact of complexity on software reliability by performing various statistical test. Graylin [6] states that complexity of any software system is directly correlated with the line of code. Subramanyam and Krishnan [7] predict the fault before testing phase, i.e., in early software development life cycle using CK metrics. Lee et al. [8] identifies two important parameter coupling and cohesion on which reusability of any component based system depends. Briand et al. [9] identifies that cohesion measure the strength of any module. Highly cohesive module is highly reliable. Kumar et al. [10] proposes a new metrics called the conceptual cohesion of classes (CCC). Which measure the how conceptually classes of a module are related with other. Binkley and Schach [11] identifies that coupling is a metric which find out that how much a software module is depends on other. Yadav and Khan [12] finds out that module with high cohesion is less fault prone. Narasimhan et al. [13] stated the limitation of using the CBS approach. Their focus was on the integration among the various components. They then derived metrics based on the complexity of the system to overcome this problem. Namely, component package density (CPD), and component integration density (CID). CPD targets the density of the components while CID targets the interaction between these components. They delineated the observations for both the metrics. A befitting acknowledgement to the importance of 'critical components' has also been discussed. Koziolek [14] States that operational profile are important for software reliability as they take input from the users. He outlines the various operational profiles (Musa, user, customer, and system-mode, functional and operational profiles). These are used in the calculation of usage metric.

3 Experimental Setup

In order to find out the critical parameter which affect the reliability of a component-based system. A system is considered which constitute of 19 components and having approx. 25,000 line of code. Following steps are performed to find out the critical parameter. Values of different parameter affecting the reliability is calculated using Table 1.

Step1: Faults are predicted using halstead metric

Step 2: Chidamber and Kemerer (CK) metrics weighted method per class (WMC), depth of inheritance (DIT), number of children (NOC), coupling between objects (CBO) response for a class (RFC)

Step 3: Cyclomatic complexity (CC) of given system is calculated

Step 4: Component packet density (CPD) and component integration density (CID) is calculated

Table 1 Formulae to calculate various parameters

S. No.	Formula	
1.	Faults [15]	$F = V/S_0$ where V is the volume of the program and value of $S_0 = 3000$
2.	CK Metrics [16]	(i) Weight methods per class (WMC): It is the submission complexity of all the methods defined in the class [3] (ii) Depth of inheritance (DIT): It is the length of hierarchy from the nodes to the root [3] (iii) Response for class (RFC): RFC = $q + r$ where q is the total number of methods in the class and r is the number of direct methods called by other methods of the class (iv) NOC: It's the number of intermediary subclasses of a class
3.	Cyclomatic complexity (CC) [16]	CC = $E - N + 2$ where E is the number of edges N is number of nodes
4.	Component integration density, component package density [17]	(i) CPD = # of constitute/# of components where constituents includes LOC, operations and classes for different components (ii) CID = #I/#Imax where I is the absolute interaction and $I_{\max}$ is the maximum available interactions
5.	Coupling and cohesion [16]	(i) Cohesion $\mathrm{COM}_i(c) = \frac{\lvert s_i(c)\rvert}{\lvert w_i(c)\rvert * \lvert N_i(c)\rvert}$ (ii) Coupling $NU_j = \frac{\left\lvert \cup_{1 \le i \le m \cap i \ne j} NU_{j,i} \right\rvert}{\lvert N_j\rvert + \lvert U_j\rvert}$

Step 5: Opinion from the expert is taken to find out the usage of a particular component

Step 6: Decision tree which is a dimension reduction technique is applied using Rapid Minor tool.

Values calculated using Table 1 is given in Table 2.

Table 2 Values of different parameters

Project	Faults	Usage	CC	Coupling	Cohesion	CPD	CID	WMC	DIT	NOC	RFC
								2	**2**	**2**	**34**
Component 1	0.044	Med	62	35	80	12.6	1	2	1	1	16
Component 2	1.04	Low	135	85	15	1.5	1	1	3	3	14
Component 3	0.033	High	130	57	12	9.3	0	1	3	3	13
Component 4	1.07	Med	19	36	36	6.2	0.4	3	3	3	20
Component 5	0.152	High	60	50	13	4.3	1	9	2	2	23
Component 6	0.84	High	65	55	15	1.9	0.4	0	1	1	18
Component 7	0.029	High	168	68	36	1.7	1	1	0	0	14
Component 8	1.85	High	175	55	43	2.7	1	1	2	2	13
Component 9	0.122	High	168	85	21	1.4	1	4	2	2	20
Component 10	1.2	Med	90	55	87	1.5	1	3	3	3	23
Component 11	0.69	Low	145	40	45	3.4	0.083	1	1	1	18
Component 12	4.372	Low	55	36	25	2	1	0	3	3	13
Component 13	0.359	High	65	55	15	2.4	1	3	1	1	5
Component 14	4.889	Low	65	40	20	10.7	1	9	2	2	2
Component 15	0.849	Low	55	47	20	3.6	0.4	1	2	2	17
Component 16	0.486	Low	34	25	50	2.9	1	4	2	2	20
Component 17	0.38	Low	80	37	20	23.7	0	2	3	3	18
Component 18	0.383	High	145	65	12	6.4	1	0	1	1	14
Component 19	0.646	High	95	55	25	8	1	1	2	1	15

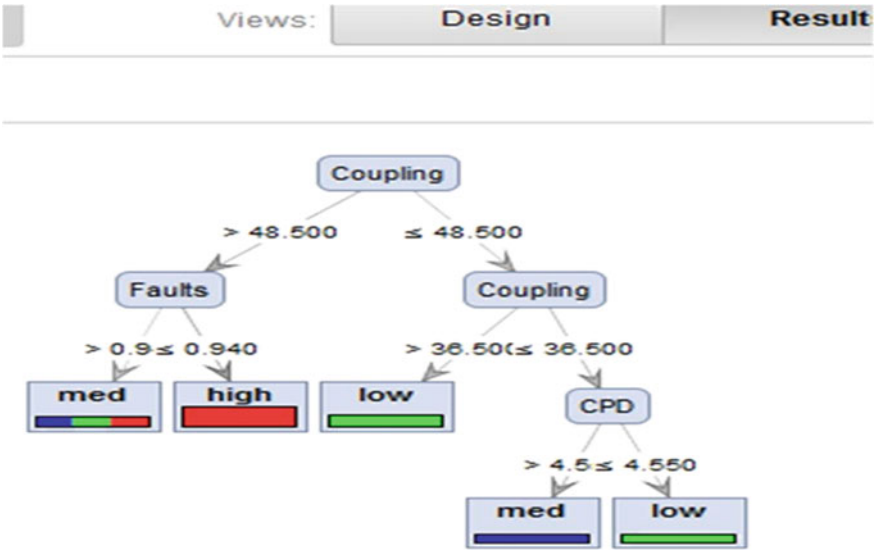


Fig. 1 Important factors identified by rapid minor

4 Results

To find the important parameters these calculated values are executed in a data mining tool, Rapid Minor. After executing this data in rapid minor, three parameter namely coupling, faults, and component density comes out be as an important parameter which affects the reliability of a component based at the most (Fig. 1).

Many metrics are used for calculating the reliability of software. We used a decision tree because it helps us narrow down metrics to important metrics and is easier to interpret. Decision tree development does not require any knowledge of the domain and can work well with large data. From the obtained decision tree the important metrics came out to be coupling, component package density, and faults.

5 Conclusion

In the literature, there exist many parameters which affect the reliability of a component-based system. To calculate each and every parameter is a tedious job. To find out the most critical parameters is always a desired job so that these parameters should be given more attention.

6 Future Scope

In this case study, important parameters which contribute to the reliability of a component-based software is identified using the decision tree approach. Identified metrics may have direct and indirect relationship with the reliability of a component-based system. Keeping this relationship in mind a new metrics can be. proposed which will be more realistic and predicting the reliability of a component-based system more efficiently.

References

1. S. Mohanta, G. Vinod, and R. Mall, "A technique for early prediction of software reliability based on design metrics," *Int. J. Syst. Assur. Eng. Manag.*, vol. 2, no. 4, pp. 261–281, 2011.
2. R. Sehgal and D. Mehrotra, "Predicting Faults before Testing Phase using Halstead's Metrics," vol. 9, no. 7, pp. 135–142, 2015.
3. R. Tripathi, "Early Stage Software Reliability and Design Assessment," 2005.
4. R. Shatnawi and W. Li, "The effectiveness of software metrics in identifying error-prone classes in post-release software evolution process," *J. Syst. Softw.*, vol. 81, no. 11, pp. 1868–1882, 2008.
5. Y. Shin and L. Williams, "Is Complexity Really the Enemy of Software Security,", *Proc. 4th ACM Work. Qual. Prot. Alexandria, Virginia, USA, Oct.*, vol. 27, pp. 47–50, 2008.
6. J. Graylin, "Cyclomatic Complexity and Lines of Code: Empirical Evidence of a Stable Linear Relationship," *J. Softw. Eng. Appl.*, vol. 02, no. 03, pp. 137–143, 2009.
7. R. Subramanyam and M. S. Krishnan, "Empirical analysis of CK metrics for object-oriented design complexity: Implications for software defects," *IEEE Trans. Softw. Eng.*, vol. 29, no. 4, pp. 297–310, 2003.
8. J. K. Lee, S. J. Jung, S. D. Kim, W. H. Jang, and D. H. Ham, "Component identification method with coupling and cohesion," *Proc. Asia-Pacific Softw. Eng. Conf. Int. Comput. Sci. Conf. APSEC ICSC*, no. February 2016, pp. 79–86, 2001.
9. L. C. Briand, J. W. Daly, and J. Wust, "A unified framework for cohesion measurement in object-oriented systems," *Empir. Softw. Eng.*, vol. 3, pp. 65–117, 1998.
10. M. S. Kumar, S. V Achutarao, S. Ali, and A. Shaik, "A Class Level Fault Prediction in Object Oriented Systems : Cohesion Approach," vol. 2, no. 2, pp. 918–922, 2012.
11. A. B. Binkley and S. R. Schach, "Validation of the coupling dependency metric as a predictor of run-time failures and maintenance measures," *Proc. - Int. Conf. Softw. Eng.*, pp. 452–455, 1998.
12. A. Yadav and R. A. Khan, "IMPACT OF COHESION ON RELIABILITY," vol. 3, no. 1, pp. 7762, 2012.
13. V. L. Narasimhan and B. Hendradjaya," A New Suite of Metrics for the Integration of Software Components", Informing Science and Information Technology 2008.
14. H. Koziolek, "Operational Profiles for Software Reliability," *Semin.* "*Dependability Eng.*, pp. 1–17, 2005.
15. HALSTEAD MAURICE, Elements of Software Science, Elsevier North Holland, New York.
16. J. Chen, H. Wang, Y. Zhou, and S. D. Bruda, "Complexity Metrics for Component-based Software Systems," vol. 5, no. 3, pp. 235–244, 2011.
17. V. L. Narasimhan and B. Hendradjaya," A New Suite of Metrics for the Integration of Software Components", Informing Science and Information Technology 2008.

A Novel Differential Evolution Test Case Optimisation (DETCO) Technique for Branch Coverage Fault Detection

Vibhor Gupta, Avneet Singh, Kapil Sharma and Himanshu Mittal

Abstract Test case optimisation is an important research area of the software industry. As, testing takes so much time, effort and moreover it is very costly. So, it becomes very important for us to test the software effectively without doing so much effort. There are many techniques or nature inspired algorithm which helps us to do testing of a software effectively and one of the nature inspired algorithm is Differential Evolution Algorithm. Hence, this paper proposes a novel test case optimisation technique, i.e., differential evolution test case optimisation (DETCO). The proposed technique optimizes the test case selection and prioritization of the test cases to have comprehensive branch coverage and faults detection. Twenty test cases for a sample code have been generated. The proposed technique selects three test cases which provide complete branch coverage as well as fault detection.

1 Introduction

Test case optimisation means to select out effective test cases, which have maximum code coverage and fault detection capability. It results in minimizing and prioritizing the test cases. Minimisation of test cases means to reduce test suites by eliminating redundant test cases. A test case is called redundant if same demand is fulfilled or met by other test cases. On the other hand, test case prioritization is

V. Gupta (✉) · A. Singh · K. Sharma · H. Mittal
Computer Science and Engineering, Jaypee Institute of Information Technology, Noida, UP, India
e-mail: vibhor.gupta9913103515@gmail.com

A. Singh
e-mail: singhavneet77@gmail.com

K. Sharma
e-mail: kapilsharma3514@gmail.com

H. Mittal
e-mail: himanshu.mittal224@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_26

reordering of the test suites according to suitable criteria like branch detection, code coverage, fault detection, etc.

There are various types of test case optimisation techniques which are natured inspired such as Genetic, bacteriological algorithm which is a variant of genetic, Ant colony optimisation and differential evolution etc.

So the aim here is to optimize the test cases using a natured-inspired approach which have been widely used to solve complex integrative optimization problems. This paper is concerned with test case optimization for any software with Meta-Heuristic Differential Evolution Algorithm [1] and requirement mapping-based approach [2]. Meta-heuristics are problem-independent techniques that can be put into a service to a wide range of problems. A meta-heuristic knows nothing about the problem, it can handle functions as black boxes. Black Box Testing is the functionality of the software under test without knowing internal code or structure. It is based entirely on the software requirements and on the specification.

The Meta-Heuristic approach is separated into two different parts—Single solution based and initial population based. We in this paper are using the initial population based approach and hence we begin the process of search with initial population generated randomly and it is farther intensified to make better with many successive iterations.

Differential Evolution algorithm is a method that optimizes problem iteratively and make an effort to make better candidate solution. It can solve many difficult problems such as non-continuous, nonlinear and gives us approximate solution. Nevertheless, Differential Evolution algorithm which is meta-heuristics does not ensure an optimal solution.

2 Literature Survey

Software testing is one of the major part of software development life cycle as it takes around 50% efforts as suggested by Pressman in 2001, [3] therefore, it is under continuous research by researchers. From the past many years the research is being carried out in the minimisation of testing time and test suites. The first few approaches suggested were based on classic greedy approach [4].

Classic greedy approach uses a recursive function which rules out the requirements met by a test case and continues to do so until all requirements are fulfilled. The main problem with this approach is that it reduced the fault detection capability of the test suites. To remove these drawbacks from this approach Horgan [5] suggested to keep all the test suites sizes constant, the next notable work in this field was the introduction of genetic algorithm [6].

Krishnamoorthi [7] proposed a new approach for regression testing using GA for test case optimisation. This approach was based on mutation of test cases, crossover of the these and selection of the best on the basis of a function value but the major problem of Genetic Algorithm is that it does not take all generation result into

consideration, therefore, a new approach following the footsteps of GA but a little more advanced and inspired by nature (bacteria) Bacteriologic Algorithm was suggested by Baudry et al. [8].

Bacteriologic Algorithm is based on initial population, mutation and crossover same as Genetic Algorithm [9]. Bacteriologic Algorithm works on chromosomes representation but its limitations are that it does not work well enough in complex problems and with dynamic data.

A new approach differential evolution (DE) was suggested it is also a meta-heuristic approach as Bacteriologic Algorithm the main advantage of it is that it make very less or no postulations about the problem to be optimized and can easily handle large and dynamic data [10].

3 Definitions and Concepts

1. **Branch Coverage**—It is a testing method, which intention is to assure that every one of the possible branch from every decision point is executed at least once and because of that it assures that all reachable code is executed.
2. **Fault Detection—**Its a method for discovering a failure in software. Faults usually occur when we are handling variables and doing some move or arithmetic operations on them. It helps to see how well a test suite is as if a test suite covers all areas where a fault can occur then chances are we could catch the problem while testing.
3. **Differential Evolution—**It is a method that optimizes problem iteratively and make an effort to make better candidate solution. DE being a meta-heuristic black box technique optimizes any problem by enhancing the initial population by replacing the initial population with better solutions and maintains it of the same size on the basis of a formula.
4. **Fitness Function—**Fitness value is calculated with the formula

$$\text{FIT} = w_1 * \text{BC} + w_2 * \text{FDA}$$

   Here w_1 and $w_2 \in (0, 1)$ and $w_1 + w_2 = 1$

   - $w_2 < w_1$ incline towards 'some c-use and all p-use'
   - $w_2 > w_1$ incline towards 'some p-use and all c-use'
   - $(w_1 == w_2)! = 0$ incline towards 'some p-use and some c-use'.

5. **General Feature Selection**—It is a defined technique to select the important or useful subsets out of the various subsets present. The method we used here had N test cases and we made a $N \times N$ matrix with each row and column representing TC-1, TC-2, TC-3 … TC-N respectively. Each index of the matrix was given a random value between 0 and 1 and each row was also given a random value 0 to 1. When traversing only those columns were given 1 which had the value greater than the respective row value. The conditions here are

- No two same columns can be 1 again in different rows if the are found to be same with previously selected rows and columns then all row index again gets random value and a new random value for the particular row is generated again.
- Exactly two columns are to be made one.

0	1	0	1	0
1	0	0	1	0
0	1	1	0	0
0	0	0	1	1
1	0	0	0	1

An example of 5 × 5 is shown below (it is generated randomly).

Though the above example is generated randomly but it satisfies the condition that no two columns are 1 for any other two rows and only two columns are marked one hence this matrix can be used for the selection procedure.

A. ***PSEUDO CODE FOR DE***

BEGIN

Initial population is randomly generated.
Fitness value is calculated for each parent present in initial population.

REPEAT

For each parent (X) test case select three random children from the population (g,h,i) each distinct from each other and as well as the parent.
Create one new test suite using the DE FUNCTION.
Do this step equal to the population size.
For each new sibling check

if it has more fitness value than parent, then replace the parent with the improved variant in the initial population.
else leave the parent as it is.

Until stopping condition is not met.

B. ***PSEUDO CODE FOR DE FUNCTION***

a. Randomly pick an index RI ∈ (1…N).
b. Compute the new sibling's new position P={P_1,P_2,…., P_N} by:

(i) For each k ∈ {1…N} pick uniformly distributed number such that u_k ≅(0,1).

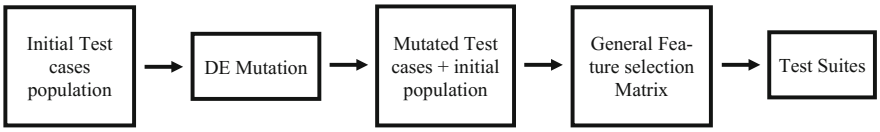
(ii) If (u_k< CP) or (k = RI) then

$P_k = g_k + D\_W * (h_k - i_k)$
else
$P_k = X_k$

(iii) if (fit (P_k) > fit (X_k)) then
Replace the parent in population with the improved variant in the population.
Here, D_W is differential weight ∈ (0,2) and CR is crossover probability ∈ (0,1) both are selected by the user.

4 DETCO

DE is an optimisation technique which iteratively modifies a population of candidate solutions to make it converge to an optimum of your function. The DE algorithm gives us a description of or can be delineated as an evolutionary type, random optimization algorithm. The quality of DE algorithm over others is that it is easy structure not at all complicated and robust. To the same degree all evolutionary algorithms, it runs or functions by applying a set or population P = {P1, P2, …, PN} of possible answer to search the solution space. The population of size (N), remains continuous everywhere. In every extension the algorithm goal is to make fresh or newborn population by putting in place of points in the present population P with improved points. The choicest or most essential part or most vital part of some idea that the population is merely a set of points $P_{k,j}$ where k represents the indices of the member's in the initially generated population of test cases and j representing the iteration of the population to it belongs. Each $P_{k,j}$ consists of n components, where n being the dimension of the represented problem. By a recurrent procedure of reproduction (mutation and crossover) and selection, the population N is used to determine the direction of the global maxima.



5 Experimental Result

1. **Case Study**

Explanation of the approach is being done by using a search program of binary search written in C++ language [11]. The code takes an input value that is searched in the integer array and return a pointer pointing to the index of the searched value if found inside the array else NULL is returned.

```
1. int * search_binary (int value)
2. {
3. int L_b = 0, U_b = array_length(array1), Middle;
4. while (L_b<U_b)// BRANCH_1
5. {
6. Middle = (L_b + U_b − 1)/2;
7. if (value = = array1 [Middle])// BRANCH_2
8. return (array1 +Middle);
9. else if (value <array1[Middle]) // BRANCH_3
10. U_b = Middle;
11. else// BRANCH_4
12. L_b = Middle +1;
13. }
14. return NULL;
15. }
```

Since, DE is a meta-heuristic approach having the initial population. So the initial population of the test cases is shown in Table 1 the thing to remember her is to not take the test cases which give all branch coverage and all fault detection as their combination will always give 100% fit with any other test case. These test cases would be executed on the programme code with sample array {−15, −8, −1, 2, 5, 11, 13} in order to find the Branch Coverage and Fault Detection as shown in Tables 2 and 3 respectively. Fitness value is calculated with $w1 = 1$ and $w2 = 0$ so the fit depends only of branch coverage and not on fault detection.

Table 1 Test cases

Test cases	L_b	U_b	Value	Test cases	L_b	U_b	Value
TC-1	0	6	−16	TC-11	0	7	−16
TC-2	0	6	−15	TC-12	0	7	−15
TC-3	0	6	−9	TC-13	0	7	−9
TC-4	0	6	−7	TC-14	0	7	−8
TC-5	0	6	−1	TC-15	0	7	−2
TC-6	0	6	1	TC-16	0	7	1
TC-7	0	6	3	TC-17	0	7	2
TC-8	0	6	8	TC-18	0	7	8
TC-9	0	6	11	TC-19	0	7	11
TC-10	0	6	14	TC-20	0	7	14

Table 2 Branch coverage matrix

Test cases	BRANCH_1	BRANCH_2	BRANCH_3	BRANCH_4	Test cases	BRANCH_1	BRANCH_2	BRANCH_3	BRANCH_4
TC-1	YES	NO	YES	NO	TC-11	YES	NO	YES	NO
TC-2	YES	YES	YES	NO	TC-12	YES	YES	YES	NO
TC-3	YES	NO	YES	YES	TC-13	YES	NO	YES	YES
TC-4	YES	NO	YES	YES	TC-14	YES	YES	YES	NO
TC-5	YES	YES	NO	NO	TC-15	YES	NO	YES	YES
TC-6	YES	NO	YES	YES	TC-16	YES	NO	YES	YES
TC-7	YES	NO	YES	YES	TC-17	YES	YES	NO	NO
TC-8	YES	NO	YES	YES	TC-18	YES	NO	YES	YES
TC-9	YES	YES	NO	YES	TC-19	YES	YES	NO	YES
TC-10	YES	NO	NO	YES	TC-20	YES	NO	NO	YES

Table 3 Fault detection matrix

Test cases	L_B (3, 6)	U_B (3, 6)	Middle (6, 8)	Middle (6, 10)	Middle (6, 12)	Test cases	L_B (3, 6)	U_B (3, 6)	Middle (6, 8)	Middle (6, 10)	Middle (6, 12)
TC-1	YES	YES	NO	YES	NO	TC-11	YES	YES	NO	YES	NO
TC-2	YES	YES	YES	YES	NO	TC-12	YES	YES	YES	YES	NO
TC-3	YES	YES	NO	YES	YES	TC-13	YES	YES	NO	YES	YES
TC-4	YES	YES	NO	YES	YES	TC-14	YES	YES	YES	YES	NO
TC-5	YES	YES	YES	NO	NO	TC-15	YES	NO	YES	YES	YES
TC-6	YES	YES	NO	YES	YES	TC-16	YES	YES	NO	YES	YES
TC-7	YES	YES	NO	YES	YES	TC-17	YES	YES	YES	NO	NO
TC-8	YES	YES	NO	YES	YES	TC-18	YES	YES	NO	YES	YES
TC-9	YES	YES	NO	YES	NO	TC-19	YES	YES	YES	NO	YES
TC-10	YES	YES	NO	YES	YES	TC-20	YES	YES	NO	NO	YES

Differential evolution is carried out on each and every test case and hence new as well as better test cases are generated as shown:

Current: 0 6 16
Random 1: 0 7 2
Random 2: 0 6 9
Random 3: 0 6 8
Mutation Vector: 0 6 15

Since parent's fitness value was 50% and fitness value of mutation vector was 75% therefore parent is replaced with mutation vector. Table 4 gives the new mutated test cases which are further used. After mutating the whole population we combine all the test cases by forming their pair and randomly combining them using general feature selection matrix which is generated randomly and can vary. After combining the two test cases fit value is computed and only those are selected which have 100% fit value. The new test suits are {TC-2, TC-3}, {TC-7, TC-9}, {TC-2, TC-5}, {TC-2, TC-4}, {TC-9, TC-11}, {TC-2, TC-6}. These test cases are the minimized test cases and can be further used for testing to save time and cost [12].

Hence it is seen here that using DETCO we can lower the time and cost spent on the testing phase as the test cases provided by it are efficient and minimal.

2. **Tables**

See Tables 1, 2, 3 and 4.

Table 4 Modified test cases

Test cases	L_b	U_b	Value	Fit %	Test cases	L_b	U_b	Value	Fit %
TC-1	0	6	−16	50	TC-11	0	7	−16	50
TC-2	0	6	−15	75	TC-12	0	7	−15	75
TC-3	0	6	−9	75	TC-13	0	7	−9	75
TC-4	0	6	−7	75	TC-14	0	7	−8	75
TC-5	0	6	9	75	TC-15	0	7	−2	75
TC-6	0	6	1	75	TC-16	0	7	1	75
TC-7	0	6	3	75	TC-17	0	7	2	50
TC-8	0	6	8	75	TC-18	0	7	8	75
TC-9	0	6	11	75	TC-19	0	7	11	75
TC-10	0	6	14	50	TC-20	0	7	6	75

6 Conclusion

The paper presented a novel technique, differential evolution test case optimisation (DETCO), for test case optimization. The proposed algorithm analyzed on an example which optimizes the test cases in a way that gave maximum fault detections well as code coverage. The solutions provided by the proposed technique were optimal in context with BC and FD. Moreover, DETCO classified the solutions and prioritised them in different categories. The FIT value of test cases selected by DETCO is 100%. So, it is very useful in reducing the test cases and has a significant decrease in number of test cases as compared to initial test cases. Thus, DETCO is quite efficient and useful for minimization and prioritization of the test cases of the test suites that completely covers the code and places where fault can occur. The future work includes the applicability of the proposed technique on real-time environment and straightaway accessible for practical applications.

References

1. Becerra, R.L., Sagarna, R. and Yao, X., 2009, May. An evaluation of differential evolution in software test data generation. In *Evolutionary Computation, 2009. CEC'09. IEEE Congress on* (pp. 2850–2857). IEEE.
2. Jeffrey, D. and Gupta, N., 2007. Improving fault detection capability by selectively retaining test cases during test suite reduction. *IEEE Transactions on software Engineering*, *33*(2).
3. Pressman, R.S., 2005. Software engineering: a practitioner's approach. Palgrave Macmillan.
4. Thomas H. Cormen, Leiserson, C.E., Rivest, R.L. and Stein, C., 2001. *Introduction to algorithms* (Vol. 6). Cambridge: MIT press.
5. Wong, W.E., Horgan, J.R., London, S. and Mathur, A.P., 1995, April. Effect of test set minimization on fault detection effectiveness. In *Proceedings of the 17th international conference on Software engineering* (pp. 41–50). ACM.
6. Holland, J.H., 1992. Adaptation in natural and artificial systems: an introductory analysis with applications to biology, control, and artificial intelligence. MIT press.
7. Krishnamoorthi, R. and Mary, S.S.A., 2009. Regression test suite prioritization using genetic algorithms. *International Journal of Hybrid Information Technology*, *2*(3), pp. 35–52.
8. Baudry B, Fleurey F, Jézéquel JM, Le Traon Y. Automatic test case optimization: A bacteriologic algorithm. ieee Software. 2005 Mar; 22(2):76–82.
9. Srivastava, P.R., 2016. Test case optimisation a nature inspired approach using bacteriologic algorithm. *International Journal of Bio-Inspired Computation*, *8*(2), pp. 122–131.
10. Price, K., Storn, R.M. and Lampinen, J.A., 2006. Differential evolution: a practical approach to global optimization. Springer Science & Business Media.
11. Tanenbaum, A.M. (2008) Data Structures using C and C++, 2nd ed., Prentice Hall India, USA.
12. Rothermel, G., Untch, R.H., Chu, C. and Harrold, M.J., 2001. Prioritizing test cases for regression testing. *IEEE Transactions on software engineering*, *27*(10), pp. 929–948.

Comparative Analysis of Authentication and Access Control Protocols Against Malicious Attacks in Wireless Sensor Networks

Vikas Mittal, Sunil Gupta and Tanupriya Choudhury

Abstract The major goal of this analysis is to compare and find out the appropriate protocol for research. According to our analysis, the access control method and authentication used in the wireless sensor networks in some protocols is costlier in the security and message exchange. In analysis, we find out that various security solutions are based on public key cryptography which is highly expensive, susceptible to replay and denial of service attacks. Most of access control protocols depend on the key pre-distribution mechanisms which are combined together with either a one-way key chain or a pseudorandom function. The solution for the access control inculcates various vulnerabilities of the mechanism on which it is developed and its security features also rely on the same. This paper provides detailed analysis over improvements for all the recent protocols that cover the shortcomings of each other.

1 Introduction

The wireless sensor network (WSN) consists of many tiny sensor nodes and a few controlling nodes called base stations (BSs). In order to sense conditions of immediate surroundings, each sensor node is composed of one or a few sensing

V. Mittal (✉)
Department of Computer Science, Maharaja Agrasen College,
University of Delhi, Delhi, India
e-mail: vikas.mittal.10@gmail.com

S. Gupta
Department of Computer Science & Engineering,
BML Munjal University, Gurgaon, India
e-mail: sunil.gupta@bml.edu.in

T. Choudhury
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: tchoudhury@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_27

components, which is used for processing as well as communication for performing simple computation on raw data and also to communicate with the neighboring nodes. The sensor nodes basically make use of wireless links for communication over short distances and they are generally densely deployed on large scale. Security features permit an assured use of wireless sensor nodes. A WSN application without security may cause detrimental effects. Because of low-cost security solutions, the WSN is gaining attention in the real-world hurdles.

The proposal behind a sensor network is to disperse small sensing devices for sensing changes in a parameter and used for monitoring of physical and environmental conditions like pressure, temperature, noise, vibration, humidity, soil composition, noise level, lighting conditions, mechanical stress levels, vehicular movement and motion in different localities. There are wide range of fields for the usage of WSNs including battlefield surveillance, target tracking, traffic control, environmental monitoring, industrial monitoring, civilian monitoring, health monitoring, habitat monitoring and home automation [1].

Wireless communication and electronic advancement led to the usage of multifunctional, low power and cost sensor nodes. Tiny nodes capable of sensing and data processing as well as communication components motivated the idea of sensor networks. Sensor network consists of varied systems which have tiny actuators and sensors containing elements with general purpose computing capabilities [2].

In case of several applications, the sensor nodes may be developed in such a way that they can be unattended for a long time after deployment because battery recharging or replacement may not be always possible [2]. Communication, processing and sensing make sensor nodes an important device. A sensor network seems to be closely related to the wireless network, with only one difference that these nodes are highly resource-constrained and they have very limited memory as well as power and computation capabilities. However, the feature of being resource-constrained influences the network design and behavior to such an extent that sensor networks differ significantly from typical wireless networks. As a critical measure, any protocol for sensor networks must be designed considering the constrained resources. Moreover, because of low power, the transmission range of sensor nodes is restricted leading to a multihop transmission pattern. Furthermore, because the life of low powered sensor nodes is short, many nodes are deployed densely in the network to increase its functional time [3].

2 Reviews on Authentication and Access Control

Cheng et al. [4] introduced a new method which uses chameleon hash function as well as elliptic curve cryptography for access control. Twice Diffie–Hellman is used for key exchange in this case. To achieve key exchange and robust authentication, they have used signature parameter. Using chameleon hash value of the node, each node authenticates the other node during authentication and key establishment phase. As base station, each node of the wireless sensor network should have the

same hash value. Many types of attacks such as forgery, replay, new and legal node masquerading, and man in the middle can be resisted by the proposed method.

The key idea introduced by Zhi et al. [5] was that the gateway node (GW-node) allots different secret keys to each user ID as well as each sensor node for avoiding GW-node impersonation and GW-node by passing attacks. The authors assumed that without its secret key user ID cannot impersonate the GW-node. Therefore, it is difficult for the opponent owing one sensor node secret key to bypass the GW-node so that it can access other sensor nodes in absence of their corresponding secret keys. The proposed scheme has three phases, i.e., registration, password change and authentication. In the first phase of the proposed scheme, an initial password is generated by GW-node for each user ID. This design is well suited to prevent the privileged insider attack. Also, it is adaptable to the card issuer' style. Users can update the initial password directly by the utilization of the password change operation after receiving the smart card. Second, in the proposed scheme there is a provision to modify the password without performing any interaction with the GW-node. The main cause being that the GW-node cannot change any password information of the user and thus it prevents the likelihood of the privileged insider attack. The third phase of the proposed scheme is invoked in either of the two cases. In the first scenario, whenever user wants to access some of the data from the WSN. Second scenario occurs when user wants to perform some query from the WSN. The authors related the proposed protocol only with the scheme by Khan and Alghathbar [6] because both the schemes were based on the same encryption tool and provided the same security goals. The proposed scheme differs in terms of nonce whereas the scheme by Khan et al., is based on a timestamp. For timestamp-based systems, time clocks should be both secured and synchronized. It is difficult to guarantee the prevention of the adversarial modification of local time clocks in many distributed systems such as WSNs. There is a pitfall in the nonce-based system in which case, there is requirement of an additional message exchange in comparison to the timestamp-based system.

The authors highlighted two areas for future studies. First area of future study was to study the security of user authentication scheme by adopting an appropriate formal method for WSNs; Second area of future study was the method for presenting a formal definition of the user authentication as a part of setting of WSN, and in addition to that also designing the scheme which can be taken to the level of satisfying the definition assuming minimal cryptographic algorithms.

Arikumar and Thirumoorthy [7] introduced an improved the user authentication process for WSNs. In this method, the user gets a shrewd card from the GW-hub while the enlistment procedure is going on and afterward the client secret key and brilliant card allows the client to sign into that of the sensor/GW-hub for getting to the information in the system. There are three stages in the plan, which are as per the following: the enlistment stage, the validation stage and the change of the secret word. At the point when the enlistment stage is finished, the validation stage is done each time the client sign into the framework. This convention escapes many signed in clients with the indistinguishable login ID and the stolen-verifier assaults; these are anticipating dangers for an arrangement of secret word based in the event that it

keeps the verifier table at the GW-hub or sensor hub. Also, this convention opposes alternate assaults in WSNs aside from the hub which trade off and DOS assaults. The clients are permitted by this convention to choose and in addition change their passwords in a simple way. This system is well-designed for WSNs with limited resources to authenticate without the public key requirement and it uses only smart cards and the one-way hash functions and it can be put into action efficiently.

Yeh et al. [8] proposed a secure authentication protocol for WSNs using ECC and their analysis, with a comprehensive analysis of the protocol proposed by Das [9], and showed some security pitfalls of the protocol. In addition, the authors proposed a more efficient authentication protocol using ECC. They revised the basics of ECC. Therefore, the proposed protocol is suitable for secure authentication in WSNs. There are five phases in the protocol which are registration, login, verification, mutual authentication and password changing.

Remote user authentication security issues are discussed by the author including resistance to masquerade and insider attacks, mutual authentication and securely changing or updating a password. They stated that the protocol proposed by Das [9] is not suitable for mutual authentication reason being it is vulnerable to forgery and replay attacks. The calculation is performed by combining point multiplication and addition. The authors considered that the ECC computational cost for generating a small key size is lower than RSA security. The ECC-based protocol is more useful than other protocols because it resolves the weaknesses of the other protocol and is suitable for many applications demanding a high security. The proposed protocol resolves the issue of mutual authentication observed in the protocol proposed by Das and uses less hash function compared with the other protocols. The authors compared communication and computation costs, security and performances of the proposed protocols.

Sarika and Nawaz [10] proposed a user authentication protocol which confirms that access and quality of data are limited to authorized users only in a WSN. In this protocol, the user must first register with a GW-node with a security key to access the sensor network data. After registering, the GW-node starts a smart card to each and every authorized user. Users can submit their inquiries in an authentic manner and during administrative configurable period, the users at any time can access the sensor network data. The user registration, login, then authentication and password change are thus the four phases in which the framework is divided.

Furthermore, multifactor framework strength was proposed for performance and security analysis. Security analysis includes replay, impersonation, stolen-verifier, password guessing, node compromise, man-in-the-middle, DOS and secure password change attacks. Performance analysis examines the performance and summarizes the security functionality of the multifactor framework and compares it with the multifactor scheme by Das. The proposed two-factor system involves 13H computational cost and offers strong security features including mutual authentication, secure password change phase and prevents attacks including DOS, against node compromise and many more.

Zhou et al. [11] introduced a protocol for access control which uses ECC for sensor networks. Key establishment was included in this access control protocol for allowing the new node to join a sensor network dynamically and create shared keys with its neighbors for carrying out secured communications among sensor nodes. A bootstrap was included to provide authentication. The basic phases of this protocol were node authentication and key establishment.

Node authentication

To inform neighbors about their existent, each node must broadcast a message. In simple words, a node *Ni* bootstraps itself at a time *Ti* and broadcasts a message.

$$Ni\,Nj: [*, Ni, Ti, Li, Pi, Ci, Ci]$$

First, Lee-Chun Ko [12] highlighted the weaknesses of the scheme proposed by Tseng et al. and then later on introduced a novel dynamic user authentication scheme for WSNs by incorporating benefits of scheme proposed by Tseng et al. to achieve mutual authentication and enhanced its security strength. This method has the same assumptions as the scheme by Tseng et al. Furthermore, it makes use of two crucial parameters namely exclusive OR operations and hash functions. Both of these crucial parameters do not increase the computational overhead and hence are affordable to common sensor platforms.

Huang [13] proposed a novel access control protocol (NACP) which is based on the authentication hash chain as well as ECC. He suggested that NACP could provide resistance against various attacks such as replay and forgery attacks. NACP involves three phases namely initialization, then authentication and lastly the key establishment and new node addition. On comparing NACP with the access control protocol proposed by Zhu et al., it was observed that NACP reduced considerable amount of computations and communications between two nodes.

3 Analysis of Protocol

All the measures of security against various attacks are being summarized in Table 1. Moreover, a detailed access control view is provided in it against various attack types in order to provide all security measures with its computational cost and communication overhead. Table 2 presents a comparison of computation and transmissions of different access control systems.

Therefore, we compared the efficiency and communications of the recent protocol shown in figures. Figures 1 and 2 show that the proposed protocol is more efficient than the other previous protocols.

Table 1 Security measures against different types of attacks

Attack type	Security measure							
	Zhou et al. [11]	Huang [13]	Ko [12]	Sarika and Nawaz [10]	Yeh et al. [8]	Arikumar and Thirumoorthy [7]	Zhi et al. [3]	Cheng et al. [4]
New node deployment	√						√	√
Eaves dropping	√	√	√	√				√
False report injection	√		√					√
Masquerade attacks		√		√	√		√	√
Sybil attacks	√					√		
Wormhole attacks	√					√		
Secure connectivity		√	√		√	√		

Table 2 Comparison of computation of different protocols

Scheme	Computation for each node to achieve authentication and compute a shared key	The total number of transmissions in the protocol for key establishment
Zhou et al. [11]	$3T_{EM} + T_I + T_H$	21
Huang [13]	$2T_{EM} + 5T_H$	10
Ko [12]	$5T_H$	7
Sarika and Nawaz [10]	$T_{EM} + 5T_H$	12
Yeh et al. [8]	$2T_{EM} + 7T_H$	16
Arikumar and Thirumoorthy [7]	$2T_{EM} + 2T_H$	14
Zhi et al. [3]	$3T_{EM} + 5T_H$	15
Cheng et al. [4]	$3T_{EM} + 2T_H$	11

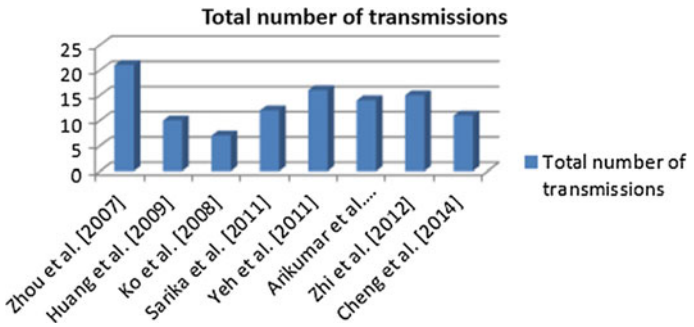


Fig. 1 Total number of transmission in key establishment

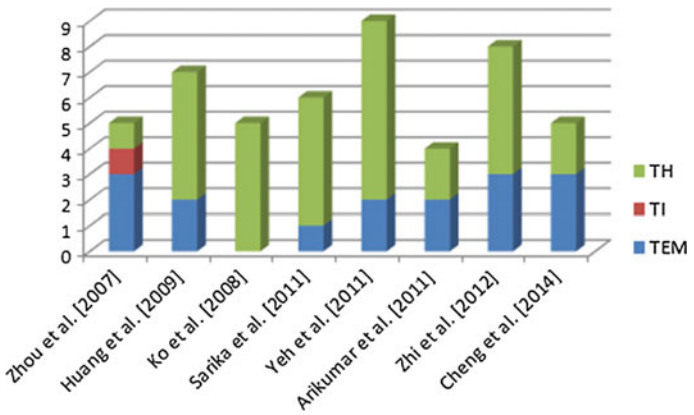


Fig. 2 Computation for each node to achieve authentication

4 Conclusion

This paper gives a brief knowledge of various existing authentication and access control protocols in wireless sensor networks. They both have advantages and disadvantages to remove the vulnerabilities and provide robust security against malicious attacks between communications in wireless sensor networks. This motivates us to design an improved authentication and access control protocol in WSNs.

References

1. Akyildiz, I.F., Su, W., Sankarasubramaniam Y., and Cayirci, E., "A survey on sensor networks", *IEEE communication magazine*, Vol. 40, No. 8, August, pp. 102–114.
2. Karlof, C. and Wagner, D., "Secure routing in wireless sensor networks: attacks and countermeasures", *Adhoc networks journal*, Vol. 1, No. 2, pp. 293315, 2004.
3. Zhi, S., Jian-Xin, L., Zhi-Yong, F., Zheu-Fu, C. and Guang-Quan, X., "On the security and improvement of a two-factor user authentication scheme in wireless sensor network", Vol. 17, No. 5, pp. 895–905.
4. Cheng, Y., Alan, D., and Wang, H., "Secure access control method for wireless sensor networks*", International Journal of distributed sensor networks*, Vol. 2015, No. 1, pp. 1–6.
5. Zhu, S., Setia, S. and Jajodia, A., "LEAP: Efficient security mechanisms for large-scale distributed sensor networks", *Proceedings of the ACM conference on computer and communications security (CCS '03),* October, pp. 89–97, 2003.
6. Khan, M. K. and Alghathbar, K., "Cryptanalysis and security improvements of two-factor user authentication in wireless sensor networks", *Sensors*, Vol. 10, No. 3, pp. 2450–2459.
7. Arikumar, K.S. and Thirumoorthy, K., "Improved user authentication in wireless sensor networks", *Proceeding of ICETECT*, March, pp. 1010–1015.
8. Yeh, H.L., Chen, T.H., Liu, P., Kim, T.H. and Wei, H.W., "A secured authentication protocol for wireless sensor networks using elliptic curves cryptography", *Sensors*, Vol. 11, No. 5, pp. 4767–4779.
9. Das, M.L., "Two-factor user authentication in wireless sensor networks", *IEEE transactions on wireless communications*, Vol. 8, No. 3, pp. 1086–1090.
10. Sarika, T. and Nawaz, S.S, "Multi-factor user authentication in wireless sensor networks", *International journal of computer science and telecommunications*, Vol. 2, No. 6, pp. 59–63.
11. Zhou, Y., Zhang, Y. and Fang, Y., "Access control in wireless sensor networks", *Adhoc networks*, Vol. 5, No. 1, pp. 313.
12. Ko, L.C. A Novel Dynamic User Authentication Scheme for Wireless Sensor Networks. Proceedings of IEEE ISWCS, Reykjavik, Iceland; 2008; pp. 608–612.
13. Huang, H.F., "A novel access control protocol for secure sensor networks", *Computer standards and interfaces*, Vol. 31, No. 2, pp. 272–276.
14. Lee, H., Shin, K. and Lee, D., "PACPs: Practical access control protocol for wireless sensor networks", *IEEE transaction on consumer electronics*, Vol. 58, No. 2, pp. 491–499.

Blockchain—Technology to Drive the Future

Shweta Bhardwaj and Manish Kaushik

Abstract Blockchain technology first came into public discourse through the rapid growth of Bitcoin currency. The financial services was first to realize its importance, but in recent years, we have started seeing the application of Blockchain technology in different streams—manufacturing, healthcare, e-voting, financial services and legal contracts. Through this paper, we will try to cover the current usage of blockchain technology in different areas, the potential of this technology in newer areas and see how it is changing the fundamental ways of transactions in a lot of different business areas.

1 Introduction

Blockchain technology uses a distributed ledger model that facilitates authentication of transactions in a fast, cheap and secure manner. The building block of this technology is a block of records, which are distributed between different members of the network, which are publicly available, synchronized and uneditable. This is called open ledger chain as all the participants in the network know the transactions of each participant, i.e., transactions are transparent and open.

S. Bhardwaj (✉)
Department of Computer Science & Engineering,
Amity University, Noida, Uttar Pradesh, India
e-mail: shwetabhardwaj84@gmail.com

M. Kaushik
Axis Bank, Mumbai, India
e-mail: kaushik.manish@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_28

1.1 Blockchain

The growing importance of blockchain technology can be gauged by the fact that reputed organizations like World Economic Forum, which in a recent report projects that 10% of world economic output will be stored on blockchains or blockchain-related technology. Its primary application is in the field of financial services, primarily cross-border trade and payments as it enables transactions between entities in a faster and cheaper way. Blockchain already is finding a lot of application in areas of banking, media, e-governance and other fields which require a third party central repository of data to authenticate transactions. To understand the implication of blockchain technology, we have to go to its basic building blocks —the users have access to a distributed database, a user on the network can edit only the part it owns using keys to write its file and the files of every user on this database are always kept updated, whenever anyone user makes changes in its file, this change is updated across the database.

The current systems of doing transactions require a neutral third party—either regulatory or participatory, which validates the transaction between two parties. So for instance, we use digital signatures for signing contracts or we have banks governed by a central regulatory body which facilitates transfer of funds between two entities across borders. The blockchain is of great use in these test cases as its distributed verifiable database helps reduce costs (banks charge a huge fee for cross-border transfers), it is faster (turnaround time is much faster) and the system is a lot more secure (it is not easily hack able).

1.2 How a Blockchain Works?

Suppose user A wants to send data to user B using a network, every transaction from A to B is done through the network and this transaction is represented as a "block". This block is broadcasted to every node in the network and these nodes are able to verify the data in the block. The block which is verified, is added to the chain, and this is now available for use by all users. This block cannot be edited, but can be only seen by all users. This completes the data transaction between A and B (Fig. 1).

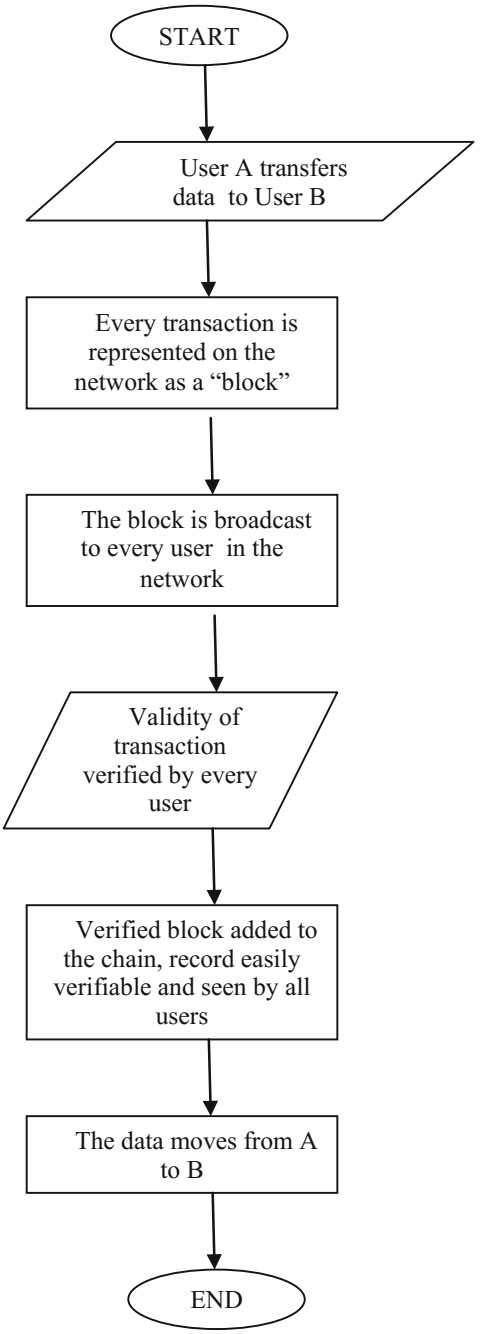


Fig. 1 Flowchart for how a blockchain works

Table 1 Comparison between blockchain and traditional database [10]

Attribute	Blockchain	Traditional Database
Data ownership and privacy	Encryption and decryption algorithms	Centrally monitored in form of rows and columns
Access	Same for all verified nodes	Decided by central monitor
Data validity	Transparent, visible through verifiable public data	One query at a time can be dealt with
Transaction	Known to all the nodes	Central monitor only manages all the transactions
Security	More secure as one can keep checking previous blocks	Not very secure

2 Comparison with Traditional Database

(See Table 1 [5]).

3 Usage Cases

Currently, there are a lot of gray areas and it is difficult to arrive at a common language, especially when we talk about rules covering banks, legal affairs, and government and there is a lot of different interpretation among these different departments. In these uses, we can use blockchain technology, such that these different bodies are aware of the change in rules through a verifiable database and it would really enhance the productivity, reduce conflicts across different departments and find applications in areas like land records, social welfare projects, insurance databases and the ever changing landscape in KYC norms enforced in financial markets.

3.1 Trade Payments

Financial sector companies [1] after a lot of initial reluctance have started embracing the technology. While earlier they looked at this technology at a disruptor and opposed it, they have realized that this technology can help them deliver better solutions, which helps them have better relationships with their clients and grow their business. It can play the role of a facilitator by reducing the execution timeframe of transactions, while enhancing the transparency and security of these transactions. The test cases are in the domain of international trade finance [2], subsidiary payments and digital payment cross-border platforms.

3.2 Insurance

In the insurance industry, there is a lot of focus on identifying the right underlying asset, which can be easily identified as well as not easily copied. This problem can be resolved using a blockchain which can keep the record of an asset, the history as well as record the changes, every time the ownership of the asset changes. This can then used by general insurance industry in diverse areas for keeping as well as verifying records, property, cars, laptops, and other physical assets.

3.3 Credit Cards

We see different uses in different verticals across the banking channel. Currently, suppose we use three different cards for spending, we realize that the reward points we obtain on different cards individually do not add up to a significant value and so many times, these points lapse, as we do not find any purchase to justify spending those reward points. In China, China Union Pay and IBM [3] has completed a pilot project wherein the customers using cards from different banks can exchange these bonus points across different banks and make good use of them.

3.4 Real Estate

In the real estate transactions, we always need a central authority, which certifies the authenticity of the land records, before two parties actually can execute a transaction. A blockchain can resolve that problem, as here the records can be stored, wherein the document is secure, authentic and is easily verifiable by a neutral third party. Already we see law firms using this technology to overcome the cumbersome and tedious process of certifying records.

3.5 Travel Industry

It is a very nightmarish experience for a lot of us, when we book our holidays and then find that the hotel room we get, is not the one we paid for. An Australian company Webjet [3] is trying to solve this problem with the help of Microsoft. They are using blockchain for its application in its interaction with travel agents, which supply hotel rooms, so as to ensure that the errors in this sector are taken care of. This would ensure that they have the right idea about the inventory available and hence make optimal decisions in hotel booking.

3.6 Contracts

Another potential area of blockchain usage which excites a lot of players is its ability to enforce contracts, with potential contracts and agreements replaced by blockchain applications. We already have the usage of smart contracts—these are contracts where rules are enforced by computer programs. Blockchain makes it easy to register, verify and implement smart contracts. A test case for smart contracts can be banks, which use escrow accounts to pull in and pay according to certain conditions, blockchain can ensure simpler execution of these escrow accounts.

3.7 Electronic Voting

This technology can be used for a robust electronic voting system. Participants in an election can register online and receive a unique electronic vote. Now these individual votes can be recorded in a blockchain and every voter can check whether his vote was marked correctly, and hence it is a quick and secure verification by the entire group of voters on individual votes. This could take more heat from the criticism we hear these days about electoral [4] and make it more transparent. Every voter would be able to verify his own individual vote. NASDAQ is already using it on trial basis for vote on its shareholder meetings.

3.8 Electrical Distribution

There have been instances of huge transmission losses in electrical distribution system and it is a critical area, as we have a scenario of ever increasing demand and limited sources of energy. One project involves the creation of a smart local power grid-based on distributed blockchain technology. This has tremendous potential in inaccessible remote areas, such systems would allow the distribution, metering and billing of electricity to be administered within the community itself, rather than being reliant on external multinational power and finance institutions.

3.9 Intellectual Property Rights

As we move toward a future digital age and rapid dissemination of information on the Internet, there is a lot of concern on the gray areas around intellectual property rights and how do we protect IPR in this age. Blockchains can be used to create a permanent or transferable link between the owner and a piece of IP, to handle licensing and distribution issues of individual IP items.

3.10 Health Records

A very high impact application of blockchain technology is in the space of health records. The security, verifiability and low costs associated with a blockchain make it a suitable candidate for sharing medical records. Estonia is among the few if not the only digital societies which have 100% of their medical health records online. This technology will be a great enabler for health, as it provides access to patient records and helps them with both clinical and financial assistance (lowering the overall costs). It reduces the intermediary costs by a significant margin.

3.11 Media Companies

Media companies have also started looking at blockchain technology to optimize their assets and have identified the following areas for usage of blockchain technology. Some areas identified are as follows—instant payments for streaming live video, rent excess space from their storage for commercial purposes, digital identity to replace username password and smart contracts for enforcing digital contracts.

3.12 Manufacturing

Manufacturing smart equipment can replace human contracting parties [5] for certain transactions. Devices on the Internet of Things can communicate with smart contracts to keep track of the status and state of smart contracts [6] for settlements. Smart shipping containers could, for example, automatically sell their surplus capacity. It facilitates faster settlements using cryptocurrencies.

3.13 Verification

The problem of fakes is as old as the human civilization. Even now as we move to digital age from the physical age, we have to tackle this problem in a bigger way. The trust of an online marketplace depends on its suppliers providing the right product to its customers [7]. Blockchain technology can help in this chain involving product companies, suppliers and marketplace, by providing all the players in the chain, individual points, which can verify the genuineness of the product.

In India, RBI has set up a committee to study use of blockchain technology to reduce use of paper currency [8]. ICICI Bank has used blockchain to do a cross-border trade transaction and seen its use in reducing time for executing the transaction.

4 Challenges

As blockchain gets more users, some security issues have also cropped up. Though centrally blockchain has a robust secure system, there are challenges at an individual node. If a participant key is stolen, then the blockchain security can be compromised at that node. The adoption is still in pilot stage, unless we see more widespread usage, it will not make a significant difference to the ecosystem. The transparency that is essential to the blockchain, combined with the ability to trace participants' real identities, can lead to serious privacy issues. We still have to see how regulators react to it, they were very skeptical toward the Bitcoin usage.

5 Conclusion and Future Potential

The current stage of blockchain technology is exciting and its use is been explored in a lot of areas. It has seen a lot of adoption in financial systems, but its real test will come, when it is used in commercial applications and by government is executing large-scale projects (Fig. 2).

The enormous interest can be seen that existing large corporations are experimenting on the technology through pilot projects, while a few new companies are entirely working on one or more applications of the blockchain technologies. We believe the large-scale use of blockchain is still a few years away and we will see innovation on the way.

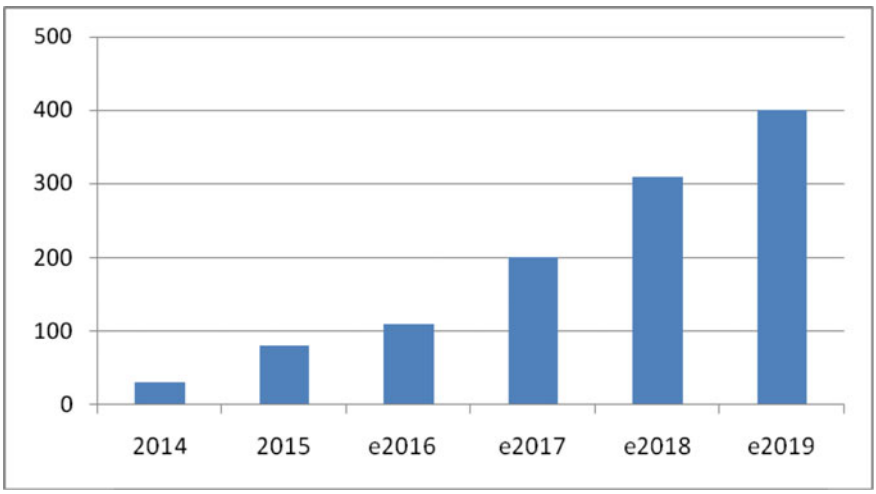


Fig. 2 Graph demonstrating spending on blockchain technology (USD Million) year wise [9]

References

1. Blockchain Technology: The Ultimate Disruption in the Financial System-Nathaniel Karp, BBVA research.
2. Blockchain Technology and the Financial Services Market-Infosys Consulting.
3. Blockchain Technology-Beyond Bitcoin- Pantas &Ting –Sutardja centre for Entrepreneurship &Technology.
4. Vincent Lee; Haozheng Wei, "Exploratory simulation models for fraudulent detection in Bitcoin system", IEEE 11th Conference on Industrial Electronics and Applications (ICIEA), 2016.
5. Blockchain-Understanding the potential – Barclays- Simon Taylor.
6. Blockchains Smart Contracts: Cognizant - Prasad Satyavolu, Abhijeet Sangamnerkar.
7. Florian Tschorsch; Björn Scheuermann, "Bitcoin and Beyond: A Technical Survey on Decentralized Digital Currencies", IEEE Communications Surveys & Tutorials, 2016, Volume: 18, Issue: 3, Pages: 2084–2123.
8. http://www.financialexpress.com/.
9. https://www.whitecase.com/publications/insight/beyond-bitcoin-blockchain-revolution-financial-services.
10. https://www.linkedin.com/pulse/banking-blockchain-gary-rowe.

Unified Payment Interface—A Way Ahead for Demonetization in India

Shweta Bhardwaj and Manish Kaushik

Abstract The payments infrastructure in banking has seen a rapid development in India over the last few years. With the ever-increasing smartphone penetration in India (over 220 million in Feb 2016—Counterpoint Research) and the growth of Internet, there has been a focus to take banking to the mobile phone. There has seen a rapid growth of digital payment systems—National Electronic Funds Transfer (NEFT), Real-Time Gross Settlement (RTGS), Immediate Payments Service (IMPS), and mobile application transfer compared to the manual payment methods. The latest addition to the list is UPI (Unified Payments Interface). This paper covers the basic model of UPI, how it can be used in different business transactions and usage scenarios have been analyzed.

1 Introduction

It has been introduced by the NPCI (National Payments Corporation of India.) Here one can make financial money transfer using one's smartphone. The payments can be done using aadhaar number, virtual address, account number and Indian Financial System Code (IFSC), mobile number, and MMID (Mobile Money Identifier). The payment is in the framework of the RBI 2 factor authentication, but does at a convenience of one input. Biometric authentication and use of payer's smartphone for secure credential capture, etc., are other unique features. The RBI in alignment with the government has been trying to move to a cashless society by utilizing the latest technological innovations, UPI is the next step in providing a structure and framework for meeting this objective.

S. Bhardwaj (✉)
Department of Computer Science and Engineering,
Amity University, Noida, Uttar Pradesh, India
e-mail: shwetabhardwaj84@gmail.com

M. Kaushik
Axis Bank, Mumbai, India
e-mail: kaushik.manish@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_29

1.1 UPI

Indian economy is still primarily cash-driven economy, the total noncash touch points on an average stands at 6 for our population. Even most of our small-scale traders, merchants prefer cash, and even after the rapid growth of cards in India still around 6 lakh merchants accept cards in India. Combining the latest penetration of the smartphones, and also the fact that smartphones [1] are getting cheaper and more technologically advanced with every iteration—a good camera smartphone will be the bank of the future.

What India has achieved with Aadhaar is not easily replicated anywhere in the world. It has given a digital identity to the Indian citizen and now other players in the ecosystem—be it government, corporate bodies, they can use Aadhaar as a biometric identification tool and using that can roll out their solutions. It reached the kind of scale that was never achieved in any biometric identity system in the world [2]; it has crossed the 1 billion mark in 2016.

The cost of transaction using UPI is much lower than e-wallets. The advantage it has over e-wallets like Paytm, PayU is that one does need to transfer money to a new wallet to make the transaction; here one simply uses the existing bank account to make transactions (Fig 1).

One simple way is to use the virtual address—one needs to download a UPI application from any of the participating banks, register on it using any existing bank account, and make your virtual payment address and M-Pin once. Then when you need to transfer any money, you just need to know the virtual address of the receiving entity and the money can be transferred 365 * 24 * 7 to that virtual address.

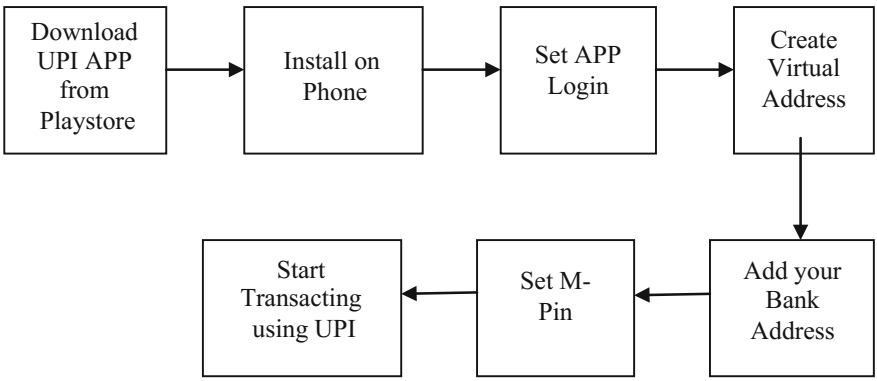


Fig. 1 UPI system [6]

1.2 NEFT

National Electronic Funds Transfer (**NEFT**) is a way to transfer funds electronically. According to Reserve Bank of India, National Electronic Funds Transfer (NEFT) is a nation-wide payment system to facilitate one-to-one funds transfer. Under NEFT, individuals, firms, and corporates can electronically transfer funds from any bank branch to any individual, firm, or corporate having an account with any other bank branch in the country participating in the scheme [3]. The maximum amount to be remitted through NEFT is Rs. 10 lakh.

1.3 RTGS

Real Time Gross Settlement—It is defined as real-time settlement of funds which is done individually on an order by order basis. The settlement is done in the books of RBI, hence it is irrevocable. It is primarily used for large payments; the minimum amount is Rs. 2 lakhs, while the maximum limit is Rs. 10 lakhs.

1.4 IMPS

Immediate payment service is an innovative real-time payment service that is available round the clock. This service is offered by National Payments Corporation of India (NPCI) that empowers customers to transfer money instantly through banks and RBI authorized Prepaid Payment Instrument Issuers (PPI) across India. It is available throughout the year. It can be initiated using all three channels—mobile, Internet and ATM.

2 Related Works

2.1 Financial Transactions

UPI supports the following financial transactions viz:

i. Payment Request: A payment request is a transaction where the initiating customer is pushing funds to the beneficiary using Account Number/IFS Code, Mobile No/MMID, Aadhaar Number, Virtual Address etc.
ii. Collect Request: A collect request is a transaction where the customer is pulling funds from the remitter by using virtual address [4]. In case of pull transactions, customer will have option to define the expiry time of collect request (up to

45 days). In case customer has not defined the expiry time, the default time should be taken as 30 min.

The PSP has to provide an option to customer to define minimum validity of 1 min, in case customer is selecting expiry time.

2.2 Nonfinancial Transactions

UPI supports the following nonfinancial transactions viz:

i. Mobile Banking Registration
ii. Generate One Time Password (OTP)
iii. Set/Change PIN
iv. Check Transaction Status Note: The PSP shall continue to provide option to their customers for raising dispute/complaints using PSP App and adhere to resolve the same within TAT as defined in UPI Operating and Settlement guidelines.

UPI can be accessed on all platforms, viz., Android/iOS & Windows—As of now, the Apps have been developed by members only on Android platform.

3 Analytical Comparison Between Different Modes of Electronic Transfer

Attributes	UPI	NEFT	RTGS	IMPS
Speed	Instant	Not instant, done in hourly batches	Real time, the beneficiary bank has to credit the beneficiary's account within 30 min of receiving the funds transfer message.	Instant
Access	Available 24 * 7 on public/bank holidays	Monday to Saturday (except 2nd and 4th) between 8 AM and 6:30 PM and public holidays	Monday to Saturday (except 2nd and 4th) between 8 AM and 6:30 PM and public holidays	Available 24 * 7 on public/bank holidays
Ease	No preregistration of beneficiary for fund transfer	Preregistration of beneficiary for fund transfer	Preregistration of beneficiary for fund transfer	No preregistration of beneficiary for fund transfer
Method and limit	Fund transfer using virtual payment address of	Fund transfer from any bank branch to any individual	Fund transfer from any bank branch to any individual	Fund transfer using MMID (mobile money identifier),

(continued)

(continued)

Attributes	UPI	NEFT	RTGS	IMPS
	beneficiary. Per-transaction cap is Rs. 1 lakhs.	having an account with any other bank branch in the country participating in the scheme. Maximum is Rs. 10 lakhs	having an account with any other bank branch in the country participating in the scheme. Meant for large value transactions. The minimum amount to be remitted through RTGS is Rs. 2 lakh	Aadhaar number and mobile number or bank account and IFSC code. Maximum is Rs. 10,000 for mobile and Rs. 2 lakhs for bank account

4 Benefits

(a) It uses the infrastructure of Aadhaar, which is a biometric application and hence can be used for KYC [5].
(b) Transfers are simpler, as one needs to only remember the virtual address to which payments are to be meant, no need to remember IFSC code and account numbers [7].
(c) It uses the increasing Smartphone population to get people into digital banking —its low cost, easy and easily scalable.
(d) It follows RBI's guidelines on a 2 factor authentication, but achieves this with only one input key. Here your mobile and PIN make the transactions in line with the RBI regulations [8].
(e) End-user friendly customers can make or receive payments with ease and security to/from friends, relatives, merchants, pay bills, etc., all using their mobile phones without sharing banking credentials. Alerts and reminders, consolidation of multiple banking relationship via single mobile app, use of special purpose virtual addresses, etc., simplify end-users experience.
(f) Flexibility for Payment Service Providers (PSPs)—Payment System Providers can build functionality rich mobile apps using UPI.

5 Usage Scenarios

5.1 Domestic Remittance

A factory security guard, Rakesh, working in Delhi has to transfer monthly money to his family in his village in Bihar [9].

Using Jandhan scheme, he opened an account for himself at Bank A and at the same time, his family opened their account at Bank B. With the spread of Aadhaar, both have Aadhaar accounts, which are linked to their bank accounts.

Rakesh has a low-cost smartphone given to him by his company.

Here is how it works:

i. Rakesh can now use UPI to send money.
ii. He just needs to go to his bank A mobile application, which has a PIN associated to it.
iii. He can save his mother Aadhaar number saved on his mobile application.
iv. Using UPI, he can simply transfer money using his mother's Aadhaar account.
v. The mobile app of his bank will be storehouse of his transactions and he can keep account of his balances there.
vi. The money will be sent real time to his mother's account.

5.2 E-Commerce

You can use UPI to pay for buying goods on e-commerce sites [10]. Here rather than using credit/debit cards, net banking; one can use UPI to pay. The advantage is the ease, the mobile application and m-pin is sufficient to pay for UPI. A person transacting on the e-commerce website has a failure rate, when the authentication chain is long, but using UPI, the chances of failure are reduced, as the transaction can be authenticated easily with your M-Pin and Virtual address.

5.3 Internet Banking

The ease of transaction will also help consumers using websites/application, which have lot of data traffic, for instance Indian Railways, IRCTC. The normal experience of consumers using IRCTC is that they get logged out before they can complete the transaction or at times, the seats get booked before they can complete the transaction. With UPI, the success rate of transactions on heavy traffic sites like IRCTC will improve.

5.4 Cash on Delivery

A lot of e-commerce companies in India have expanded their business using the cash on delivery option for its customers [11]. Here, customers pay the company in cash, once they receive the goods at their home. Now with demonetization and the government's focus on reducing cash transactions, these companies will look at

alternate ways for payments. There are various modes available—POS machines using credit/debit cards, here UPI will be a much easier way of collecting payments from customers. On delivery of goods, customers can simply transfer money to the virtual address of the merchants and make payments. The customers already have smartphones, so companies do not need to invest in buying POS machines which accept credit/debit cards. The payment is instant and is open 365 * 24 * 7, so companies will be able to acknowledge payments, as soon as they receive them.

5.5 Aggregators

It is of great use to businesses. A car rental agency employing 10 drivers, UPI can be used to pay drivers for every trip, based on the successful completion of the trip by them. It can be used by any business that needs to transfer money to its employees or vendors. So now using UPI, one can make 10 different virtual addresses for the drivers. Whenever they complete a trip, money can be transferred to their virtual address and the money gets deposited in their bank account. There are no reconciliation issues, track recording of all payments through mobile application and the drivers are happy, as they get paid instantly when they complete the trip. Earlier a lot of these transactions will be done in cash, there will be a lag in payments and so there will be a lot of reconciliation issues as well as difficult in keeping records.

6 Security Framework and Concerns

Banks have to follow NPCI standards. There is a third-party audit for every bank launching a UPI app. Anyone building a UPI app using a bank's API also needs to get its app audited by a third party. Anyone who sets up a UPI has to undergo two-factor authentication—one for mobile phone verification and debit card verification.

It will also lead to an increase in smartphone users using advanced security features on their phones.

7 Conclusion

The verdict is still unclear whether UPI will be the game changer for digital payments in India. As of now, it is still being used on experimental basis and the real benefits will come in, once a critical mass of people will be using it. The demonetization exercise has given it a boost, but its adoption will remain a

challenge till people start embracing digital banking and think of mobiles as their banks and not physical bank branches.

It was launched in the month of August with 21 banks and is yet to go live on a lot of merchant application sites. It will be a great tool to pay and collect, as it is very cheap, secure and uses the current payment infrastructure to make electronic transfers. It will facilitate the vision of digital India and will make banking accessible to a large number of Indians, both in the urban and rural areas.

References

1. http://www.bgr.in/news/unified-payment-interface-heres-how-rbis-upi-app-will-turn-your-smartphone-into-a-bank/.
2. www.mpf.org.in.
3. Seema Malik, "Technological Innovations in Indian Banking Sector: Changed face of Banking", International Journal of Advance Research in Computer Science and Management Studies, Volume 2, Issue 6, June 2014.
4. www.npci.org.in.
5. http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research%20Articles/India_readies_Unified_Payment_Interface_for_mobile_payments.pdf.
6. http://www.simpleinterest.in/unified-payment-interface-upi/.
7. http://www.livemint.com/Industry/bTGwxmykXhSKX5Vf8050NI/How-UPI-works.html.
8. http://www.thehindu.com/business/Economy/Change-the-way-you-pay-with-Unified-Payments-Interface/article14235265.ece.
9. N. Delic; A. Vukasinovic, "Mobile Payment Solution - Symbiosis Between Banks, Application Service Providers and Mobile Network Operators", Third International Conference on Information Technology: New Generations (ITNG'06).
10. J. L. Abad Peiro; N. Asokan; M. Steiner; M. Waidner, "Designing a generic payment service", IBM Systems Journal 1998, Volume: 37, Issue: 1, Pages: 72–88.
11. http://www.livemint.com/Companies/rAIjBJQ2psfquOESwCemSK/How-can-unified-payment-interface-be-a-gamechanger-for-mobi.html.

Evolutionary Algorithm Based Faults Optimization of Multi-modular Software

Rana Majumdar, P.K. Kapur, Sunil K. Khatri and A.K. Shrivastava

Abstract Computer systems characteristically comprise of hardware and either system or application software. In software developing environment, to accomplish precision is a great thought-provoking task. As there exists every probability that a mistake can be introduced and can persist in software during its established phase. Occurrence of fault cannot be predicted it may be due to human's mistake which gets noticed during execution of a software activity and at times these faults can lead to failures with disastrous results. Hence, software organizations put emphasis on evading introduction of faults during software development before software gets released. A single software is a combination of several segments each segment has its specific functionality. When all these segments come together, the reliability of the software becomes of utmost importance as it quantifies software failures during the development process and also in operational phase. In order to increase the reliability, an all-inclusive test plan should be included which ensures that all requirements are covered and tested accurately. The main purpose is to maximize the number of faults removed within time constraint during the development phase of software. Each segment may consist of finite number of subparts. These subparts may have errors of different severity depending upon the factors like quality of manpower involved, computer time consumed, etc. The objective of this work is to maximize the number of faults removed in different modules using the Genetic Algorithm and optimized time while removing them; hence find out the faults of different severity and time devoted to removing them in various modules with a predefined reliability.

R. Majumdar (✉)
Amity School of Engineering and Technology, Amity University, Noida, UP, India
e-mail: rmajumdar@amity.edu

P.K. Kapur · A.K. Shrivastava
Amity Center for Interdisciplinary Research, Amity University, Noida, UP, India
e-mail: pkkapur1@gmail.com

A.K. Shrivastava
e-mail: kavinash1987@gmail.com

S.K. Khatri
Amity Institute of Information Technology, Amity University, Noida, UP, India
e-mail: skkhatri@amity.edu; sunilkkhatri@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_30

1 Introduction

In software development, to accomplish excellence is a pronounced thought-provoking task. During development phase of software, faults can be hosted and can persist in software. A fault takes place due to bad design, human mistake, and diverse operational profile and in execution phase these faults can lead to failures with disastrous outcomes. Hence significant controlling is imposed by the development team on evading introduction and generation of faults in the course of software development and to remove different categories of faults before releasing the product for its operational usage, with high quality and performance that can be persistent over time. During software development process, some issues that need to be addressed are (i) Occurrence of software failure? (ii) Testing stop time? (iii) Software release time? Quantification of quality gives us a better insight into the development processes [1, 2]. In the past, researchers developed several Software Reliability Models and from literature it is established that in SRGM the relationship between the testing time and number of faults identified/removed is either exponential or S-shaped in nature or in some cases it is a mixture of the two [1, 3–8]. The software consists of diverse types of faults and each fault requires varied strategies and dissimilar extents of testing effort to remove them [9]. The importance of modelling and analysis of software failure occurrence or fault detection and removal phenomenon has been well recognized and many studies have addressed this problem. This observation is useful for planning purposes, in both the growth and the functioning phases of the software systems. A number of SRGMs have been proposed in the literature, under specific set of conventions and testing environments and many of them are based on the nonhomogeneous Poisson process (NHPP) assumptions Musa et al. [10], Kapur et al. [1], Pham [11], Ohba [7]. Kapur and Garg [6] in their work discussed a fault removal process more precisely, with the assumption that fault removal process may remove some of the additional faults without putting any serious effort to remove them [9]. If a model is characterized by its growth curves which is either exponential or S-shaped or even both, in literature this models are characterized as flexible models [3, 6, 7]. Kapur et al. [1] proposed an SRGM with categorization of faults and they are characterized by exponential model of Goel and Okumoto [5], delayed S-shaped model of Yamada et al. [8], and three-stage Erlang model [1, 12, 13] based on faults severity. In general, practicable and sustainable software products are complex in nature and usually a combination of number of modules. These modules collectively form complete software. In this work, an optimization problem for modular software is formulated in which the objective is to maximize the number of faults subject to a time and reliability constraint. Software faults are considered as simple, hard, and complex faults [1, 2]. It is well assumed and common practice employed by the industry people for testing software are failure observation/isolation and fault

removal. Severity of faults is detected based on time delay between the failure observation and subsequent removal. The more severe the fault the more the time delay.

The main contributions of the paper are twofold:

(1) Provides a framework for multi-modular software developers with the flexibility of maximizing faults with certain constraints and obtain module-wise optimal testing time;
(2) The Genetic Algorithm based solution provides robust parameters which have all the possibilities to be explored further in our future research work.

The organization of this paper is Sect. 2 described the outline for evolving the software reliability growth model comprising of faults of dissimilar strictness. Section 3 talks about reliability evaluation of SRGM. The fault and time optimization problem is framed in Sect. 4 and illustration of problem solution is given through a numerical example. Section 5 comprises of genetic algorithms and its usage for present problem is under consideration. Conclusion is given in the final section.

2 Framework for Modeling

Basic Assumptions: $N(t)$ is the expected number of faults with mean value function $m(t)$.

SRGM is assumed as:

$$Pr\{N(t) = n\} = \frac{(m(t))^n}{n!}\exp(-m(t)) \tag{1}$$

$$m(t) = \int_0^t \lambda(x)\mathrm{d}x, \tag{2}$$

where $\lambda(x)$ is intensity function. Failure intensity is the rate of change of the expected number of failures with respect to time and acts as a basic building block for NHPP models in the field of software reliability [12].

This work considered Generalized Erlang SRGM proposed by Kapur et al. [13], which states that fault categorization is identified by its separate growth curve.

Notations used

$m_{pn}(t)$ random process indicating the number of faults eliminated of type n (1, 2, 3) in p number of stages by time t.
b_p Fault detection rate for pth (1, 2, 3) module.

a_{p1} Simple faults (type 1) before testing starts.
a_{p2} Hard faults (type 2) before testing initiated.
a_{p3} Complex faults (type 3) at the beginning of testing.
a Total fault content in software at the beginning of testing; $a = a_1 + a_2 + a_3$.
T_p Testing time of each module.
$R(X|t)$ Reliability of software system.

2.1 Model Norms

(1) Failure happening, fault detection/removal phenomena follow an NHPP.
(2) Software is subject to failures during execution caused by faults remaining in the software.
(3) The faults present in the software are of three types namely type 1, type 2, and type 3, which are demonstrated by one stage, two stages and three stage processes, respectively.
(4) Perfect debugging environment is assumed.
(5) Whenever a failure occurs an immediate action takes place to realize the cause of the failure and to eliminate it. The time delay between failure observation and fault removal is supposed to signify the severity of the faults. Here it is assumed that elimination of severe fault will introduce more time delay [2, 14].

2.1.1 Modeling the Faults

The basic idea is that the diverse modules (or classes) of the software experience an exponential failure rate; however, the rates vary over these modules to reflect their different characteristics. This could be due to different programming group's assigned different task, introduction of new code, use of dissimilar languages for section wise coding and specifically faults with different characteristics require autonomous control. Based on these observations, it is assumed that type 1 faults exhibit exponential distribution whereas type 2 and type 3 are shown as S-shaped curves due to their time-delayed behavior. As stated in the earlier section, this work considers only three types of faults, i.e., type 1, type 2, and type 3.

a_1, a_2 and a_3 symbolizes types of faults.

Then $a = a_1 + a_2 + a_3$.

The precise association of simple fault removal [6] is as follows:

$$\frac{\mathrm{d}m_1(t)}{\mathrm{d}t} = b_1(a_1 - m_1(t)) \tag{3}$$

At $m_1(0) = 0$ we get:

$$m_1(t) = a_1(1 - \exp(-b_1 t)) \tag{4}$$

Hard faults are removed using [2] as a two-staged process:

$$\frac{\mathrm{d}m_{2f}(t)}{\mathrm{d}t} = b_2\big(a_2 - m_{2f}(t)\big) \tag{5}$$

$$\frac{\mathrm{d}m_2(t)}{\mathrm{d}t} = b_2\big(m_{2f}(t) - m_2(t)\big) \tag{6}$$

With $m_{2f}(0) = 0, m_2(0) = 0$,

$$m_2(t) = a_2(1 - (1 + b_2 t)\exp(-b_2 t)), \tag{7}$$

where $m_{2f}(t)$ denotes failures detected in time t and $m_2(t)$ denotes those faults are eliminated in time t.

Unlike simple and hard faults, complex fault exclusion process is demonstrated by Kapur et al. [15]:

$$\frac{\mathrm{d}m_{3f}(t)}{\mathrm{d}t} = b_3\big(a_3 - m_{3f}(t)\big) \tag{8}$$

$$\frac{\mathrm{d}m_{3is}(t)}{\mathrm{d}t} = b_3\big(m_{3f}(t) - m_{3\mathrm{is}}(t)\big) \tag{9}$$

$$\frac{\mathrm{d}m_3(t)}{\mathrm{d}t} = b_3(m_{3is}(t) - m_3(t)) \tag{10}$$

for $m_{3f}(0) = 0, m_{3is}(0) = 0$ and $m_3(0) = 0$, solving Eqs. (8)–(10) we get:

$$m_3(t) = a_3\left(1 - \left(1 + b_3 t + \frac{b_3^2 t^2}{2}\right)\exp(-b_3 t)\right) \tag{11}$$

2.1.2 Modeling Total Faults

The total fault removal process is mathematically defined as a summation of simple, hard, and complex faults. Here, $m_2(t)$ and $m_3(t)$ are stated as delayed S-shaped Yamada model and three-stage Erlang growth curves, respectively and b_1, b_2, b_3 are

the removal rates for simple, hard and complex faults, respectively. In this work, it is expected fault removal rates to be constant, although in real environment these rates may differ depending upon fault severity. Here $m(t)$ represents summation of faults for a single module.

$$m(t) = m_1(t) + m_2(t) + m_3(t) \tag{12}$$

$$\begin{aligned} m(t) = {} & a_1(1 - \exp(-b_1 t)) + a_2(1 - (1 + b_2 t)\exp(-b_2 t)) \\ & + a_3\left(1 - \left(1 + b_3 t + \frac{b_3^2 t^2}{2}\right)\exp(-b_3 t)\right) \end{aligned} \tag{13}$$

Considering $b_1 = b_2 = b_3 = b$, Eq. (13) can be rewritten as

$$m(t) = a_1(1 - \exp(-bt)) + \sum_{n=2}^{3} a_n \left[1 - \exp(-bt)\left[\sum_{j=0}^{n-1} \frac{(bt)^j}{j!}\right]\right] \tag{14}$$

3 Reliability Evaluation of SRGM

In SRGM reliability can be defined as:

$$R(X|t) = \mathrm{e}^{-m(t+x)-m(t)} \tag{15}$$

Based on Eq. (15), the reliability of integrated system can be expressed as

$$R(X|t) = \mathrm{e}^{-\sum_{p=1}^{3}\sum_{n=1}^{3}[m_{pn}(t+x)-m_{pn}(t)]}$$

$$R_p(X|t) = \prod_{p=1}^{3}\left(\prod_{n=1}^{3}\mathrm{e}^{-[m_{pn(t+x)}-m_{pn(t)}]}\right) > R_0 \tag{16}$$

A component functioning without failure until time t, that is, the probability that the time to failure is greater than t. Equation (16) denotes that the reliability with three modules p (1, 2, 3) and with three types of faults n (1, 2, 3) of different severities. Therefore, for multi-module software, it is more error prone as any unnoticed fault in any one of the module may cause a failure. For this type of modelling, categorization of faults is to be considered individually for each of the modules [2].

4 Fault Maximization and Testing Time Optimization Problem

4.1 Problem Conceptualization

The objective is to identify and classify faults of different severities in a modular-based software and to remove them based on their module-wise severity and with certain time and reliability constraint. In this framework, no budgetary constraint is considered. The above problem is solved using soft computing technique based on the following two critical information set by the development team.

- The preferred reliability of each module is at least 0.9.
- The overall testing time offered is supposed to be 1500 (module wise).

4.2 Mathematical Formulation

A software may consist of any number of modules depending on its applicability and usage. In each module, faults with different severity may occur, therefore continuous testing and controlling is required for the software before releasing in the market within given release time with testing time and reliability constraint. The objective is to maximize the number of faults of each independent module within time constraint, i.e., to maximize (optimize) faults during development phase/testing phase by achieving minimum reliability level R_0 with time T to be the total testing time available.

In our study, we consider the modular software consisting of 3 modules with 3 different fault types, n (1, 2, 3) for (simple, hard and complex faults) present in each of the modules.

Then from Eq. (14), the expected number of faults removed by time t for each module p (1, 2, and 3) is given as:

Maximize

$$m_p(t) = \sum_{p=1}^{3}\sum_{n=1}^{3} m_n(t) = \sum_{p=1}^{3} a_{p1}\left(1 - \exp\left(-b_{p1}t\right)\right) + \sum_{n=2}^{3} a_{pn}\left[1 - \exp\left(-b_{pn}t\right)\left[\sum_{j=0}^{n-1}\frac{(bt)^j}{j!}\right]\right]$$

Table 1 Parameter estimates for severity of faults

Module	a_p (simple)	a_p (hard)	a_p (complex)	Total no of faults	Fault detection rate
1	313	107	81	501	0.037
2	332	97	76	505	0.023
3	298	64	32	394	0.021

Subject to

$$\sum_{n=1}^{3} T_n \leq T,$$

$$R(X|t) = \prod_{p=1}^{3} \left(\prod_{n=1}^{3} e^{-[m_{pn(t+x)} - m_{pn(t)}]} \right) > R_0.$$

4.3 Numerical Illustration

The optimization problem defined in this section is explained with numerical examples. Here, we consider software consisting of three modules for simplicity, whose parameters are estimated using failure data Ohba [16]. Here, the failure data was recorded for 19 weeks and 47.65 h consumed. The parameter estimation for each module is presented in Table 1.

5 Evolutionary Approach (GA)

Genetic Algorithms (GAs) are adaptive heuristic search algorithm inspired by Darwin's theory of evolution. The basic idea behind GAs is to design and to simulate processes in natural way needed for evolution, following the philosophies of "survival of the fittest." Algorithm is started with a set of solutions called population. The algorithm repeatedly modifies that population and at each step try to evolve the population and improve its individuals [17].

5.1 Framework of Genetic Algorithm

(1) Initialization: Random initial population.
(2) Evaluation: The first step of evaluations is to generate new populations.

The algorithm works by implementing the following steps

(a) Computation of fitness value.
(b) Member selection is done based on fitness function.
(c) Selection helps keeping the best individuals by removing the bad ones.
(d) Crossover by relating pair of parents.
(e) Replaces present population with succeeding generation.

(3) Stopping criteria: When end condition gets satisfied [18].

5.2 Implementation of Genetic Algorithm

There exist numerous openings for addressing optimization problems; some of them are challenging enough like optimizing schedules to minimize cost and time, while maximizing output. The genetic algorithm works not by considering every possible combination in its input domain instead it tries intelligently to get closer to the best solution based on problem definition, i.e., fitness function. Optimization performance depends on number of variables and possibly on initial population. The parameter values settings are inherently dependent on the nature of the problem addressed refer Table 2.

The optimum testing period allocation of different form of fault in multiple modules and hence total fault identified and detached and time of removing faults is shown in Table 3. The best solution for optimized results in terms of faults, time, and reliability is shown in Fig. 1 based on GA parameter considered for solving optimization problem.

Table 2 Parameter values

Initial population	Random ($T < 1500$)
Selection	Tournament selection
Crossover	Single point crossover with value 0.50
Mutation	Mutation process is flip one bit with value 0.25
Reliability	Min reliability required $R(t) = 0.9$
Population size	Population size considered = 100
Generation	Total generation = 30
Time	Max time allotted = 1500

Table 3 GA optimization result

Module	Total no of removed $m(t)$	Reliability	Time (t)
1	490.94	0.97	473.31
2	477.24	0.99	499.96
3	344.27	0.99	139.04
Overall system reliability 0.95			

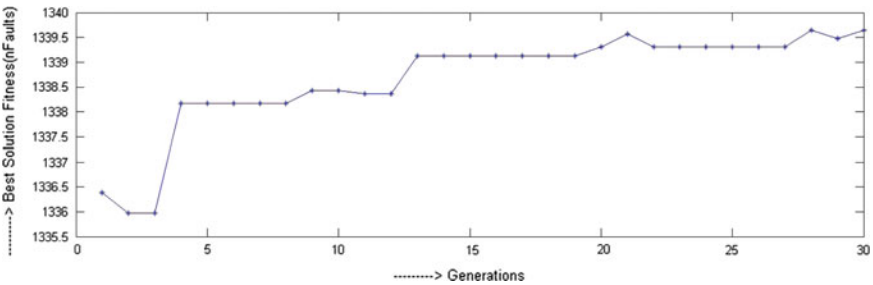


Fig. 1 Fault maximization and time optimization chart

6 Conclusion

This work emphasizes on optimizing (maximizing) total faults and time (minimizing) subject to desired level of reliability attainment set by the organizations. In addition, we address the concern of defining the optimal testing period module wise before software gets ready to release. In development environment, there exists an administrative involvement and never-ending trade-off between reliability and testing time. An optimization problem is formulated to govern the optimal testing time, by combining reliability is explained using Genetic Algorithm. Numerical example is discussed to illustrate the optimization problem using evolutionary approach.

Acknowledgements Authors express their deep sense of gratitude to The Founder President of Amity Universe, Dr. Ashok K. Chauhan for his keen interest in promoting research in the Amity Universe, he has always been an inspiration for achieving great heights.

References

1. P.K Kapur, R B Garg, and S Kumar, Contributions to hardware and Software Reliability, World scientific, Singapore, 1999.
2. Kapur, P. K., and Nitin Sachdeva. "Optimization Problems For A Modular Software With Faults of Different Severity", International Journal of Reliability Quality and Safety Engineering, 2016.
3. S Bittanti, P Bolzern, E Pedrotti and R Scattolini, "A flexible Modelling approach for software reliability growth," in Software reliability Modelling and Identification, G Goos and J Harmanis, Eds, pp. 101–140, Springer, Berlin, Germany, 1998.
4. T Downs and A scott, "Evaluating the performance of software reliability models," IEEE Transactions on Reliability. Vol. 41, pp. 533–538, 1992.
5. A L Goel and K Okumoto, "Time dependent error detection rate model for software reliability and other performance measures," IEEE Transactions on Reliability, Vol. 28, no. 3, pp. 206–211, 1979.
6. P K Kapur and R B Garg, "Software Engineering journal, vol. 7, no. 4 pp. 291–294, 1992.

7. M Ohba, "Software reliability analysis models," IBM Journal of Research and development, vol. 28, no. 4, 428–443, 1984.
8. S Yamada, M Ohba and S Osaki, "IEEE Transactions on reliability, vol. 33, no. 4, pp. 289–292, 1984.
9. P. Kapur, Amit Bardhan "Statistical Models in Software Reliability and Operations Research", DOI:10.1007/978-1-84628-288-1_25. In book: Springer Handbook of Engineering Statistics, Publisher: Springer, pp. 477–496.
10. Musa, J. D., Iannino, A., Okumoto, K., 1987. Software Reliability: Measurement Prediction Application. McGraw-Hill, New York.
11. Pham, H., 1993. Software reliability assessment: Imperfect debugging and multiple failure types in software development. EG & GRAMM-10737, Idaho National Engineering Laboratory.
12. P K Kapur, S Younes and S Agarwala, 'Gegeneralised Erlang model with n types of faults," ASOR Bulletin, vol. 14, no. 1, pp. 5–11, 1995.
13. P K Kapur, V B Singh and B yang, "Software reliability growth model for determining fault types," in processing of 3rd international Conference on Reliability and Safety Engineering (INCREASE '07) p. 334–349, Reliability Center, Kharagpur, India December 2007.
14. P K Kapur, Sunil Kumar Khatri, Prashant Johri, Ompal Singh, Incorporating concept of two types of Imperfect Debugging for developing Flexible Software Reliability Growth Model in Distributed Development Environment, Journal of Technology and Engineering Sciences Vol. 1, No. 1 January –June 2009.
15. P. K. Kapur "Optimal Testing Resource Allocation for Modular Software considering COST, Testing Effort and Reliability using Genetic Algorithm" International Journal of Reliability Quality and Safety Engineering, 2009.
16. M. Ohba, "Software reliability analysis models," IBM Journal of Research and Development, vol. 28, no. 4, pp. 428–443, 1984.
17. Gilberto C. Pereira, Marilia M. F. de Oliveira*, Nelson F. F. Ebecken, "Genetic Optimization of Artificial Neural Networks to Forecast Virioplankton Abundance from Cytometric Data", journal of Intelligent Learning Systems and Applications Vol. 5, No. 1, Article ID: 28065, DOI:10.4236/jilsa.2013.51007, 2013.
18. http://www.theprojectspot.com/tutorial-post/creating-a-genetic-algorithm-for-beginners/3
19. B Oksenda, Stochastic Differential Equations: A introduction with Applications, university text, Springer, Berlin, Germany, 6th edition, 2003.

Chip-Based Key Distribution Technique

K. Naveen Kumar and Manisha J. Nene

Abstract Online transaction's security is challenging. Entities involved in such transactions need to be intelligent enough and sustainable to its misuse. Online applications are more vulnerable to attacks. There are methods to overcome these vulnerabilities by implementing security measures. One of the recent popular measures includes two-factor authentication system, where the user will be having password (known to him) and one time password (OTP) will be sent as short messaging service (SMS) to the authorized user mobile. However, due to misplacement of mobile or less physical secured mobile devices or due to man-in-middle attacks or OTP sniffing, the OTP can be compromised. The work in this paper proposes a methodology to distribute the keys securely over the network. Further, an algorithm is proposed, which proposes an authentication mechanism which is sustainable to the misuse of OTP enabled authentication mechanism. This novel authentication technique uses an additional security hardware TPM at both the communicating ends to achieve the security requirements such as confidentiality, integrity, and authenticity. The proposed method provides a mechanism that may be used whenever there is a need to eliminate the involvement of trusted third party in any real-time transactions.

K. Naveen Kumar and M.J. Nene are employees of Center Artificial Intelligence and Robotics (CAIR), Bangalore and Defence Institute of Advanced Technology (DIAT), DRDO, MoD, Pune, respectively. K. Naveen Kumar is currently pursuing his post graduation in Computer Engineering from DIAT.

K. Naveen Kumar (✉) · M.J. Nene
Department of Computer Science & Engineering, Defence Institute of Advanced Technology (DIAT), Pune 411025, Maharashtra, India
e-mail: naveen_mce15@diat.ac.in

M.J. Nene
e-mail: mjnene@diat.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_31

1 Introduction

A digital world is an electronic spectrum of creating, storing, retrieving, and manipulating data across the Internet [1]. Digital world, which are interconnected through digital devices, media, services, and technologies are available to everyone throughout the year. Internet has made it possible to connect each other through these technologies. Many online applications ranging from banking transaction to online reservation systems for airlines, railways to online retail sales and auctioning, etc., have made our life easier, productive, efficient, and time-saving. The design and development of these applications were based on the functionality and user-friendliness. Security for these applications is important and these applications were not designed to meet the security requirements. The applications were designed with flaws such as injection vulnerabilities, buffer overflows, sensitive data exposures [2], etc. Due to these design flaws, the applications are more vulnerable to the security attacks. There are many methods to achieve the security of an application which includes both software [3–5] and hardware [6–8] based security methodologies. However, the methods to achieve this security are at the cost of involvement of trusted third party or through the methods like multifactor authentication, etc.

In this paper, we propose a two-level security methodology Internode CBKDT (Chip-Based Key Distribution Technique) to achieve the security requirements of any computing device by including the features of Trusted Platform Module (TPM) [9] to meet the defined objectives. The rest of the paper is organized as follows: Sect. 2 provides proposed work. Section 3 discusses the CBKDT protocol and Sect. 4 describes the verifications, observations, and results. Finally Sect. 5 presents the conclusion.

2 Proposed Work

2.1 Aim and Motivation

OTPs provided in all banking transactions are believed to be secured as the password or pin generated during this process is used for single time and the lifetime of this password is for short duration, i.e., usually 60 s. However, the studies and research show the vulnerabilities of OTP [10–12]. Using different sniffing and hacking techniques, an adversary can easily gain access to this OTP. We propose CBKDT protocol to eliminate the need of one time password (OTP) or any third-party authenticator. The method also transfers the keys generated securely over the untrusted network. The key generated in this method can also be used for further transaction between two communication entities (Table 1).

Table 1 Terms and terminologies used

Terms	Definition
I	Initiator node
R	Responder node
M	Message packet
$E(M)$	Encryption algorithm applied on message M
M'	M' is the encrypted message, i.e., obtained after encryption algorithm $M' = E(M)$
$D(M')$	Decryption algorithm applied on encrypted message M'
$M = D(M')$	$D(M')$ is the decryption algorithm
T_s	The time stamp of the packet while sending
T_r	The receiving time stamp
T_d	The delay time that occur during the packet transit
TPM	Trusted platform module is secure microcontroller that can store the artifacts used to authenticate the platform
RTR	Root of trust for reporting
RTS	Root of trust for storage
RTM	Root of trust for measurement
PCR	Platform configuration registers is a TPM's secure register
Cryptographic hash function	A function that takes input (a message) and returns a fixed size alpha-numeric character
Measurements or code identity or RTM	A cryptographic hash over a software binaries, inputs, libraries and configuration files
$H(I)$, $H(R)$	The hash values of initiator node and responder node that is stored in PCR register
Booting process	A start-up sequence of any device, when it is power on
Secure boot	A process which verifies the stored hash value during the boot process and halts the execution process if it doesn't match with the stored hash value
Time synchronization	Precisely matching or coordinating time between two or more nodes in the SN using some defined protocols
Storage root key	A master key known only to the creator, which is used to access the PCRs

2.2 Deployment Environment

Communication entities used in this methodology can be any device such as laptop, desktop, server machine, mobile phones, or any embedded system with additional TPM chip hardware present in the device. Communication is internode, i.e., it can be between server and client or peer to peer or between any two computing devices. The work in this paper proposes a methodology, where the keys are generated using *Secure Boot* [13] functionality of the commodity hardware TPM.

3 CBKDT Protocol

The CBKDT protocol works in three phases.

3.1 PHASE I: RTM Calculation

The hash value of an individual platform is calculated by hashing the RTM of BIOS, Boot-Loader, OS and Application together and storing the final hash value in one of the PCRs [14] as shown below and the calculation is diagrammatically shown in Fig. 1. An initial random value n which is a positive integer such that $n \geq 0$ is assigned to strengthen the cryptographic function. This term n represents a seed or initial vector. B, L, O, A are the RTM of BIOS, Boot-loader, Operating System and Application, respectively. PCR_i is the Platform Configuration Register and i is the number of register from 0 to 23, h is the hash function, $H(I)$ and $H(R)$ is the final hash value of the initiator node and responder node, respectively.

$$\mathrm{PCR}_i \leftarrow h(n \,||\, B)$$

$$\mathrm{PCR}_i \leftarrow h(h(n \,||\, B) \,||\, L)$$

$$\mathrm{PCR}_i \leftarrow H \leftarrow h(h(h(h(n \,||\, B) \,||\, L) \,||\, O) \,||\, A)$$

$$\mathrm{PCR}_i \leftarrow H\,(I) \text{ or } H(R)$$

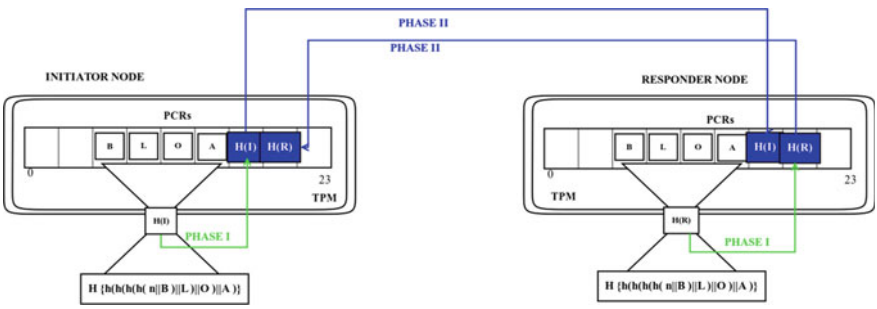


Fig. 1 RTM calculation

3.2 PHASE II: Key Discovery

See Fig. 2.

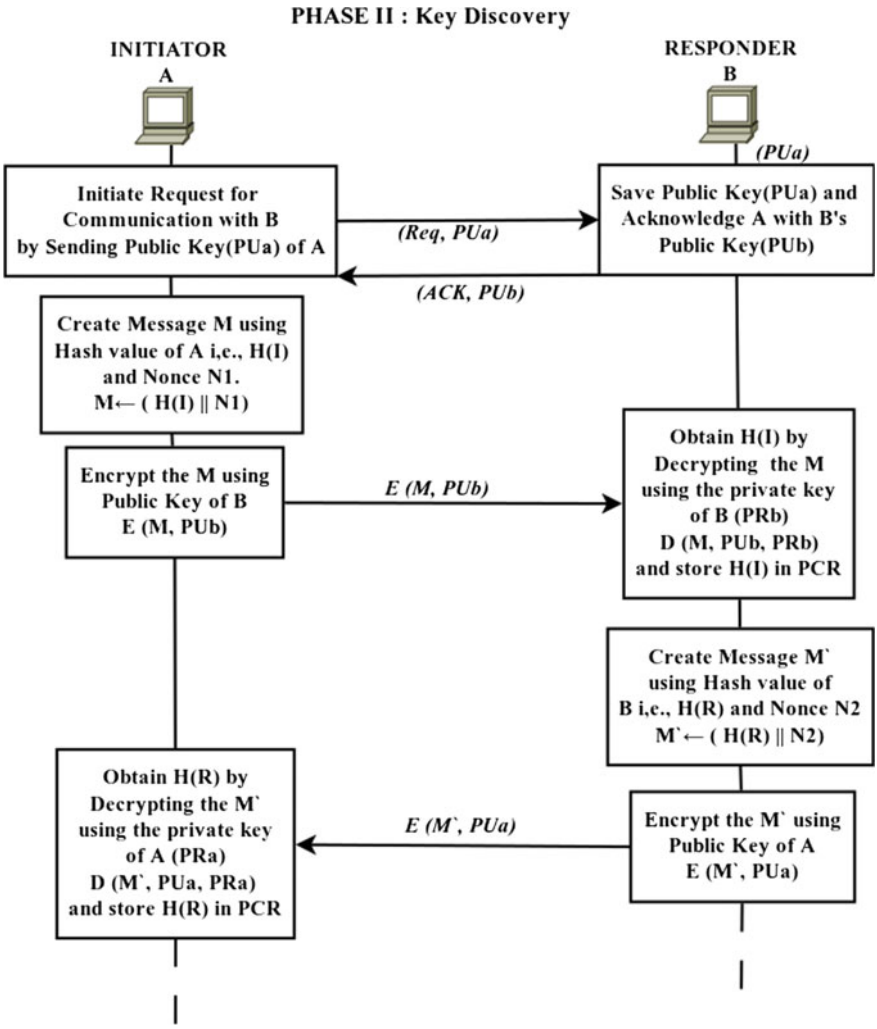


Fig. 2 Key discovery phase is the phase where the hash value of initiator and responder are securely communicated over the network through public key encryptions. The steps are as shown in the flowchart

3.3 PHASE III: Key Establishment

Key establishment phase uses the hash values exchanged during phase II and calculates the key K' at both ends. The algorithm is explained in detail in the following steps:

Step 1: At the source *INITIATOR* node I, time T_s, compute K using $H(R)$

$$I : K = \{H(R) + T_s\}$$

Step 2: Compute K' by XOR-ing the K with $H(I)$

$$I : K' = K \oplus H(I)$$

Step 3: Encrypt the message M using encryption algorithm and send the encrypted message M'

$$I : M' = E_{(K',M)}$$

At the destination *RESPONDER* R needs to compute the key K to decrypt the message M' in order to obtain the original message M.

Step 4: Compute K' using $H(R)$ and time stamp T_r, T_d to obtain T_s, i.e., $T_s = T_r - T_d$

$$R : K' = \{H(R) + (T_r - T_d)\}$$

Step 5: Now calculate K using $H(I)$

$$R : K = K' \oplus H(I)$$

Step 6: Finally decrypt the message with the key obtained. If the obtained key does not match then the packet is discarded, otherwise message is decrypted.

$$R : M = D(K', M')$$

4 Observations and Results

The evaluation of the proposed CBKDT protocol is categorized into [1] Case A: A case to evaluate their ability to identify the legitimate and adversary node using CBKDT in ideal and attack scenario. [2] Case B: Tamper-resistant ability of CBKDT against any attack methods.

To evaluate the proposed methodology CBKDT protocol, we have connected three 64 bit machine with TPM device together within a network and assigned different IPs with the same subnets to make it realistic. We have assumed that the adversary has the control of server and the victim machine and can wiretap the

communication medium. In this experiment, both the server and the victim's machine are using Ubuntu Linux OS with kernel IMA (Integrity Measurement Architecture), SeaBIOS, TrouSerS API, TPM emulator, and OpenPTS to simulate the scenario.

4.1 Ability to Identify the Legitimate and Adversary Node

Authenticity property can be obtained in key discovery phase, where the hash value of the nodes are exchanged using public key encryption and these hash value are obtained by RTM using secure boot of TPM. Hash value obtained by TPM provides the collision resistant property, i.e., it guarantees the integrity of append only log and even if malicious software gains the control of the platform, it cannot erase its identity from the log without rebooting the platform and loosing control of the nodes.

If there is any change in the configuration of the platform, the measurements change and the hash value obtained by RTM also changes. The change in hash value will result in different keying material and the packets will be automatically discarded. This provides the authenticity of both initiator and responder. Thereby eliminates the use of third-party authentication or the use of OTP as the hash value provides their claimed identity.

4.2 Tamper-Resistant Ability of CBKDT

The hash values of the communicating entities $H(I)$ or $H(R)$ are stored in the PCRs using storage root key known only to the user and the measurements are taken with the environment and configuration of the platform taken into consideration. These environment and configuration are unique and generated with time. These measurements are specific to individuals and cannot be replicated or reproduced at any given instance or with any given platform. This provides the uniqueness in the key generated by CBKDT and also due to collision resistant property no malicious software can penetrate into the platform.

5 Conclusion

Entities involved in online transactions need to be intelligent enough and sustainable to its misuse. Online application are more vulnerable to attacks. There are methods to overcome these vulnerabilities by implementing security measures. The work in this paper proposes a methodology to distribute the keys securely over the network. Further, an algorithm is proposed, which proposes an authentication

mechanism which is sustainable to the misuse of OTP enabled authentication mechanism. The novel authentication technique uses an additional security hardware TPM at both the communicating ends to achieve the security requirements such as confidentiality, integrity, and authenticity. The proposed method provides a mechanism that may be used whenever there is a need to eliminate the involvement of trusted third party in any real-time transactions. The future work may address the need to incorporate multiple devices and mobility associated with it.

Acknowledgements The authors would like to thank the *Director* and the *Members of Review Committee*, *CAIR* for the permission to publish this work.

References

1. Tyner, K., 2014. *Literacy in a digital world: Teaching and learning in the age of information*. Routledge.
2. http://resources.infosecinstitute.com/the-top-five-cyber-security-vulnerabilities-in-terms-of-potential-for-catastrophic-damage/.
3. Seshadri, A., Perrig, A., Van Doorn, L. and Khosla, P., 2004, May. SWATT: Software-based attestation for embedded devices. In *Security and Privacy, 2004. Proceedings. 2004 IEEE Symposium on* (pp. 272–282). IEEE.
4. Seshadri, A., Luk, M., Shi, E., Perrig, A., van Doorn, L. and Khosla, P., 2005, October. Pioneer: verifying code integrity and enforcing untampered code execution on legacy systems. In *ACM SIGOPS Operating Systems Review* (Vol. 39, No. 5, pp. 1–16). ACM.
5. Kennell, R. and Jamieson, L.H., 2003, August. Establishing the Genuinity of Remote Computer Systems. In *USENIX security* (p. 21).
6. Redmore, S., Marconi Communications, Inc., 2005. *Hardware based security groups, firewall load sharing, and firewall redundancy*. U.S. Patent 6,901,517.
7. Beckmann, N. and Potkonjak, M., 2009, June. Hardware-based public-key cryptography with public physically unclonable functions. In *International Workshop on Information Hiding* (pp. 206–220). Springer Berlin Heidelberg.
8. Bajaj, S. and Sion, R., 2014. TrustedDB: A trusted hardware-based database with privacy and data confidentiality. *IEEE Transactions on Knowledge and Data Engineering*, *26*(3), pp. 752–765.
9. http://www.trustedcomputinggroup.org/work-groups/trusted-platform-module/.
10. https://www.wwpass.com/vulnerability-of-one-time-passwords-over-sms/.
11. Konoth, R.K., van der Veen, V. and Bos, H., 2016. How Anywhere Computing Just Killed Your Phone-Based Two-Factor Authentication. In *Proceedings of the 20th International Conference on Financial Cryptography and Data Security*.
12. Yoo, C., Kang, B.T. and Kim, H.K., 2015. *Case study of the vulnerability of OTP implemented in internet banking systems of South Korea. Multimedia Tools and Applications, 74(10), pp. 3289–3303.*
13. Casper, W.D. and Papa, S.M., 2011. Root of Trust. In *Encyclopedia of Cryptography and Security* (pp. 1057–1060). Springer US.
14. Springer Berlin Heidelberg. Parno, B., McCune, J.M. and Perrig, A., 2011. Bootstrapping Trust in Modern Computers. Springer Science & Business Media.

An Efficient Way to Find Frequent Patterns Using Graph Mining and Network Analysis Techniques on United States Airports Network

Anant Joshi, Abhay Bansal, A. Sai Sabitha and Tanupriya Choudhury

Abstract We are currently in the Information Age where massive amounts of data is being collected and analyzed to find interesting and frequent patterns. The need for mining data has been steadily increasing over the past few years. Graphs are one of the best studied data structures in the fields of mathematics and computer science. And due to this, in the recent years graph-based data mining has become quite popular. Graph data mining uses the graph nodes and the links between them to represent the entities, their relationships with other entities and their attributes and discovers interesting patterns in the graphs. Transportation networks are networks of routes from one location to another through various modes of travel. In this article, we use a transportation network of airports in United States of America and apply graph data mining techniques and network analysis techniques on US airports and flights datasets.

1 Introduction

Data mining is a process of computational work of finding patterns in huge data sets. It is often confused with Knowledge Discovery in Databases (KDD) but it is actually a crucial part of KDD. The ability to mine the data so as to extract the helpful knowledge is presently one of the most crucial and significant hurdles in scientific communities and governments. We have learned much from processing of

A. Joshi (✉) · A. Bansal · A. Sai Sabitha · T. Choudhury
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: anant.joshi@live.com

A. Bansal
e-mail: abansal1@amity.edu

A. Sai Sabitha
e-mail: assabitha@amity.edu

T. Choudhury
e-mail: tchoudhury@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_32

data which represents a set of separate, independent entities, and their relevant attributes, but we can still discover interesting knowledge from the relationships between such entities. There are many forms of such relational knowledge which range from recurring patterns of transactions to that of complicated structural patterns of interlinked transactions. The extraction of such knowledge requires that the data is represented in such a way that captures the relational knowledge and also supports effective and efficient data mining and thus helps the comprehensibility of the resulting knowledge [1]. Data mining encompasses many techniques such as classification, clustering [2, 3], etc.

Data in its graphical representation is fairly common in many practical fields. For example, chemical compounds, Internet information flow patterns, social networks, and citation networks. Graph data mining has already been applied to various domains such as link or citation analysis [4], chemical compound analysis [5], and Web searching [6]. This ubiquitousness of graphs provides us with the opportunity to extract novel information from them. One of the main reasons graphs are popular is because they are easy to visualize and comprehend. The comprehensiveness of graphs allows them to convey large, messy data in a simplistic format. The importance of the application of graph mining in fields of medical research and business analysis is immense. Graph mining is quickly broadening the scope of its application in many other fields such as social networks, big data analysis, and even cloud computing [7, 8]. This graph representation can also be used for transportation networks and in context of this paper; airport networks. Airport networks consist of airports as the vertices and the routes of airplanes as the edges. Mining airport data is useful in analysis of routes and city connections which can be used to improve quality of services provided by airlines on those routes as well as increase safety precautions. This also provides airport authorities information on routes that are the most important and help in flight delay management.

2 Theoretical Work

2.1 Types of Data Mining

2.1.1 Linked Data Mining

Most traditional data mining tasks find patterns in datasets which generally contain a group of instances of a single relation. Mining richly structured, heterogeneous data sets are a key challenge for data mining. The key similarities are that the data in the domain is made up of a large variety of objects and object types that can be connected in some way. The link between the objects, for example, may be a URL, or an operation between the tables of the database. A URL is a form of explicit link while an operation represents a constructed link.

Traditional inference procedures cannot be applied on these data sets by assuming they are independent. This can lead to false conclusions and incorrect results. The correlations due to links must be handled carefully to avoid such a situation. In fact, the link is information which can be utilized to progress the prediction accuracy of the learned models as, usually, there are correlations between the attributes of objects that are linked and such links commonly exist between objects that have some common factors [9].

2.1.2 Web Data Mining

Web mining is, simply, the utilization of data mining techniques on the World Wide Web (WWW) to discover pattern. It is comprised of Web content mining, Web structure mining, and Web usage mining. Web usage mining discovers usage patterns for Web-based applications. It collects the required information from the users such as identity, origin, browsing behavior, and any other relevant and useful information. It is mostly used in e-commerce Websites to suggest products that a user has searched for in the past and may buy it the future. This allows companies to target customers and increase profits [10]. Web content mining mines the content on Web pages to extract useful data and information. Web content mining can be further divided into Information Retrieval View and Database View. Web structure mining uses graph theory to analyze the links and connections of a Website. The structure of a Website is the relevant data and patterns in these links and connections are mined.

Web mining can be divided into the resource finding, information selection and preprocessing, generalization, analysis.

2.1.3 Graph Data Mining

The extraction of helpful and new information from the data graph representation is called graph data mining. Graphs are sets of nodes and edges which can be directed or undirected. While data can have many forms which may be simple or complex to varying degrees, graph data is used to represent the relationships crucial to the domain. The patterns that are often discovered from mining graph data are also in the form of graphs. Graph data mining is used to mine structured data and find the frequently appearing substructures present in such data. The most common use of graph data mining is its use in cheminformatics, bioinformatics, and social networking but it has also been used for citation analysis and in fields of privacy preservation [11] and cloud computing [7].

2.2 Graph Mining Approaches

2.2.1 Inductive Logic Programming (ILP)

Inductive Logic Programming is used to create predicate descriptions or hypotheses from background knowledge and examples. It is a subfield of machine learning and uses logic programming to obtain results. There have been some applications of ILP in data mining but it has been mainly used in mining data and databases related to chemical compounds. It has been used to find frequent substructures in such databases. For example, the ILP is used in the data mining algorithm WARMR. WARMR was built to mine structural chemical data and used to discover the frequently appearing substructures in a database of chemical compounds. The frequently appearing substructures were used to create prediction rules which related compound descriptions with carcinogenesis. These were fairly accurate rules and provided insight into the relationships present in the database. WARMR is a great data mining tool for analyzing chemical databases as it can accurately provide probabilistic prediction rules and provide knowledge about the relationships present in the database [12].

2.2.2 Incomplete Beam Search

The beam search algorithm expands the best or the most promising node of the graph first. It is a type of best-first search which is a search which orders partial solution according to some conditions and attempts to predict how close a partial solution is to a complete solution. Subdue is an IBS greedy relational learning system which discovers substructures which are both frequent and compress the dataset. It starts with a single vertex in the graph and then expands the best substructure present in the graph with a new edge. It then limits the number of most optimal substructures and then evaluates them on the bases of their ability to compress the input graph by using the minimum description length (MDL). It terminates after unique substructures are no longer discoverable. It is called an incomplete beam search because it limits the amount of best or most promising substructures [13].

2.2.3 Graph Theory Based Approaches

Apriori Algorithm

The Apriori algorithm operates on transactional databases to discover and identify frequently appearing items in item sets. It repeats this bigger item sets given that the items appear sufficiently often [14]. This algorithm is able to find association rules

which show the general trends present in the database [15]. In context of graph data mining, item sets can be considered graphs and items can be considered the nodes of the graph. There are two important factors which are can be controlled in the Apriori algorithm; the support threshold and confidence. The support is the number of occurrences of each individual item and the support threshold is the minimum number of occurrences of an item that should be in the set. The confidence is the how often the left side of the transaction implies the right side. To apply the Apriori algorithm to graphs, we first discover all the frequently appearing subgraphs of size K. Then we discover all candidates of size $k + 1$ edges by combining the candidates of size k edges. They must share a common subgraph of $k - 2$ edges.

Pattern Growth

This algorithm is also known as the FP-growth algorithm. The FP stands for frequent pattern. It uses the depth-first approach and grows a frequent subgraph recursively and finds frequent item sets. This algorithm uses an extended prefix-tree to store crucial information in compressed form. This tree is called the frequent pattern tree. It is both efficient and scalable and has been proven to be more effective than other algorithms at mining frequent patterns. The algorithm works by compressing the database into an FP-tree and then dividing the FP-tree into sets of conditional databases, one for each frequently appearing pattern. Then these divided databases and mined separately which reduces the cost of searching for smaller patterns repeatedly. They are also concatenated to form longer frequently appearing patterns [5].

2.3 Previous Research

A large amount of research work has been done of graph mining. Some of the research work done in the graph mining is shown in Table 1.

The bar charts shown above are extracted from Table 1 and show which fields of graph data mining that have been researched the most. Figure 1 shows that frequent pattern growth is considered the most efficient and effective method for mining graph data. It is followed closely by Apriori-based approaches which build on the original Apriori algorithm. Figure 2 shows popular applications of graph mining. Cheminformatics and Bioinformatics are two closely related fields which use graph mining on chemical compound databases to find frequent patterns. Social network analysis is a resurging field in which graph mining is used to find patterns in users of social networking Websites and the relationships between these users. These are among many others the most popular applications of graph mining techniques.

Table 1 Table of certain research work done in the field

Name	Year	Approach used	Application
Inokuchi et al. [14]	2000	Apriori-based approach	Artificial simulation and carcinogenesis data
Yan et al. [17]	2004	Graph indexing	Web analysis, bioinformatics
Yan and Han [5]	2002	Pattern growth	Cheminformatics
Wang et al. [18]	2005	Graph indexing	Disk-based graphs
Ketkar et al. [13]	2005	Approximation methods	Cheminformatics
Palmer et al. [19]	2002	Approximation methods	IMDB, Networking
Kuramochi and Karypis [20]	2004	Apriori-based approach	Cheminformatics
Huan et al. [21]	2004	pattern growth	Cheminformatics
Meinl et al. [22]	2004	Pattern growth	Bioinformatics, Cheminformatics
Williams et al. [23]	2015	Signal processing, complex network	Social interactions
Chen et al. [7]	2013	Cloud computing	Big data, cloud computing
Steinbauer and Kotsis [24]	2013	Cloud computing	Email
Nettleton [25]	2013	Apriori-based approach, pattern growth	Social networking
Pinheiro et al. [26]	2013	Pattern growth	Cheminformatics
Sidhu et al. [27]	2014	Pattern growth	Sociology/social networking
Livne et al. [4]	2013	Indexing	Citation analysis, networking
Jia et al. [28]	2011	Approximation methods	Cheminformatics
Akoglu and Faloutsos [29]	2013	N/A	Security
Hu [30]	2011	N/A	Bioinformatics
Patel and Pattewar [11]	2014	Apriori-based approach, pattern growth	Security
Xie et al. [31]	2009	Apriori-based approach	Social networking
Ranjan and Vaish [32]	2014	Apriori-based approach	Social networking
Gudes et al. [6]	2006	Apriori-based approach	Web analysis, XML data
Peng et al. [33]	2008	Pattern growth	Bioinformatics
Nawaz et al. [34]	2014	Pattern growth	Social networking

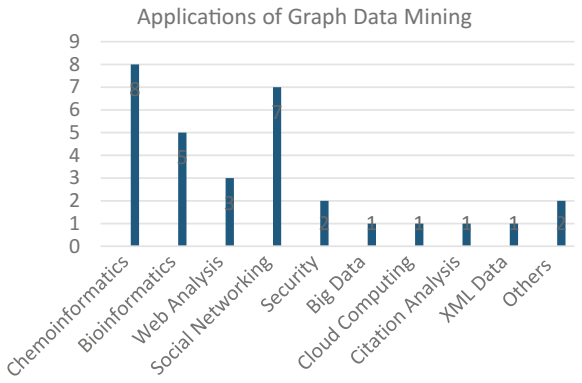


Fig. 1 Graph showing the most popular application of graph data mining

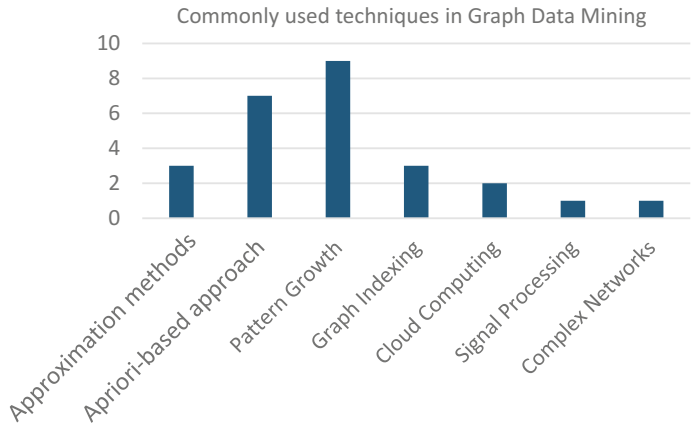


Fig. 2 Graph showing the most popular graph mining techniques

3 Methodology

The initial objective in a data analysis/mining project is the search for relevant data and collection of that data. The data was collected from the U.S. Bureau of Transportation Statistics Website. One of the dataset is a collection of on-time flights during January 2016. The data consists of a few attributes which have missing values. These attributes are removed from the dataset and missing values are removed. Then the data was processed using Rattle to find frequent item sets in the dataset. Rattle uses a modified form of the Apriori algorithm to find frequently appearing item sets and generate association rules for the dataset. These results are plotted onto a graph where the *x*-axis represents the items and the *y*-axis represents the relative frequency of items. Due to the direct correlation between a city and state (For example, Los Angeles and California), the most frequent item sets are states.

However, relevant statistics can be mined from the dataset by comparing the correct attributes (For example, ignoring states when processing cities and vice versa). Then we constructed a weighted graph of the *T*-100 Market All Carriers dataset. It was weighted on the basis of number of passengers on each route. Then network analysis techniques were used on this weighted network to find the betweenness, degree and closeness of airports. The *R* packages tnet and igraph were used to perform the network analysis.

4 Experimental Setup

4.1 Data Set

The dataset used is taken from the Website of United States Bureau of Transportation Statistics which is a part of the United States Department of Transportation and Research and Innovative Technology Administration. The dataset consists of around 440,000 instances of on-time flights during the month of January in 2016. There are about a 100 provided attributes which range from the date, origin city and state, destination city and state, market IDs, airport names, airport IDs to delay time, delay causes to diverted airport information attributes. The data set consists of 290 unique cities and 294 unique airports. We also use the BTS Master Coordinate database from January 2016 to May 2016 and the BTS Air Carrier Statistics T-100 Market All Carriers dataset for network analysis [16] (Fig. 3).

4.2 Attribute Selection

We only consider the attributes which represent the date, number of flights, distance, airport ID, origination city and state of flight and destination city and state of flight. We also used PASSENGERS attribute to create weighted network.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	YEAR	QUARTER	MONTH	DAY_OF_M	DAY_OF_W	ORIGIN_A	ORIGIN_A	ORIGIN	ORIGIN_C	ORIGIN_S	DEST_AIRF	DEST_AIRI	DEST	DEST_CITY	DEST_STA	FLIGHTS	DISTANCE
2	2016	1	1	1	5	11433	1143302	DTW	Detroit, M	Michigan	11298	1129804	DFW	Dallas/For	Texas	1	986
3	2016	1	1	1	5	14747	1474703	SEA	Seattle, W	Washingtc	12478	1247803	JFK	New York,	New York	1	2422
4	2016	1	1	1	5	12478	1247803	JFK	New York,	New York	14747	1474703	SEA	Seattle, W	Washingtc	1	2422
5	2016	1	1	1	5	14831	1483103	SJC	San Jose, C	California	13930	1393004	ORD	Chicago, Il	Illinois	1	1829
6	2016	1	1	1	5	13930	1393004	ORD	Chicago, Il	Illinois	14831	1483103	SJC	San Jose, C	California	1	1829
7	2016	1	1	1	5	14107	1410702	PHX	Phoenix, A	Arizona	11298	1129804	DFW	Dallas/For	Texas	1	868
8	2016	1	1	1	5	12892	1289203	LAX	Los Angele	California	11278	1127803	DCA	Washingtc	Virginia	1	2311
9	2016	1	1	1	5	13930	1393004	ORD	Chicago, Il	Illinois	15304	1530402	TPA	Tampa, FL	Florida	1	1012
10	2016	1	1	1	5	13204	1320402	MCO	Orlando, F	Florida	13930	1393004	ORD	Chicago, Il	Illinois	1	1005
11	2016	1	1	1	5	11292	1129202	DEN	Denver, CC	Colorado	13303	1330303	MIA	Miami, FL	Florida	1	1709
12	2016	1	1	1	5	13303	1330303	MIA	Miami, FL	Florida	11292	1129202	DEN	Denver, CC	Colorado	1	1709
13	2016	1	1	1	5	12758	1275803	KOA	Kona, HI	Hawaii	12892	1289203	LAX	Los Angele	California	1	2504
14	2016	1	1	1	5	12892	1289203	LAX	Los Angele	California	12758	1275803	KOA	Kona, HI	Hawaii	1	2504
15	2016	1	1	1	5	11298	1129804	DFW	Dallas/For	Texas	13303	1330303	MIA	Miami, FL	Florida	1	1121
16	2016	1	1	1	5	13303	1330303	MIA	Miami, FL	Florida	11298	1129804	DFW	Dallas/For	Texas	1	1121
17	2016	1	1	1	5	12266	1226603	IAH	Houston, T	Texas	13303	1330303	MIA	Miami, FL	Florida	1	964
18	2016	1	1	1	5	13303	1330303	MIA	Miami, FL	Florida	12266	1226603	IAH	Houston, T	Texas	1	964
19	2016	1	1	1	5	13303	1330303	MIA	Miami, FL	Florida	12478	1247803	JFK	New York,	New York	1	1089
20	2016	1	1	1	5	12478	1247803	JFK	New York,	New York	13303	1330303	MIA	Miami, FL	Florida	1	1089
21	2016	1	1	1	5	12892	1289203	LAX	Los Angele	California	13303	1330303	MIA	Miami, FL	Florida	1	2342
22	2016	1	1	1	5	13303	1330303	MIA	Miami, FL	Florida	12892	1289203	LAX	Los Angele	California	1	2342

Fig. 3 RITS/BTS Jan 2016 on-time flights dataset

No. of instances/rows—445,829
No. of attributes—17

4.3 Tools Used

R is programming language used for data analysis and statistical computing. RStudio is an integrated development environment (IDE) for the *R* programming language which allows the user to create and load *R* projects easily. The *R* programming language contains many packages which aid data mining and while they can be implemented directly, there is an option to use user-developed GUIs for ease of use. Rattle is an open-source graphical user interface (GUI) made in *R* for the purposes of data mining. The Rattle GUI allows the user to easily load a dataset and perform data analysis and mining as well as create models, evaluate, associate, cluster, and transform the data in many ways. We use Rattle to find frequent item sets and use *R* packages igraph and tnet to perform network analysis.

4.4 Measures

The dataset used contains all the on-time flights in January 2016. This, however, means that the support for each item set is quite low as the frequencies of the flights have less than 0.07 support. Thus the measure for support used is 0.0300 and the confidence used is 0.4000.

5 Result and Analysis

Case Study 1—Graph Mining using Apriori algorithm: Processing all the attributes concurrently, we get the following results from the frequent item plot. We can see that most frequently found item set is California as the origin and destination state. It followed closely by Texas and then Florida. To make the frequently appearing item clearer, we selected corresponding attributes in absence of all others. It is significant to note down that the graphs like the U.S. airport network are highly symmetric in nature.

Ignoring all the attributes except ORIGIN_STATE_NAME and DEST_STATE_NAME, we get the following graph. This graph clarifies that the most commonly found state during the month of January in 2016 was California.

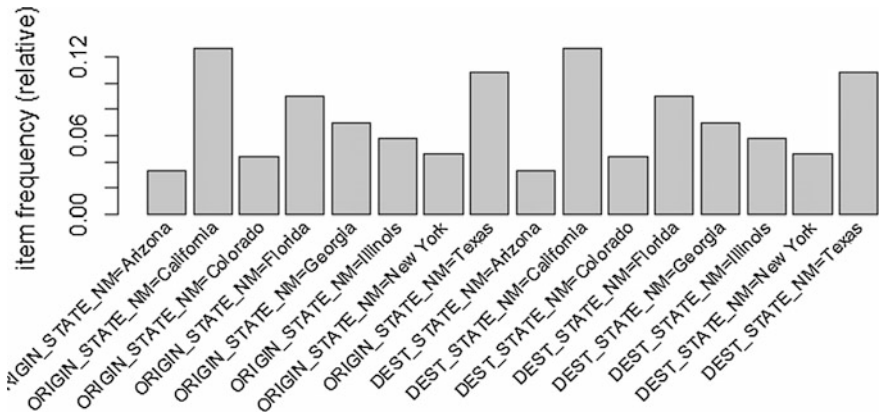


Fig. 4 Graph of the most frequently found states

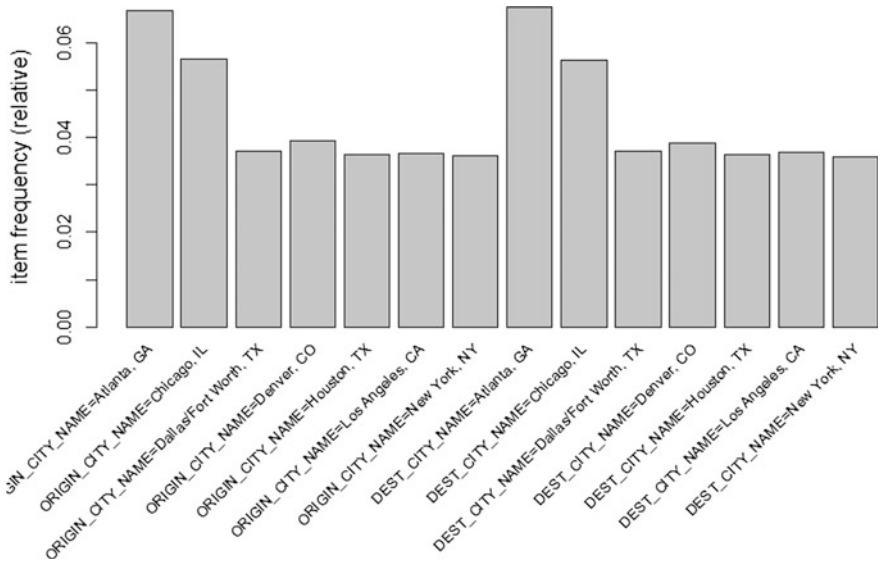


Fig. 5 Graph of most frequently found cities

It also gives us insight onto the most commonly found states during that time period. This can be attributed to a large number of interstate flights (Figs. 4, 5 and 6).

To calculate the most frequently appearing cities, we ignore all other attributes except ORIGIN_CITY_NAME and DEST_CITY_NAME. From the graph, we see that the most commonly found city is Atlanta. It is followed by Chicago and Denver. We see that even though California is the most commonly found state, neither of the three most commonly found cities are in California. Atlanta lies at the

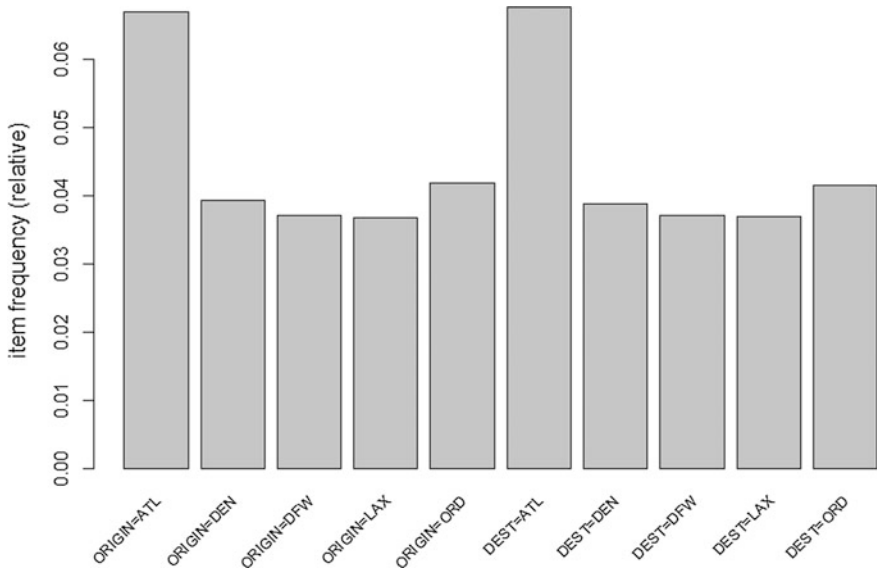


Fig. 6 Graph of most frequently found airports

heart of this network and thus is often found on cross-country routes such as those which go from the western coast to the eastern coast and vice versa.

Similarly, we can calculate the most frequently appearing airport by only selecting the ORIGIN and DEST attributes. From this graph, we can see that the most commonly found airport is Hartsfield–Jackson Atlanta International Airport in Atlanta, Georgia. It is then followed by O'Hare International Airport in Chicago, Illinois and the Dallas/Fort Worth International Airport and then the Los Angeles International Airport (Figs. 7, 8 and 9).

Case Study 2—Networking analysis of airport network: Using link analysis techniques, we also perform network analysis of the airport network. Using *R* tnet package, we can convert the dataset into an *R* network and calculate several important features.

We calculate the airports in the network with the highest closeness, betweenness and degree. These factors allow us to find the airports with the most contacts which are the node with the highest degree. We can see that the Hartsfield–Jackson Atlanta International Airport is the airport with the most contacts. This can be attributed to its central position in the U.S. airport network. The closeness score allows us to see which airports are the most easily accessible from other airports.

	Closeness Node	Closeness Score	Normalized Closeness Score
1	LAX (Los Angeles, CA)	8.039694e-07	6.877412e-10
2	ATL (Atlanta, GA)	8.039639e-07	6.877364e-10
3	ORD (Chicago, IL)	8.039590e-07	6.877323e-10
4	SFO (San Francisco, CA)	8.039564e-07	6.877300e-10
5	DEN (Denver, CO)	8.039545e-07	6.877284e-10
6	DFW (Dallas/Fort Worth, TX)	8.039536e-07	6.877277e-10
7	JFK (New York, NY)	8.039529e-07	6.877270e-10
8	SEA (Seattle, WA)	8.039521e-07	6.877264e-10
9	LAS (Las Vegas, NV)	8.039515e-07	6.877258e-10
10	PHX (Phoenix, AZ)	8.039480e-07	6.877228e-10
11	MCO (Orlando, FL)	8.039443e-07	6.877197e-10
12	LGA (New York, NY)	8.039433e-07	6.877188e-10
13	FLL (Fort Lauderdale, FL)	8.039389e-07	6.877151e-10
14	MIA (Miami, FL)	8.039384e-07	6.877147e-10
15	MSP (Minneapolis, MN)	8.039366e-07	6.877131e-10

Fig. 7 U.S. airports with the highest closeness

We can see that the LAX Airport has the highest closeness score and thus is, on average, closer to most airports. The betweenness score shows us which airport bridges the shortest path between the two airports. Binary analysis shows us that Ted Stevens Anchorage International Airport (ANC) is the airport with the highest betweenness but this does not take into account the weight along each route. Weighted analysis shows that the LAX airport has the highest betweenness and shows that for most routes LAX acts as an intermediary airport. It is followed closely by ATL and SEA airports.

	Degree Node	Degree Score	Degree Output
1	ATL (Atlanta, GA)	260	20416032
2	ORD (Chicago, IL)	253	14321432
3	DFW (Dallas/Fort Worth, TX)	231	12598092
4	LAX (Los Angeles, CA)	227	15088065
5	JFK (New York, NY)	222	11071372
6	IAH (Houston, TX)	213	8104021
7	MIA (Miami, FL)	209	8883988
8	EWR (Newark, NJ)	206	7690938
9	DEN (Denver, CO)	197	10856092
10	MSP (Minneapolis, MN)	193	7148817
11	LAS (Las Vegas, NV)	192	9154151
12	IAD (Washington, DC)	191	3841255
13	CLT (Charlotte, NC)	176	8798788
14	DTW (Detroit, MI)	176	6730900
15	PHL (Philadelphia, PA)	175	5797157

Fig. 8 U.S. airports with the highest degree

	Betweenness Node (Binary)	Betweenness Score (Binary)	Betweenness Node (Weighted)	Betweenness Score (Weighted)
1	ANC (Anchorage, AK)	387881.10	LAX (Los Angeles, CA)	741978
2	JFK (New York, NY)	108944.66	ATL (Atlanta, GA)	576193
3	SEA (Seattle, WA)	96426.40	SEA (Seattle, WA)	550996
4	FAI (Fairbanks, AK)	93878.29	ANC (Anchorage, AK)	418512
5	MSP (Minneapolis, MN)	93525.56	JFK (New York, NY)	185175
6	LAX (Los Angeles, CA)	90897.40	ORD (Chicago, IL)	144887
7	MIA (Miami, FL)	87814.64	MIA (Miami, FL)	140686
8	DEN (Denver, CO)	87800.65	DFW (Dallas/Fort Worth, TX)	131673
9	ORD (Chicago, IL)	87160.30	BOS (Boston, MA)	108614
10	ATL (Atlanta, GA)	87106.80	DEN (Denver, CO)	105470
11	HPN (White Plains, NY)	85336.36	BET (Bethel, AK)	93176
12	IAH (Houston, TX)	69354.69	FAI (Fairbanks, AK)	88339
13	DFW (Dallas/Fort Worth, TX)	60251.69	FLL (Fort Lauderdale, FL)	87978
14	BET (Bethel, AK)	60058.12	MSP (Minneapolis, MN)	84722
15	BOS (Boston, MA)	59242.94	HPN (White Plains, NY)	77518

Fig. 9 Binary and weighted analysis of betweenness in U.S. airport network

6 Conclusions

The results from mining the dataset of on-time flights during January, 2016 allow us to find out which airports were the busiest during that time and which cities and states were visited most frequently. We can see that the Hartsfield–Jackson Atlanta International Airport was the busiest airport. The most frequently traveled to city is also Atlanta, Georgia and the most frequently traveled state was California. The ATL airport also has the highest degree which means it is the most connected airport and thus it is important to ensure that it functions properly. This will also help in identifying which routes should avoid disruption the most. Routes with LAX as one of the nodes are examples of one such route. Flights are seasonal in nature and therefore change month to month, therefore it is important to determine which airports, cities, and states are frequently visited and when, to improve quality of service and safety on flights that take place on those routes. It is also crucial to figure out that the loss of which airport causes the most disconnections in the airport network in case of emergencies or attack.

References

1. Cook, D. J., & Holder, L. B. (Eds.). (2006). Mining graph data. John Wiley & Sons.
2. Sabitha, A. S., Mehrotra, D., & Bansal, A. (2012, May). Quality metrics a quanta for retrieving learning object by clustering techniques. In *Digital information and communication technology and it's applications (DICTAP), 2012 Second International Conference on* (pp. 428–433). IEEE.
3. Sabitha, A. S., Mehrotra, D., & Bansal, A. (2016). Delivery of learning knowledge objects using fuzzy clustering. *Education and Information Technologies*, *21*(5), 1329–1349.
4. Livne, A., Adar, E., Teevan, J., & Dumais, S. (2013, February). Predicting citation counts using text and graph mining. In *Proc. the iConference 2013 Workshop on Computational Scientometrics: Theory and Applications*.
5. Yan, X., & Han, J. (2002). gspan: Graph-based substructure pattern mining. In *Data Mining, 2002. ICDM 2003. Proceedings. 2002 IEEE International Conference on* (pp. 721–724). IEEE.
6. Gudes, E., Shimony, S. E., & Vanetik, N. (2006). Discovering frequent graph patterns using disjoint paths. *IEEE Transactions on Knowledge and Data Engineering*, *18*(11), 1441–1456.
7. Chen, C. C., Lee, K. W., Chang, C. C., Yang, D. N., & Chen, M. S. (2013, October). Efficient large graph pattern mining for big data in the cloud. In *Big Data, 2013 IEEE International Conference on* (pp. 531–536). IEEE
8. Tanupriya Choudhury, Vivek Kumar and Darshika Nigam, Cancer Research Through The Help of Soft Computing Techniques: A Survey, International Journal of Computer Science and Mobile Computing, IJCSMC, vol. 2, issue 4, pg. 467–477, April (2013)
9. Getoor, L. (2003). Link mining: a new data mining challenge. ACM SIGKDD Explorations Newsletter, 5(1), 84–89.
10. Srivastava, J., Cooley, R., Deshpande, M., & Tan, P. N. (2000). Web usage mining: Discovery and applications of usage patterns from web data. *Acm Sigkdd Explorations Newsletter*, *1*(2), 12–23.
11. Patel, S. J., & Pattewar, T. M. (2014, July). Software birthmark based theft detection of JavaScript programs using agglomerative clustering and Frequent Subgraph Mining. In *Embedded Systems (ICES), 2014 International Conference on* (pp. 63–68). IEEE.
12. King, R. D., Srinivasan, A., & Dehaspe, L. (2001). Warmr: a data mining tool for chemical data. *Journal of Computer-Aided Molecular Design*, *15*(2), 173–181.
13. Ketkar, N. S., Holder, L. B., & Cook, D. J. (2005, August). Subdue: Compression-based frequent pattern discovery in graph data. In *Proceedings of the 1st international workshop on open source data mining: frequent pattern mining implementations* (pp. 71–76). ACM.
14. Inokuchi, A., Washio, T., & Motoda, H. (2000, September). An apriori-based algorithm for mining frequent substructures from graph data. In *European Conference on Principles of Data Mining and Knowledge Discovery* (pp. 13–23). Springer Berlin Heidelberg.
15. Agrawal, R., & Srikant, R. (1994, September). Fast algorithms for mining association rules. In *Proc. 20th int. conf. very large data bases, VLDB* (Vol. 1215, pp. 487–499).
16. Bureau of Transportation Statistics database (n.d.) Retrieved from http://www.transtats.bts.gov/DataIndex.asp
17. Yan, X., Yu, P. S., & Han, J. (2004, June). Graph indexing: a frequent structure-based approach. In *Proceedings of the 2004 ACM SIGMOD international conference on Management of data* (pp. 335–346). ACM.
18. Wang, W., Wang, C., Zhu, Y., Shi, B., Pei, J., Yan, X., & Han, J. (2005, June). Graphminer: a structural pattern-mining system for large disk-based graph databases and its applications. In *Proceedings of the 2005 ACM SIGMOD international conference on Management of data* (pp. 879–881). ACM.
19. Palmer, C. R., Gibbons, P. B., & Faloutsos, C. (2002, July). ANF: A fast and scalable tool for data mining in massive graphs. In *Proceedings of the eighth ACM SIGKDD international conference on Knowledge discovery and data mining* (pp. 81–90). ACM.

20. Kuramochi, M., & Karypis, G. (2004). An efficient algorithm for discovering frequent subgraphs. *IEEE Transactions on Knowledge and Data Engineering*, *16*(9), 1038–1051.
21. Huan, J., Wang, W., Prins, J., & Yang, J. (2004, August). Spin: mining maximal frequent subgraphs from graph databases. In *Proceedings of the tenth ACM SIGKDD international conference on Knowledge discovery and data mining* (pp. 581–586). ACM.
22. Meinl, T., Borgelt, C., & Berthold, M. (2004). *Discriminative closed fragment mining and perfect extensions in MoFa* (pp. 3–14).
23. Williams, M., Burry, J., & Rao, A. (2015, March). Graph mining indoor tracking data for social interaction analysis. In *Pervasive Computing and Communication Workshops (PerCom Workshops), 2015 IEEE International Conference on* (pp. 2–7). IEEE.
24. Steinbauer, M., & Kotsis, G. (2013, June). Platform for General-Purpose Distributed Data-Mining on Large Dynamic Graphs. In *Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE), 2013 IEEE 22nd International Workshop on* (pp. 178–183). IEEE.
25. Nettleton, D. F. (2013). Data mining of social networks represented as graphs. *Computer Science Review*, *7*, 1–34.
26. Pinheiro, F., Kuo, M. H., Thomo, A., & Barnett, J. (2013, June). Extracting association rules from liver cancer data using the FP-growth algorithm. In *Computational Advances in Bio and Medical Sciences (ICCABS), 2013 IEEE 3rd International Conference on* (pp. 1–1). IEEE.
27. Sidhu, S., Meena, U. K., Nawani, A., Gupta, H., & Thakur, N. (2014). FP Growth Algorithm Implementation. *International Journal of Computer Applications*, *93*(8).
28. Jia, Y., Zhang, J., & Huan, J. (2011). An efficient graph-mining method for complicated and noisy data with real-world applications. *Knowledge and Information Systems*, *28*(2), 423–447.
29. Akoglu, L., & Faloutsos, C. (2013, February). Anomaly, event, and fraud detection in large network datasets. In *Proceedings of the sixth ACM international conference on Web search and data mining* (pp. 773–774). ACM.
30. Hu, X. (2011, November). Data mining and its applications in bioinformatics: Techniques and methods. In *Granular Computing (GrC), 2011 IEEE International Conference on* (pp. 3–3). IEEE.
31. Xie, B., Kumar, A., Ramaswamy, P., Yang, L. T., & Agrawal, S. (2009, July). Social behavior association and influence in social networks. In *Ubiquitous, Autonomic and Trusted Computing, 2009. UIC-ATC'09. Symposia and Workshops on* (pp. 434–439). IEEE.
32. Ranjan, P., & Vaish, A. (2014, November). Apriori Viterbi Model for Prior Detection of Socio-Technical Attacks in a Social Network. In *Engineering and Telecommunication (EnT), 2014 International Conference on* (pp. 97–101). IEEE.
33. Peng, J. Y., Yang, L. M., Wang, J. X., Liu, Z., & Li, M. (2008, May). An efficient algorithm for detecting closed frequent subgraphs in biological networks. In *2008 International Conference on Bio Medical Engineering and Informatics* (Vol. 1, pp. 677–681). IEEE.
34. Nawaz, W., Khan, K. U., & Lee, Y. K. (2014, December). Core analysis for efficient shortest path traversal queries in social graphs. In *Big Data and Cloud Computing (BdCloud), 2014 IEEE Fourth International Conference on* (pp. 363–370). IEEE.

Terrorist Attacks Analysis Using Clustering Algorithm

Pranjal Gupta, A. Sai Sabitha, Tanupriya Choudhury and Abhay Bansal

Abstract The factors that are affecting the world are terrorism, economy, political changes, pollution, etc. Out of which terrorism is one the biggest factor which is affecting the economy, society along with loss of precious human lives. In this paper, the data mining techniques are implemented to infer certain trends and pattern of terrorist attacks in India. *K*-means clustering is used to determine the year in which the terrorist groups were most active and also which terrorist group has affected the most. The experimental result is implemented in Rapidminer tool to determine the active group and the affected year.

1 Introduction

Data mining is the process of extracting important knowledge from the data. It has been used in many areas such as image processing, text processing, etc. Its application includes fraud detection, attacks data analysis, etc. It involves the other processes also such as data transformation, data integration, data reduction and data cleaning. It plays a crucial role in determining the new trends through the data. Data mining are being used in analyzing and finding unknown trends or patterns of attack. Clustering technique can be used to identify the group of targeted cities of regions that are affected most. It gives the information about the group who attacked in a particular region and also tells about their active years [1].

P. Gupta (✉) · A.S. Sabitha · T. Choudhury · A. Bansal
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: pranjal.gupta2194.pg@gmail.com

A.S. Sabitha
e-mail: assabitha@amity.edu

T. Choudhury
e-mail: tchoudhury@amity.edu

A. Bansal
e-mail: abansal1@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_33

We are aware of the various terrorist activities in the world, especially in India (Kashmir). In the research work, since the attack rate is comparatively higher in Kashmir which overshadows the attack on the different states. But there are different cities too which are affected by the terrorist attacks.

The objective is to identify the other cities in Kashmir which are also affected by the terrorists' attacks and to determine the pattern and reason of those attacks.

2 Literature Survey

Large number of research work has been done on the analysis of terrorist attacks and also how to prevent the attack in future by determining the certain pattern [2]. Some of them are given in Table 1.

2.1 Clustering Technique (K-Means)

Technique of clustering is worried with gathering the comparable items jointly in a bunch and gathering disparate items in an alternate cluster. Centroid is known as the focal point of the cluster which might be a cluster piece or a fanciful point. The calculation of clustering is utilized as a part of this investigation is "*K*-means algorithm". It divides the observations in multiple clusters depending upon the value of '*K*' where each data belongs to cluster with the closest similarity among them. The value of the *K* can be determined by using such methods: Silhouette method, Elbow method, Davies–Bouldin, etc. The execution of this algorithm to a great extent relies on upon the estimation of *K′*, it ought to be picked with the end goal that it mirrors a few attributes of the information set under evaluation [3].

Table 1 Literature survey

Name of the Author/Year	Technique used	Analysis
Bhavani Thuraisingham (2005)	*K*-means clustering	Discusses various types of terrorist threats
M. Alurily (2012)	Text mining	To identify crime patterns in Arabic language
Y. Elovici (2005)	User modeling, anomaly detection	Terror-related activities on web
Jeff Jonas (2011)	Predictive data mining	Effective counterterrorism
Gabriel Weimann (2004)	Data mining	Use of internet by modern terrorist
R. Katipally (2010)	Predictive analysis	Pattern of attackers
Raphael Obi Okonkwo (2011)	Data mining and clustering	Combating crime and terrorism

2.2 Cosine Similarity and Numerical Measures

Similarity is the measure of how similar two information items are. The esteem is higher when articles are all the more indistinguishable. It frequently falls in the scope of [0,1].

Procedure for calculating it is: "For each data 'i', let $a(i)$ is average dissimilarity of 'i' with all other data within the same cluster and $b(i)$ be the lowest average dissimilarity of 'i' to any cluster, of which 'i' is not a member" [4].

It is calculated as:

$$s(i) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}}$$

Algorithm applied after determining the value of the "k":

1. Choose the center of the first cluster randomly from the bulk whose value is equal to the value of the "k".
2. Ascribe the remaining other instances to the center of the cluster which is closest.
3. Update the center of every cluster by choosing the mean of the instances of the elements.
4. Ascribe all the instances, recalculate the centroid position of "k". If no more changes are needed to make for ascribing the elements of cluster, repeat Step 2 and 3 [5].

3 Experimental Setup

3.1 Data Collector/Metadata

The dataset was collected from the website www.kaggle.com. There were 29,534 rows initially consisting of countries India, Pakistan, England, etc. The analysis is done on the country INDIA which comprises of 1,823 rows. Further the data was reduced by taking the Deaths ≥ 3 (Table 2).

Table 2 Data information

Name of file	attacks_data.csv
Website name	www.kaggle.com/datasets
Total number of attributes	7 (Id, date, country, city, deaths, injuries, description)
Number of instances (initially)	29,534
Number of attributes consider	4
Attributes name	Date, city, deaths, description
Number of instances consider after cleaning	394
Number of excel sheets created	8

3.2 Data Set

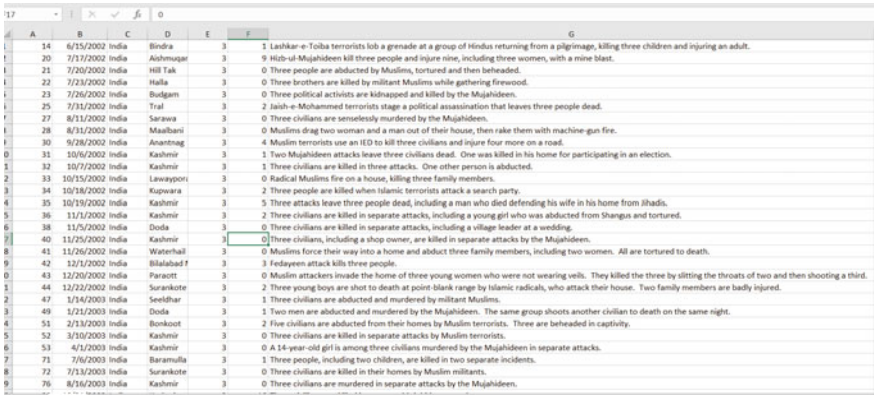
Figure 1 shows the complete data set where all countries are present. The data set was then reduced by choosing country = India where deaths ≥ 3 (Fig. 2).

3.3 Text Similarity

Figure 3 shows the similarity matrix between the objects. In order to create the matrix, the code has been written in PHP which will convert the data into a matrix form (Fig. 4).

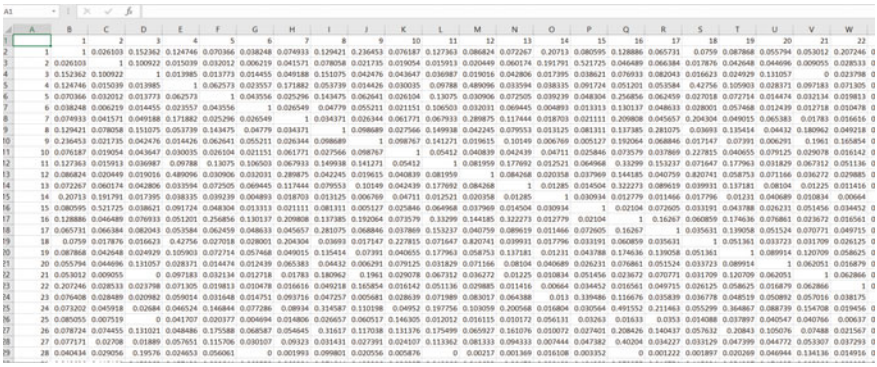
ID	Date	Country	City	Killed	Injured	Description
1	1/1/2002	Indonesia	Palu	1	0	Four bombs explode at Christian churches and one man dies in a hand grenade attack in Jakarta.
2	1/1/2002	India	Baramulla	1	0	Terrorists enter the home of a civilian and kill his wife.
3	1/1/2002	India	Poshkar	2	0	Two civilians are abducted from their homes then executed by the Mujahideen.
4	1/2/2002	India	Rajouri	6	9	Three separate terror attacks in the district leave a civilian and five security forces dead.
5	1/2/2002	India	Jehangir Cl	2	25	A Muslim militant kills two and injures twenty-five in a grenade attack on a city street.
6	1/3/2002	Pakistan	Karachi	1	0	A cleric is gunned down in a sectarian attack.
7	1/4/2002	India	Kashmir	2	0	Two civilians are abducted and killed by the Mujahideen in separate incidents (Badran and Kulgam).
8	1/5/2002	India	Mahore	2	3	An ambush on a security patrol leaves two members dead.
9	1/6/2002	India	Ramsu	3	12	Three brothers are killed in their home by Lashkar-e-Toiba terrorists. A dozen others are injured in the attack.
10	1/6/2002	India	Luddu	4	4	Four civilians, three of whom were in the same family are gunned down when fleeing their home after Jaish-e-Mohammed cadres flush them out with grenades.
11	1/6/2002	USA	Tampa, FL	0	0	Fifteen year-old flies plane into an office building in Tampa. Suicide note reveals his admiration for Osama Bin Laden and desire to commit a terrorist attack.
12	1/8/2002	India	Srinagar	1	2	Soldier killed by two Mujahideen suicide attackers.
13	1/9/2002	Israel	Kerem Sha	4	2	Palestinian terrorists infiltrate border and kill four soldiers. Two others were wounded.
14	1/9/2002	Pakistan	Gulshan-i-	1	0	Government official is killed by Islamists.
15	1/10/2002	India	Bafliaz	1	0	Terrorists kill a village official.
16	1/13/2002	India	Beerwah	1	0	A civilian is murdered by the Mujahideen.
17	1/14/2002	India	Kashmir	6	3	In separate attacks, three civilians are killed by Islamic militants. A security checkpoint is attacked as well, with three security forces killed.
18	1/15/2002	Israel	Givat Ze-e	1	1	Woman killed near gas station. Her aunt is injured in the shooting attack by Palestinians.
19	1/15/2002	Israel	Beit Jala	1	0	An American citizen is kidnapped then killed by Al-Aqsa Brigade.
20	1/15/2002	India	Keri	2	0	A man and his wife are abducted and killed by Lashkar-e-Toiba.
21	1/16/2002	Indonesia	Malei	1	0	A Christian man is gunned down by angry Muslims while collecting fruit.
22	1/16/2002	Pakistan	Lahore	0	5	Five guards are injured in an Islamist attack on the airport.
23	1/16/2002	Israel	Jenin	1	0	Arab killed in Jenin while sitting in a car bearing Israeli license plates.
24	1/17/2002	Israel	Hadera	6	35	Terrorist barges into a bat mitzvah reception and kills six guests with an assault rifle. Thirty-five others also shot.
25	1/17/2002	India	Kanak Mar	2	8	Two civilians are killed in a terrorist bombing. Eight others are injured.
26	1/18/2002	India	Budhan	0	2	Two children are injured when a Muslim throws a grenade into a house.
27	1/20/2002	India	Behra	11	3	Muslim terrorists invade a home and slaughter eight children, two women and one man in a bloody rampage.
28	1/22/2002	Israel	Jerusalem	2	40	Palestinian terrorist fires assault rifle into a bus-stop, killing two women and injuring forty others.

Fig. 1 Complete data set



14	6/15/2002	India	Bindra	3	1	Lashkar-e-Toiba terrorists lob a grenade at a group of Hindus returning from a pilgrimage, killing three children and injuring an adult.
20	7/17/2002	India	Aishmuqar	3	9	Hizb-ul-Mujahideen kill three people and injure nine, including three women, with a mine blast.
21	7/20/2002	India	Hill Tak	3	0	Three people are abducted by Muslims, tortured and then beheaded.
22	7/23/2002	India	Halla	3	0	Three brothers are killed by militant Muslims while gathering firewood.
23	7/26/2002	India	Budgam	3	0	Three political activists are kidnapped and killed by the Mujahideen.
25	7/31/2002	India	Tral	3	2	Jaish-e-Mohammed terrorists stage a political assassination that leaves three people dead.
27	8/11/2002	India	Sarawa	3	0	Three civilians are senselessly murdered by the Mujahideen.
28	8/31/2002	India	Maalbani	3	0	Muslims drag two woman and a man out of their house, then rake them with machine-gun fire.
30	9/28/2002	India	Anantnag	3	4	Muslim terrorists use an IED to kill three civilians and injure four more on a road.
31	10/6/2002	India	Kashmir	3	1	Two Mujahideen attacks leave three civilians dead. One was killed in his home for participating in an election.
32	10/7/2002	India	Kashmir	3	1	Three civilians are killed in three attacks. One other person is abducted.
33	10/15/2002	India	Lawaypori	3	0	Radical Muslims fire on a house, killing three family members.
34	10/18/2002	India	Kupwara	3	2	Three people are killed when Islamic terrorists attack a search party.
35	10/19/2002	India	Kashmir	3	5	Three attacks leave three people dead, including a man who died defending his wife in his home from Jihadis.
36	11/1/2002	India	Kashmir	3	2	Three civilians are killed in separate attacks, including a young girl who was abducted from Shangus and tortured.
38	11/5/2002	India	Doda	3	0	Three civilians are killed in separate attacks, including a village leader at a wedding.
40	11/25/2002	India	Kashmir	3	0	Three civilians, including a shop owner, are killed in separate attacks by the Mujahideen.
41	11/26/2002	India	Waterhail	3	0	Muslims force their way into a home and abduct three family members, including two women. All are tortured to death.
42	12/1/2002	India	Bilalabad F	3	3	Fedayeen attack kills three people.
43	12/20/2002	India	Paracott	3	0	Muslim attackers invade the home of three young women who were not wearing veils. They killed the three by slitting the throats of two and then shooting a third.
44	12/22/2002	India	Surankote	3	2	Three young boys are shot to death at point-blank range by Islamic radicals, who attack their house. Two family members are badly injured.
47	1/14/2003	India	Seeldhar	3	1	Three civilians are abducted and murdered by militant Muslims.
49	1/21/2003	India	Doda	3	1	Two men are abducted and murdered by the Mujahideen. The same group shoots another civilian to death on the same night.
51	2/13/2003	India	Bonkoot	3	2	Five civilians are abducted from their homes by Muslim terrorists. Three are beheaded in captivity.
52	3/10/2003	India	Kashmir	3	0	Three civilians are killed in separate attacks by Muslim terrorists.
53	4/1/2003	India	Kashmir	3	0	A 14-year-old girl is among three civilians murdered by the Mujahideen in separate attacks.
71	7/6/2003	India	Baramulla	3	1	Three people, including two children, are killed in two separate incidents.
72	7/13/2003	India	Surankote	3	0	Three civilians are killed in their homes by Muslim militants.
76	8/16/2003	India	Kashmir	3	0	Three civilians are murdered in separate attacks by the Mujahideen.

Fig. 2 Filtered data set



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2	1	1	0.026103	0.152362	0.124746	0.070366	0.038248	0.074933	0.129421	0.236453	0.076187	0.127363	0.086824	0.072267	0.20713	0.080595	0.128886	0.065731	0.0759	0.087868	0.055794	0.053012	0.207246
3	2	0.026103	1	0.100922	0.015039	0.032012	0.006219	0.041571	0.078058	0.021735	0.019054	0.015913	0.020449	0.060174	0.191791	0.521725	0.046489	0.066384	0.017876	0.042648	0.044696	0.009055	0.028533
4	3	0.152362	0.100922	1	0.013985	0.013773	0.014455	0.049188	0.151075	0.042476	0.043647	0.036987	0.019016	0.042806	0.017395	0.038621	0.076933	0.082043	0.016623	0.024929	0.133057	0	0.023798
5	4	0.124746	0.015039	0.013985	1	0.062573	0.023557	0.171882	0.053739	0.014426	0.030035	0.09788	0.489096	0.033594	0.038335	0.091724	0.051201	0.053584	0.42756	0.105903	0.028371	0.097183	0.071305
6	5	0.070366	0.032012	0.013773	0.062573	1	0.043556	0.025296	0.143475	0.062641	0.026104	0.13075	0.030906	0.072505	0.039239	0.048304	0.256856	0.062459	0.027018	0.072714	0.014474	0.032134	0.019813
7	6	0.038248	0.006219	0.014455	0.023557	0.043556	1	0.026549	0.04779	0.055211	0.021151	0.106503	0.032031	0.069445	0.004893	0.013313	0.130137	0.048633	0.028001	0.057468	0.012439	0.012718	0.010478
8	7	0.074933	0.041571	0.049188	0.171882	0.025296	0.026549	1	0.034371	0.026344	0.061771	0.067933	0.289875	0.117444	0.018703	0.021111	0.209808	0.045657	0.204304	0.049015	0.065383	0.01783	0.016616
9	8	0.129421	0.078058	0.151075	0.053739	0.143475	0.04779	0.034371	1	0.098689	0.027566	0.149938	0.042245	0.079553	0.013125	0.081311	0.137385	0.281075	0.03693	0.135414	0.04432	0.180962	0.049218
10	9	0.236453	0.021735	0.042476	0.014426	0.062641	0.055211	0.026344	0.098689	1	0.098767	0.141271	0.019615	0.10149	0.006769	0.005127	0.192064	0.068846	0.017147	0.07391	0.006291	0.1961	0.165854
11	10	0.076187	0.019054	0.043647	0.030035	0.026104	0.021151	0.061771	0.027566	0.098767	1	0.05412	0.040839	0.042439	0.04711	0.025846	0.073579	0.037869	0.227815	0.040655	0.079125	0.029078	0.016142
12	11	0.127363	0.015913	0.036987	0.09788	0.13075	0.106503	0.067933	0.149938	0.141271	0.05412	1	0.081959	0.177692	0.012521	0.064968	0.33299	0.153237	0.071647	0.177963	0.031829	0.067312	0.051136
13	12	0.086824	0.020449	0.019016	0.489096	0.030906	0.032031	0.289875	0.042245	0.019615	0.040839	0.081959	1	0.084268	0.020358	0.037969	0.144185	0.040759	0.820741	0.058753	0.071166	0.036272	0.029885
14	13	0.072267	0.060174	0.042806	0.033594	0.072505	0.069445	0.117444	0.079553	0.10149	0.042439	0.177692	0.084268	1	0.01285	0.014504	0.322273	0.089619	0.039931	0.137181	0.08104	0.01225	0.031416
15	14	0.20713	0.191791	0.017395	0.038335	0.039239	0.004893	0.018703	0.013125	0.006769	0.04711	0.012521	0.020358	0.01285	1	0.030934	0.012779	0.011466	0.017796	0.01231	0.040689	0.010834	0.00664
16	15	0.080595	0.521725	0.038621	0.091724	0.048304	0.013313	0.021111	0.081311	0.005127	0.025846	0.064968	0.037969	0.014504	0.030934	1	0.02104	0.072605	0.033191	0.043788	0.026231	0.051456	0.034452
17	16	0.128886	0.046489	0.076933	0.051201	0.256856	0.130137	0.209808	0.137385	0.192064	0.073579	0.33299	0.144185	0.322273	0.012779	0.02104	1	0.16267	0.060859	0.174636	0.076861	0.023672	0.016561
18	17	0.065731	0.066384	0.082043	0.053584	0.062459	0.048633	0.045657	0.281075	0.068846	0.037869	0.153237	0.040759	0.089619	0.011466	0.072605	0.16267	1	0.035631	0.139058	0.051524	0.070771	0.049715
19	18	0.0759	0.017876	0.016623	0.42756	0.027018	0.028001	0.204304	0.03693	0.017147	0.227815	0.071647	0.820741	0.039931	0.017796	0.033191	0.060859	0.035631	1	0.051361	0.033723	0.031709	0.026125
20	19	0.087868	0.042648	0.024929	0.105903	0.072714	0.057468	0.049015	0.135414	0.07391	0.040655	0.177963	0.058753	0.137181	0.01231	0.043788	0.174636	0.139058	0.051361	1	0.089914	0.120709	0.058625
21	20	0.055794	0.044696	0.133057	0.028371	0.014474	0.012439	0.065383	0.04432	0.006291	0.079125	0.031829	0.071166	0.08104	0.040689	0.026231	0.076861	0.051524	0.033723	0.089914	1	0.062051	0.016879
22	21	0.053012	0.009055	0	0.097183	0.032134	0.012718	0.01783	0.180962	0.1961	0.029078	0.067312	0.036272	0.01225	0.010834	0.051456	0.023672	0.070771	0.031709	0.120709	0.062051	1	0.062866
23	22	0.207246	0.028533	0.023798	0.071305	0.019813	0.010478	0.016616	0.049218	0.165854	0.016142	0.051136	0.029885	0.031416	0.00664	0.034452	0.016561	0.049715	0.026125	0.058625	0.016879	0.062866	1
24	23	0.076408	0.028489	0.020982	0.059014	0.031648	0.014751	0.093716	0.047257	0.005681	0.028639	0.071989	0.083017	0.064388	0.013	0.339486	0.116676	0.035839	0.036778	0.048519	0.050892	0.057016	0.038175
25	24	0.073202	0.045918	0.02684	0.046524	0.146844	0.077286	0.08934	0.314587	0.110198	0.04952	0.197756	0.103059	0.200568	0.016804	0.030564	0.491552	0.211463	0.055299	0.364867	0.088739	0.154708	0.019456
26	25	0.085055	0.007519	0	0.041707	0.020377	0.004694	0.014806	0.026657	0.060517	0.144305	0.012012	0.016115	0.010172	0.056131	0.03263	0.01633	0.0353	0.014088	0.037897	0.040547	0.040766	0.00637
27	26	0.078724	0.074455	0.131021	0.048486	0.175588	0.068587	0.054645	0.31617	0.117038	0.131376	0.175499	0.065927	0.161076	0.010072	0.027401	0.208426	0.140437	0.057632	0.20843	0.105076	0.07488	0.021567
28	27	0.077171	0.02708	0.01889	0.057651	0.115706	0.030107	0.09323	0.031431	0.027391	0.024107	0.113362	0.081333	0.094333	0.007444	0.047382	0.40204	0.034227	0.033129	0.047399	0.044772	0.053307	0.037293
29	28	0.040434	0.029056	0.19576	0.024653	0.056061	0	0.001993	0.099801	0.020556	0.005876	0	0.00217	0.001369	0.016108	0.003352	0	0.001222	0.001897	0.020269	0.046944	0.134136	0.014916

Fig. 3 Similarity matrix

```php
<?php

ini_set('memory_limit', '512M');

define("INPUT_FILE", "lessthan3similarity.csv");
define("OUTPUT_FILE", "output_03.csv");

$similarities2D = [];

$handleRead = fopen(INPUT_FILE, "r");
if ($handleRead) {
    while (($line = fgets($handleRead)) !== false) {
        list($compareA, $compareB, $similarity) = explode(",", $line);
        $similarity = trim($similarity);
        $similarities2D[$compareA][$compareB] = $similarity;
    }

    fclose($handleRead);
} else {
    die("Couldn't open the file");
}

$handleWrite = fopen(OUTPUT_FILE, 'a');
if ($handleWrite) {
    for ($i = 1; $i < count($similarities2D); $i++) {
        $similarities2D[$i][$i] = 1;
        $line = "";

        for ($j = 1; $j <= count($similarities2D[$i]); $j++) {
            if (!isset($similarities2D[$i][$j])) $similarities2D[$i][$j] = $similarities2D[$j][$i];
            $line .= $similarities2D[$i][$j] . ",";
        }

        fwrite($handleWrite, trim($line, ",") . "\n");
    }
} else {
    die("Couldn't open the file");
}
```

Fig. 4 Sample code

3.4 Model Construction for Clustering

Step 1. RapidMiner tool was used for determining the analysis. Refer Fig. 5 to see the arrangements in tool.

First operator "Read Excel" is use to take the.xlsx file comprises of information which is need to be analyzed. "Clustering" operator which applies the *K*-means algorithm in order to generate the cluster, takes the.xlsx file as an input from the "Read Excel" operator. Value of "*k*" determines the operator's number [6].

Step 2: Determining *K*

The chosen value of "*K*" was determined by using Davies–Bouldin index measure. Certain values of "*K*" were taken such as 3, 4, 5, 6, 7, 8, 9, 10, 11. The value of "*K*" = 8 has the minimum Davies–Bouldin index (minimum is considered best). Refer Table 3.

Step 3

Cluster Model

```
Cluster 0: 30 items
Cluster 1: 16 items
Cluster 2: 1 items
Cluster 3: 4 items
Cluster 4: 209 items
Cluster 5: 74 items
Cluster 6: 59 items
Cluster 7: 1 items
Total number of items: 394
```

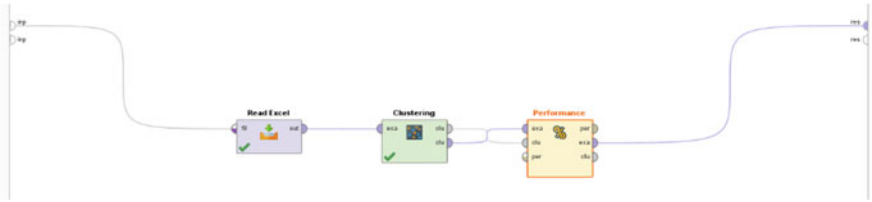


Fig. 5 Arrangements of operator

Table 3 Davies Bouldin index information

K	3	4	5	6	7	8	9	10	11
Davies Bouldin index	−0.627	−0.700	−0.786	−1.477	−1.477	−1.725	−1.543	−1.543	−1.544

Nominal values

Index	Nominal value	Absolute count	Fraction
1	Srinagar	30	0.144
2	Kashmir	18	0.087
3	Jammu	9	0.043
4	Baramulla	5	0.024
5	Mumbai	5	0.024
6	Pulwama	5	0.024
7	Rajouri	5	0.024
8	Kupwara	4	0.019
9	Poonch	4	0.019
10	Bandipore	3	0.014
11	Doda	3	0.014
12	Handwara	3	0.014
13	Hyderabad	3	0.014
14	New Delhi	3	0.014
15	Pattan	3	0.014
16	Thanna Mandi	3	0.014
17	Udhampur	3	0.014
18	Ahmedabad	2	0.010

Fig. 6 Attack count

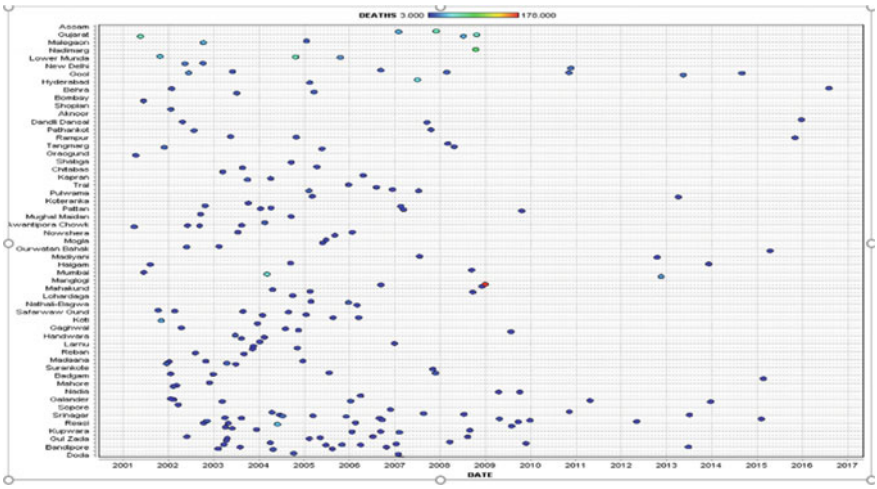


Fig. 7 Scatter pattern of cluster 4

4 Results and Analysis

Table 4 in the Appendix 1 shows the information about each cluster. ACTIVE YEAR tells us about the most active time of the terrorist. ACTIVE GROUP signifies the group which was active at that time. TOTAL CASUALTIES show the number of casualties done in the year. MAJOR CITIES depict the cities which are targeted most number of times in the active year. DESCRIPTION tells about the people and region affected the most. PATTERN tells the trend of attacks done by the terrorist. Figure 6 shows the example of cluster 4 to determine the number of times the particular city has been targeted in the cluster. Figure 7 shows the scatter pattern of deaths with respect to city and the year in the cluster 4

5 Case Study

5.1 Performance of Each Cluster

The working of each cluster has been shown in figure in Appendix 2. The figure tells about the city with the respective cluster, where colored bubbles signify the Year in which the attack took place. Active Year of each cluster is given in the Table 4 of Appendix 1. Cluster 2, 3, 7 show the less activity of terrorist group while the cluster 4 and cluster 6 give the large amount of result where terrorists activities are the most. It signifies the frequency of attacks in the particular cities along with the year in which the attack took place.

5.2 Targeted Cities in Kashmir

The map of Kashmir is shown in figure in Appendix 3. The figure shows the most affected cities/villages of Kashmir. The black arrow is used to point the most targeted cities of Kashmir by the terrorists. Black cracking line on the left side of the map signifies the India–Pakistan border in Kashmir. One can easily determine that the terrorists attacked the cities which are nearer to the border. It also becomes easy to determine the trend of attack in Kashmir. The eastern of Kashmir is affected most number of times because of the Pakistan border, as it is easy for the terrorists to enter from that region and cause the damage.

6 Conclusion

This research paper provides the simple clustering techniques to understand the cities of India affected by the terrorist attacks. Data mining technique served as a good standard to determine the pattern of attacks done by the terrorists in India.

The analysis tells us about the particular regions in Kashmir (Udhampur, Doda, Baramulla) which are affected the most. Since the Udhampur has the Northern Command Headquarter of Indian Army, it is easy to identify the attack in that region.

Baramulla is one of the most populous towns in Jammu Kashmir which makes the terrorists to attack that region for the mass number of lives loss. There are certain major cities of India which are targeted by the terrorist group. For example, Mumbai, New Delhi, Jaipur, Gujarat, etc. A pattern has been recognized that the eastern coast cities of India are largely targeted by the terrorists as they have found the way to enter in the country through the Arabian Sea. While New Delhi, being the capital of India, has been targeted by the terrorists.

Appendix 1

See Table 4.

Table 4 Information about each cluster

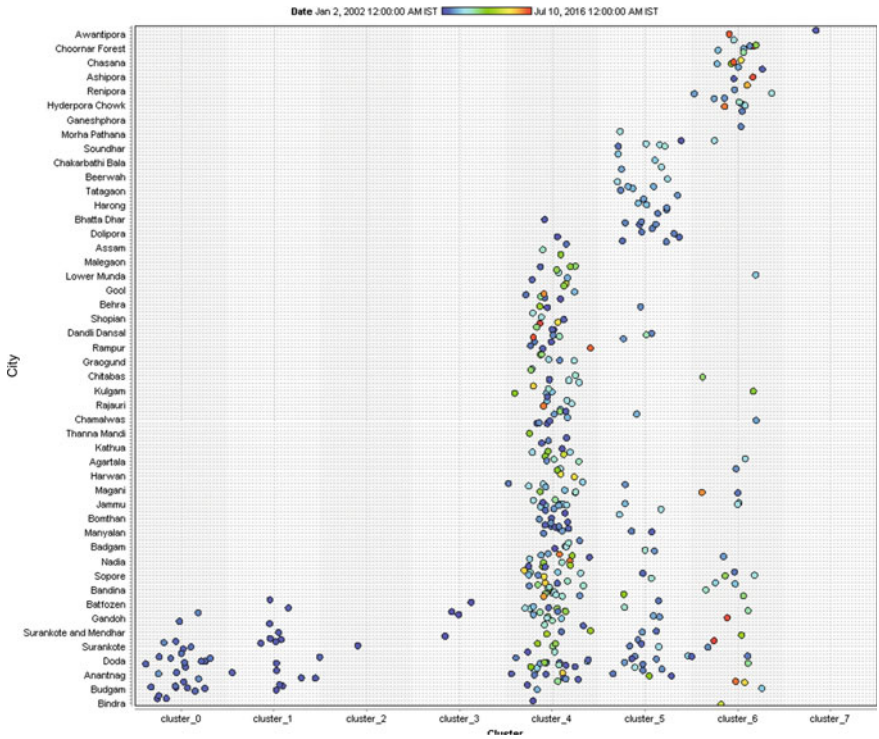
Cluster	Year	Active year	Active group	Total casualties	Major cities/casualties	Description	Pattern
0	2002–2003	Sep–Nov (2002)	Hizb-ul-Mujahideen	90	Kashmir (27), Doda (6)	Women's, Children and Families are targeted	Repeated interval of attack in the cities mentioned
1	2002	June–July (2002)	Hizb-ul-Mujahideen, Fedayeen	48	Kashmir (24), Bonkoot (3)-bandi	Police Station, Officers, Teachers	Injuries here are very leu as compare to other clusters
2	2002	Feb 2002	–	3	Kashmir (3)	–	Out layer because text has cities/villages data in it
3	2002	Jan–Feb (2002)t	Islamic Militants	12	Ramau (3), Reasi (3), Batfozen (3), Parori (3), Gujaran (3)	Injuries are more	Cities/villages nearby Pakistan border are targeted here
4	2002–2016	2003–2009	Lashkar-e-Toiba, Harkat-ul-Jehadi, Hizb-ul-Mujahideen	2068	Srinagar (216), Jammu (85), Baramulla (23), Mumbai (264), Pulwama (51), Rajouri (26), Hyderabad (70), New Delhi (107), Pattan (17), Thanna Mandi (20), Udhampur (21), Ahmedabad (88)	Large number of casualties has bees done here in the major cities	Major Northern and Western cities are targeted here by the terrorists
5	2002–2009	2003–2006	Hizb-ul-Mujahideen	239	Kashmir (55), Srinagar (15), Udhampur (11), Bandipore (6)	Family living in cities nearby Pakistan-Kashmir	Increasing correlation

(continued)

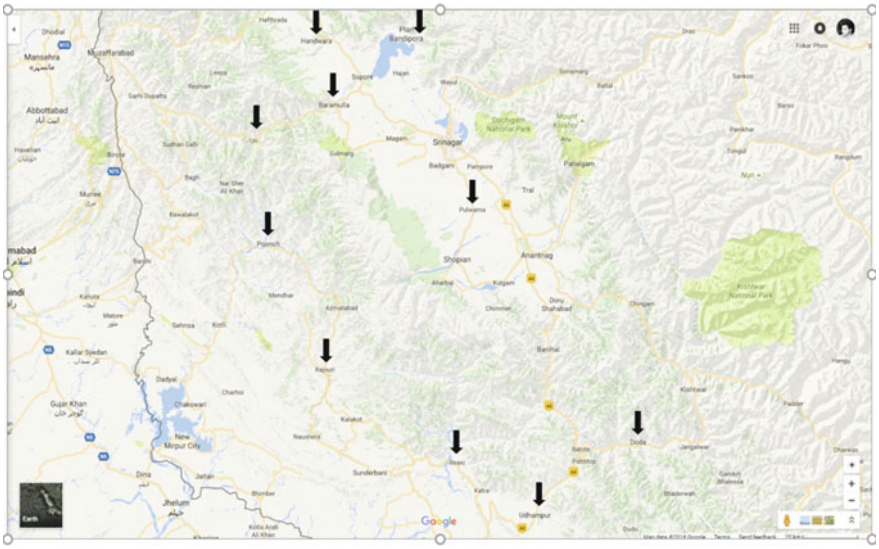
Table 4 (continued)

Cluster	Year	Active year	Active group	Total casualties	Major cities/casualties	Description	Pattern
						border are targeted	
6	2002–2016	2003–2006	Hizb-ul-Muj-ahideen, Lashkar-e-Toiba, Fedayeen	202	Srinagar (25), Kashmir (9), Udhampur (6)	Policeman and BSF are targeted here more	Cities/Villages nearby Pakistan border are targeted here
7	2002	June 2002	Not clear	3	Basuni (3)	–	Kidnapping has been done

Appendix 2


Date Jan 2, 2002 12:00:00 AM IST
Jul 10, 2016 12:00:00 AM IST
City
Awantipora
Choornar Forest
Chasana
Ashipora
Renipora
Hyderpora Chowk
Ganeshphora
Morha Pathana
Soundhar
Chakarbathi Bala
Beerwah
Tatagaon
Harong
Bhatta Dhar
Dolipora
Assam
Malegaon
Lower Munda
Gool
Behra
Shopian
Dandli Dansal
Rampur
Graogund
Chitabas
Kulgam
Rajauri
Chamalwas
Thanna Mandi
Kathua
Agartala
Harwan
Magani
Jammu
Bomthan
Manyalan
Badgam
Nadia
Sopore
Bandina
Batfozen
Gandoh
Surankote and Mendhar
Surankote
Doda
Anantnag
Budgam
Bindra
cluster_0
cluster_1
cluster_2
cluster_3
cluster_4
cluster_5
cluster_6
cluster_7

Appendix 3



References

1. http://www.tutorialspoint.com/data_mining/
2. Stump, J. L., & Dixit, P. (2013). *Critical terrorism studies: an introduction to research methods*. Routledge.
3. Spencer, A. (2010). *The tabloid terrorist: The predicative construction of new terrorism in the media*. Springer.
4. Borooah, Vani K. "Terrorist Incidents in India, 1998–2004: A Quantitative Analysis of Fatality Rates." *Terrorism and Political Violence* 21.3 (2009): 476–498.
5. Heath-Kelly, C. (2013). Counter-terrorism and the counterfactual: Producing the 'radicalisation' discourse and the UK PREVENT strategy. *The British journal of politics and international relations*, *15*(3), 394–415.
6. Young, J. K., & Findley, M. G. (2011). Promise and pitfalls of terrorism research. *International Studies Review*, *13*(3), 411–431.

A Review on VANET Routing Protocols and Wireless Standards

Gagan Deep Singh, Ravi Tomar, Hanumat G. Sastry and Manish Prateek

Abstract The vehicular ad hoc network (VANET) is an ad hoc network system based on the concept of mobile ad hoc network (MANET) in which nodes (vehicle) that are being connected with each other by wireless technologies. But due to the non deterministic mobility behavior and high velocity of automobiles, the topology is unpredictable. Such types of system can work independently and can also be interconnected through internet with in its infrastructure. The system characteristics such as multi-hop paths, node mobility, huge network, device heterogeneity, congestion and bandwidth are the constraints in designing the routing protocols for VANET. The present routing protocols that have been deployed for MANET are used to test the VANET accuracy and performance. Present research efforts are strongly emphasized on designing a novel routing algorithm and its implementations. Recent VANET research are majorly focused on predefined areas such as broadcasting and routing, security, quality of service (QoS) and infotainment with information dissemination during emergencies. In this paper authors present a detailed review of wireless standards used in VANET with a number of trials in VANET and its deployment in many of the developed countries. As a conclusion we conceptualized some of the issues and research challenges in VANET that had not yet addressed so that industry can opt for widespread adoption of scalable, reliable, secure and robust VANET protocols, architectures services and technologies and enable the ubiquitous deployment of it.

G.D. Singh (✉) · R. Tomar · H.G. Sastry · M. Prateek
Centre for Information Technology, University of Petroleum & Energy Studies, Dehradun, Uttarakhand, India
e-mail: gagan@ddn.upes.ac.in

R. Tomar
e-mail: rtomar@ddn.upes.ac.in

H.G. Sastry
e-mail: hsastry@ddn.upes.ac.in

M. Prateek
e-mail: mprateek@ddn.upes.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_34

1 Introduction

The researchers have observed various challenges and issues in vehicle to vehicle (V2V) along with vehicle-to-infrastructure (V2I) regions due to its critical functionality that need to be deployed in Traffimatics and intelligent transportation system (ITS). Several projects for VANET testing and implementation have been executed by numerous automobile sector, government consortiums and research institutions in past few years.

As wireless mobile nodes and its networks have become essential, the need for V2V and V2I will continue to raise [1]. VANET can be best utilized for safety and non-safety applications, it can also be implemented in areas of the services like navigation payment at automated toll, security, infotainment, and location-based services such as finding nearest hospital, fuel station, bank, restaurant and hotel.

The complete chapter is structured to get the detailed review of standards and protocols. We propose an overview of VANET in Sect. 2, various routing protocols for VANET in Sect. 3. We present some of the recent wireless standards adopted by organizations and groups of developed countries in Sect. 4. And a final conclusion is presented in Sect. 5.

2 VANET an Overview

2.1 Traffimatics

Traffimatics is a new concept of intelligent transportation systems where every vehicle acts as a node in a network. These nodes are responsible for sending, receiving and routing [2] to broadcast data packets in VANET. ITS is responsible for the secure and safe movement of vehicles on the road. In ITS, Vehicles are installed with radio devices and onboard units (OBU). These devices enable ad hoc network that create short range wireless, so that they can communicate between nodes and road side units (RSUs) [3]. Vehicle also needs to be equipped with devices that allow them to get details of their geographical position using global positioning system (GPS) and receiver of differential global positioning system (DGPS). Here, RSUs will act as a VANET backbone and have to be at a location to facilitate communication. Cellular BTS can also be utilized as RSUs. The total number of RSUs and its installation will depend on the communication protocol that has been deployed. These include inter-vehicle, vehicle-to-road side, and routing-based communications. These types of communication will rely on correct and accurate information of the nearby area that also requires the use of accurate location of the nodes and better communication protocols for dissemination of information [4]. The V2V communication is based on technologies like Bluetooth—IEEE 802.15.1, Ultra-wide Band —IEEE 802.15.3 and Zigbee—IEEE 802.15.4 in ITS. These technologies are used for the implementation of communication within a vehicle in wireless scenarios.

2.2 Inter-vehicle Communication

V2V communication will use multi-hop, multicast/broadcast to send and receive data over multiple hops to a cluster of receipting nodes. Every vehicle in VANET can be considered as a node for multicast/broadcast transmission. In ITS, vehicles are dealt with the activities during emergency. This can be message dissemination for an imminent collision, information broad cast for rescheduling the dynamic route. Inter-vehicle communications supports two types of message forwarding. The first is native broadcasting and the other is intelligent broadcasting. In native broadcasting, there is a risk of message collision which can result in poor rate of message delivery and increase in the rate of time for message delivery. In this, vehicles periodically send the broadcast messages and at regular intervals that generate large numbers of broadcast messages hence, message collision risk is higher [5]. In intelligent broadcasting, a node responds only for the primary message when it starts receiving a message simultaneously from several sources.

2.3 Vehicle-to-Road Side Communication

Vehicle-to-Road side communication enables a robust linkage among nodes and RSUs through high bandwidth. These RSUs can be placed at every kilometer or may be less that can enable frequent transmission of data which need to be balanced during high traffic conditions. The vehicle-to-road side communication configuration is represented by a linear broadcast in which all RSUs such as cellular BTS can broadcast information to all vehicles installed with OBUs that are running on road and highways. In such scenarios when a vehicle crosses its specified preferred velocity, then intimation is alarmed as a visual animation signal or an auditory alert, that can inform the driver to minimize his/her speed as per the regulations.

2.4 Routing-Based Communication

Routing-based communication broadcasts a message in a multiple-hopped way to transmit its desired data at the vehicle. It is a multi-hop unicast routing-based communications. When desired information is received by the vehicle, then its application immediately broadcast a unicast message along with detailed information of the node. It broadcast message on when it receives the request for the broadcast. Then, message is forwarded at the source of the query.

Table 1 Routing issues in VANET

Issues in topology-based routing	Issues in geography-based routing
Not fit for rural scenarios	Not fit for unban scenarios
Transmission can be delayed	Transit of data opts for longer path
Routing overhead will be higher	Coordinates of GPS node can be incorrect
More dropped packets	Occurrence of inherent loops
Frequent broken routes	Frequent network partitioning

2.5 Major Issues in VANET Routing

Due to the dynamic nature of network topologies, routing in VANET is most attentive area of research to increase the robustness of the networks. There has been numerous researches and studies already performed in the field of VANET to devise protocols that are much efficient. However, yet there is not a definitive routing protocol which can prove the efficient performance in every scenario. Presently, the effective routing protocols will be efficient at scenarios where the population of the nodes is confined. The proposed routing scenarios may fail to find out an accurate route due to rapid change in network topology. Whereas the proactive routing protocols have been overwhelmed due to the rapid change in network topology, this sometimes may not be able to deliver during the exchange of the routing information [6]. The position-based routing protocol schemes mainly need additionally a node's physical position and its information during the routing decision and processing. In VANET, location service is also required to provide the position information of the nodes in routing. Because of frequent and maximum mobility of the nodes and due to their constrained movement, the conventional routing schemes and topology are not perfect for VANET [7]. Issues have been raised [8] in Table 1.

3 VANET Routing Protocols

In VANET, routing is the procedure that enables different nodes to communicate continuously among them, to share the information of their link state and its topology to recognize the most appropriate, reliable and efficient paths. Figure 1 illustrates taxonomy of VANET routing protocols that are categorized among two different routing protocols: topology-based and geographic-based routing protocols [9].

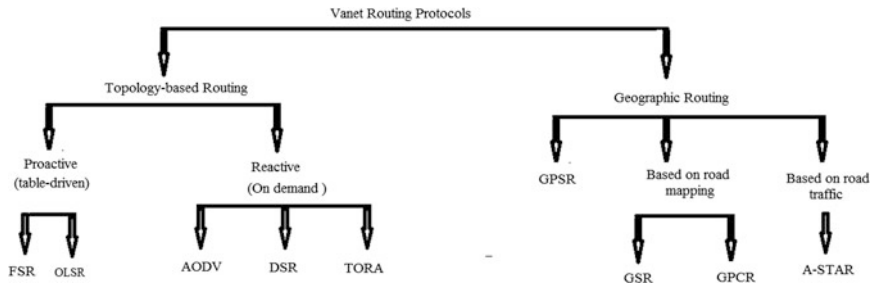


Fig. 1 Taxonomy of routing protocols

3.1 Topology-Based Protocols

Topology-based routing protocols send the data packets from source to destination. It uses the link information which is already provided in the network. Such protocols can also be classified as proactive (table-driven) and reactive (on-demand) routing protocols.

3.1.1 Proactive (Table-Driven) Routing Protocol

These protocols are based on the periodic exchange of routing tables to find the routes in advance. Fishey state routing (FSR) and optimized link state routing protocol (OLSR) are two different routing protocols that come under Proactive routing protocols.

(a) ***FSR*** [10] is based on the mechanism that changes in distant topology will not have major affect on the calculation of the local routes. Hence, function of the distance is to update the change of routing table with in the network. In FSR, all nodes update and exchange their neighbors routing information in spite of flooding the entire network with updates. All nodes propagate hop by hop at the time of transmitting information. FSR records the entire network graph but is unable to assure the accuracy of all the links among distant nodes.

(b) ***OLSR***: The Optimized Link State Routing [11] will optimize the process of broadcasting the control messages that can minimize the bandwidth consumption by using multipoint-relays (MPR) as described in Fig. 2. Here, every node contacts a subset of its neighboring node to transmit its packet at the time of broadcast. As per distribution technique of MPRs, every node in the network is acquired with minimum repetitions. In MPR, it prohibits the set of nodes from all nodes for retransmitting a packet, to a subset of all other nodes. The subset size is depended on its network topology.

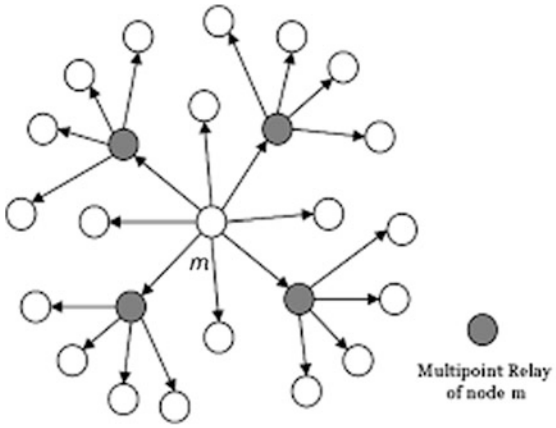


Fig. 2 MPR in OLSR

3.1.2 Reactive (On-Demand) Routing Protocols

During packet routing, a route to the destination is searched by on-demand protocol in the network. It uses the mechanism of network flooding by broadcasting a query for route lookup is, so that the aimed node can respond along with path in reverse route.

(a) ***Ad Hoc On-Demand Distance Vector (AODV)***: This works as per the concepts of distance vector routing protocols and is a reactive protocol [12]. AODV adopts the mechanism of dynamic source routing discovery of routes and its maintenance and acts as a linear hop routing and sequence numbers. AODV build a route through sequence of queries "route request/route reply". AODV checks for destination sequence numbers (DSN) for each route entry. The destination is responsible for generating DSN. The node searches for the routes with DSN and their routing information. This information is updated by the nodes to find the routes to destination nodes [13]. The routing information with highest DSN will be considered while deciding the destination route. AODV selects the routing path from source to destination through the route request (RREQ) message types, route replies (RREP) and route error (RRER), by using user datagram protocol (UDP) packets. Each source node broadcast a packet RREQ for the entire network, when it needs to establish a route to a destination. After node receives a RREQ packet it updates their source information and then in routing tables it sets return pointers to the source. The RREQ is also having the destination sequence number recently known by the source. It also contains the source IP, broadcast identifier and the current sequence number. Node that has received a RREQ packet transmits a RREP if node is either a destination or having a destination route with a sequence number. In these cases it broadcasts packets of RREP to the source or re-broadcasts the RREQ message types. In routing table nodes updates IP of each source and identifiers of RREQ

broadcast packets. In case nodes receive an already utilized RREQ, then it will be deleted from the routing table.

(b) ***Dynamic Source Routing (DSR)***: The routing of the source is the basic principle of DSR. In this protocol the routing information of the packet is attached with the data packet header from the source. This enables routers to get their complete routing information. The DSR protocol works on two distinctively routing techniques; the one is used to locate the routes, on demand and the other mechanism is to maintain the progressive routing communication. The main constraint of DSR protocol is that the method of route maintenance is not able to repair a damaged link domestically. If the mobility of the nodes suddenly increases then this results in the decrease of the protocol's performance [14].

(c) ***Temporally Ordered Routing Protocol (TORA)***: This protocol is primarily based on three levels [15]. First is to create the routes, second is to maintain the routes and third is to erase the routing information through three different packets QRY, UPD, and CLR. It stores multiple paths of routing at the same destination to recognize the mobility of vehicular networks and too many changes in the topology does not have an effect on the routing data, until entire routing information of destination are lost.

3.2 Geographic (Position-Based) Routing Protocols

Position-based routing in an ad hoc network can only be performed, if each and every node has information of their location. These location means can be recognized through GPS in which exact position of the destination node is known to the source node [16]. Some of the geographic-based routing protocols have been discussed below:

(a) ***Greedy Perimeter Stateless Routing (GPSR) Protocol***: In this routing protocol [17] its mechanism utilizes the node's position along with its destination to find other node for retransmitting data packets. It works on greedy approach and transmits the data packet to the neighboring node which is nearest to the destination. The finding of the neighboring node is performed through periodic diffusion of Beacon message that contains node's position and address.

(b) ***Geographic Source Routing (GSR)***: In this protocol [18], source node sends data packets to a destination node that will calculate the shortest routing path. Through this routing information it will reach to this target node by using geographical information of network map (road map in VANET). GSR is a protocol that uses the geographical position and the topological information of the roads to create an expertise-tailored to the metropolitan environment.

(c) ***Greedy Perimeter Coordinator Routing (GPCR)***: In this protocol [19] preference is given to coordinating nodes and based on greedy approach the transmission of the data packets are performed alongside road with in the network. The non-coordinator node is preferred for the selection of next relay

node, coordinating node (intersection node), though it is not nearest to the destination. This is result to overcome with the radios obstacle problem.

(d) ***Anchor-Based Street and Traffic Aware Routing (A-STAR)***: This protocol gathers special information on routes of the vehicles to recognize the best routing and high connectivity path for forwarding the data packets [20]. The A-STAR is a geographical positioning based protocol that has applied for Metropolitan Vehicular Environment. This protocol is just like of GSR protocol and uses an approach based routing anchor which shows attributes of the roads in a city. A-STAR protocol is also able to determine the routing paths of anchor as per traffic scenario. Here, Dijkstra's least-weight path algorithm is used to compute the anchor path.

3.3 Scalability of Routing Protocols

The most important measure for the scalability of the network and its routing protocol is the routing traffic which is sent by each node within the network. This can be indicated as packets per second and/or bits per second and can be stated as: sum of transmitted routing packets, in a network. The computed number from traffic routing is then recalculated in each packet while transmitting and receiving. To check whether the network is loaded or not a test can be performed to confirm it. Routing traffic can be expressed as per equation below:

$$\mathrm{Tr} = \mathrm{Pn} - (\mathrm{Pnr} + \mathrm{Pnl})$$

Tr Traffic routing
Pn Number of packets
Pnr Number of received packets
Pnl Number of packets lost

4 Wireless Access Standards in VANET

The VANET environments can relate in many of the wireless access standards. These wireless standards have various protocols that work on trans/receive equipments through security specification, cellular network 2G/3G/4G, routing and maintenance, service addressing and interoperability of protocols. These standards also enhance the product design and its development; reduce costs and results industry to come up with competing products.

Table 2 DSRC standards

Features	Japan (ARIB)	Europe (CEN)	USA (ASTM)
Communication	Half-duplex (OBU)/ Full duplex (RSU)	Half-duplex	Half-duplex
Radio frequency	5.8 GHz band	5.8 GHz band	5.9 GHz band
Band	80 MHz bandwidth	20 MHz bandwidth	75 MHz bandwidth
Channels (Down-link/Up-link)	7/7	4/4	7/7
Channel separation	5 MHz	5 MHz	10 MHz
Data transmission rate	Down-link/Up-link 1 or 4 MBits/s	Down-link/500 Kbits/s Up-link/250 Kbits/s	Down-link/Up-link/3–27 Mbits/s
Coverage	30 m	15–20 m	1000 m (max)
Modulation	RSU: 2—ASK OBU: 4—PSK	RSU: 2—ASK OBU: 2—PSK	OFDM

ARIB Association of Radio Industries and Businesses
CEN European Committee for Standardization
ASTM American Society for Testing and Materials
OBU Onboard unit
RSU Road side unit
ASK Amplitude shift keying
PSK Phase shift keying
OFDM Orthogonal frequency division multiplexing

4.1 Dedicated Short Range Communication (DSRC)

In VANET a short and medium range communications services are supported by Dedicated Short Range Communication for vehicle-to-vehicle and vehicle-to-roadside communications. DSRC is used for a wide range of applications that includes safety messages for V2V and vehicle-to-infrastructure, information dissemination for real time traffic, collecting toll at various points, accidents, emergencies and many others. DSRC can also support huge amount of data transfer with minimum latency during communication at confined zones. In 1999, 75 MHz of spectrum at 5.9 MHz is allocated by United States Federal Communications Commission (FCC), for DSRC usage. The ASTM-DSRC standard was approved by The American Society for Testing and Materials (ASTM) in 2003 which works on IEEE802.11a physical layer and 802.11 MAC layer [21]. Some of the recent DSRC standards are compared in Table 2.

4.2 IEEE 1609—Wireless Access in Vehicular Environments (WAVE) (IEEE 802.11p) Standards

Presently, 802.11a compliant devices can achieve maximum data rate of 54 Mbps on 802.11a hardware for moving vehicles through wireless network [22]. Challenges faced by Vehicular traffic scenarios are more as compared to fixed

wireless networks due to unpredictable traffic patterns, random change in speed and driver's behaviors. Present working of IEEE 802.11 media access control (MAC) are not appropriate when used in VANET. Such as in scenarios, when rapid exchange of data is required and essential for ensuring safety in VANET. In this scenario the multiple channels are scanned along with multiple handshakes needed to communicate. This creates complexity and overheads [23]. Hence, to overcome such complex needs of IEEE MAC functionality, the consortiums working in ASTM 2313 has changed over to the IEEE 802.11p wireless access in vehicular environment (WAVE) [24].

WAVE works on two types of equipments: road side unit (RSU) are the stagnant devices and on board unit (OBU) are the movable devices that are installed on each vehicle. RSUs and OBUs able to behave like a host or a client who use the services and both can be switched in any mode. In WAVE standards, applications which reside at RSU are devised to broadcast multiple requests through distant applications that provide access to the OBUs. Orthogonal frequency division multiplexing (OFDM) technique is adopted by WAVE that further divides the signal into various narrowband channels. This makes availability up to 27 Mbps of a data payload communication capability in 10 MHz channels [25].

IEEE 1609/802.16e standards [26] are briefly discussed in Table 3.

Table 3 IEEE 1609/802.16e standards

IEEE standards	Description
IEEE standards 1609	Defines the overall architecture, communication model, management structure, security mechanisms and physical access for wireless communications in the vehicular environment, the basic architectural components such as OBU, RSU and the WAVE interface
IEEE standards 1609.1—2006	Enables interoperability of WAVE applications, describes major components of the WAVE architecture and defines command and storage message formats
IEEE standards 1609.2—2006	Describes security services for WAVE management and application messages to prevent attacks such as eavesdropping, spoofing, alteration and replay
IEEE standards 1609.3—2006	Specifiers addressing and routing services within a WAVE system to enable secure data exchange enables multiple stacks of upper/lower layers above/below WAVE networking services, defines WAVE short message protocol (WSMP) as an alternative IP for WAVE applications
IEEE standards 1609.4—2006	Describes enhancements made to the 802.11 media access control layer to support WAVE
IEEE standards 802.16e	Enables interoperable multi-vendor broadband wireless access products

5 Conclusion

The recent research and studies have come up with many different services and are responsible for the establishing various VANET technologies. We presented an overview of VANET routing protocols with characterization of topology-based and geographic-based routing protocols in VANET. We also raised the scalability issue of VANET. In this chapter we tried to provide comparative analysis of recent regional standards with a concise discussion of IEEE 1609/802.16e standards. But the problem remains to identify the accurate routing protocol for VANET in various situations. We hope that this review of routing protocols and wireless standards used in VANET will surely improve the future of VANET and help researchers while devising the best routing protocol at application level. Our future work will include simulation-based review and study of routing protocols in VANET.

References

1. Harsch C., Festag A., and Papadimitratos P., "Secure position-based routing for VANETs.", *Proceedings of IEEE (VTC-2007), pp. 26–30, (September 2007).*
2. Jinyuan S., Chi Z. and Yuguang F., "An ID-based frame-work achieving privacy and non-repudiation", *Proceedings of IEEE (MILCOM2007), pp. 1–7, (October 2007).*
3. Zhu D.J., and Huang J.H., "The Design and Scheduling Scheme ADCSA for Mobile Wireless Sensor Network", *Journal of Computational Information System, pp. 8–18, (2012).*
4. Dahiya A., and Chauhan R.K., "A Comparative Study of MANET and VANET Environment", *Journal of Computing, pp. 87–92, (2010).*
5. Zhu D.J, Cui G. and Huang J.H, "A New Adaptive Hierarchical Routing Protocol in Wireless Sensor Network", *Int. Conf. of Information Science and Engineering (ICISE-2010), pp. 4289–4291, (2010).*
6. Barkouk Hamid, En-Naimi Mokhtar, "Performance Analysis of the Vehicular Ad-hoc Networks (VANET) routing protocols AODV, DSDV and OLSR", *Information and Communication Technology and Accessibility (ICTA)*–IEEE Xplore, *(2015).*
7. Saini P.K, Bhagchandani K., and Sharma Y.M., "Modern Investigation of Issues and Ad-hoc Routing Protocols Applied to VANET", *International Journal of Engineering and Advanced Technology - IJEAT, (December 2012).*
8. Bitman S., Mellouk A., and Zeadally S., "HyBR: A Hybrid Bio-inspired Bee swarm Routing Protocol for safety application in VANET", *Journal of Systems Architecture (2013).*
9. Mohammed ERRITALI, Bouabid EI Ouahidi, "Performance evaluation of ad-hoc routing protocols in VANETs," *Third International symposium on Automatic Amazigh processing, (SITACAM'13) pp. 33–40, (2013).*
10. Paul Bijan, Ibrahim Md., Abu Naser Bikas Md., "VANET Routing Protocols: Pros and Cons", International Journal of Computer Applications, Volume 20 (April 2011).
11. Clausen Thomas and Jacquet Philippe, "Optimized link state routing protocol (OLSR)", *IETF RFC3626, (October 2003).*
12. Perkins C.E., Belding-Royer E.M., and Das S., "Ad Hoc On Demand Distance Vector (AODV) Routing", *IETF RFC 3561, (2003).*
13. Shrivastava Laxmi, Tomar G.S., and Bhadoria S.S., "Performance Evaluation of Reactive Routing in Mobile grid Environment", *International Journal of Grid and high performance computing, IJHPC, IGI Global, Vol. 3, No. 3, (2011).*

14. Johnson D.B., Maltz D.A., Hu Y.C., "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", *Internet Draft: <draft-ietf-manetdsr-10.txt>, 19 Juillet (2004).*
15. Park V., Corson S., "Temporally-Ordered Routing Algorithm (TORA) Version 1 Functional Specification", *IETF Internet draft, work in progress, draft-ietf-manet-tora-spec-04.txt, (2001).*
16. Giordano S., et al., "Position based routing algorithms for ad hoc networks: A taxonomy," *Ad Hoc Wireless Networking, Cheng X., Huang X. and D.Z. Du (eds.), Kluwer, December (2003).*
17. Kim Young Jin and Govidan Ramesh," Greedy Perimeter Stateless Routing (GPSR) Detailed-level Design Specification (DDS) Version 0.1", *Department of Computer Science University of Southern California, (July 6, 2003).*
18. Lochert C., Hartenstein H., Tian J., Herrmann D. HERRMANN, Fubler H., Mauve M., "A Routing Strategy for Vehicular Ad Hoc Networks in City Environments", *IEEE Intelligent Vehicles Symposium (IV2003), pp. 156–161, Columbus, OH, USA, (June 2003).*
19. Lochert C., Mauve M., Fubler H., Hartenstein H., "Geographic Routing in City Scenarios", *MobiCom (2004).*
20. Seet B.C., Liu G., Lee B.S., Foh C. H., Wong K. J., Lee K.K., "A-STAR: A Mobile Ad Hoc Routing Strategy for Metropolis Vehicular Communications*", Networking 989–999, (2004).*
21. GHz band Dedicated Short Range Communications (DSRC) medium access control (MAC) and physical layer (PHY) specifications. *ASTM E2213-03, (September 2003).*
22. PartII: Wireless LAN medium access control (MAC) and physical layer (PHY) specifications., IEEE Standard 802.11 (2007), IEEE Std. 802.11 – (2007).
23. Iiker Besaran, Hasan Bulut, "Performance Comparison of non-Delay Tolerant VANET routing Protocols", *Computer and Communication (ISCC), IEEE Symposium – (2016).*
24. IEEE P802.11p/D3.0, draft amendment for wireless access in vehicular environment WAVE. (July 2007).
25. Zeadally Sherali, Hunt Ray, Chen Yuh-Shyan, Irwin Angela and Hassan Aamir, "Vehicular ad-hoc networks (VANET): status, results and challenges", Telecommun. Syst DOI 10.1007/s11235-010-9400-5, Springer Science+Business Media, LLC (2010).
26. https://www.standards.its.dot.gov/Factsheets/PrintFactsheet/80.

Mechanical CAD Parts Recognition for Industrial Automation

Jain Tushar, Meenu and H.K. Sardana

Abstract Object matching, counting and inspection are routine jobs done at several manufacturing plants, research laboratories, and other different companies. The detailed analysis of manufactured components is possible with information obtained from their inspection. For a large number of objects manual counting and inspection is a repetitive, difficult and time-taking process. The efficiency of overall object matching, counting and inspection process can be increased with industrial automation and it also minimizes resources and saves time. This paper presents a computationally efficient 3D computer vision based approach to recognize the Mechanical CAD parts. In this chapter features based industrial object detection techniques are implemented in MATLAB to recognize the presence of the industrial CAD parts in the query image.

1 Introduction

Today in different types of product manufacturing industries (e.g., locks, gear boxes, alarm clocks, engines and motors, etc.) and packaging industries with large-scale production units automated assembly systems are widely used. They used mechanized devices such as image capturing unit, conveyor, part recognition unit, part feeder, part selection unit, and intelligent robots that follow fixed sequence of steps to assemble the product [1].

In general with respect to productivity there are three categories of assembly systems namely low, medium and high volume production units. The assemblies systems are fully automated in high volume production, assembly of parts in other two classes are performed in semi-automated or manual by hand. The cost for establishing such systems initially is high, but in longer run it saves time, money,

J. Tushar (✉) · Meenu
Mechanical Engineering Department, NIT Kurukshetra, Kurukshetra, India
e-mail: tusharkaid@gmail.com

H.K. Sardana
CSIO, Chandigarh, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_35

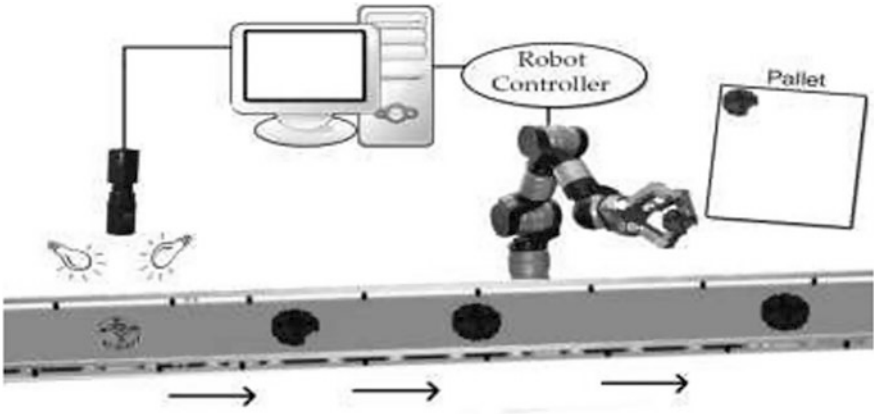


Fig. 1 A schematic diagram for machine parts detection in model assembly line

and labor. The benefits of such system are huge quantity of production, stable product design with good quality and reliability.

In automated assembly systems the machine parts identification is entirely different from simple object recognition; moreover the ability of human to differentiate between correct and no correct machine parts are better but it is a difficult task for a machine. In general with fast moving machine parts on conveyor manual defect detection by human inspectors are impractical also it is expensive, inaccurate, subjective, eye straining and other health issues to quality control inspectors. A computer vision based non-contact inspection technique is developed with image processing methods by considering these problems, for defect detection in industrial machine parts [2]. The present work will help the industrial robot used in assembly process and industrial inspection systems (Fig. 1).

2 Designing and Rendering Process

In this section CAD parts design is explained. Section 2.1 describes the design of Mechanical CAD parts using Solid Edge ST8 and wire frame modeling showing rendering using STL (standard tessellation language) is discussed in Sect. 2.2 that helps in creating the database of different Mechanical CAD parts.

2.1 Mechanical CAD Parts Design

In the present research work the mechanical CAD parts are designed with Solid Edge ST8. The design is created by 2D drawings to 3D object. Since the Solid Edge

Fig. 2 Different mechanical CAD parts designed using Solid Edge ST8

ST8 supports a direct interaction with the designer, hence the need to write program is not required at all and we can easily find out the different surfaces. Solid Edge is a combination of different software tools that encompasses all steps of the product design and development techniques like 3D parts creation, design simulation, parts manufacturing, design parts management. Solid Edge provides user friendly flexible interface to integrate the speed with simplicity using synchronous technology for the control of parametric design. Figure 2 shows the different Mechanical CAD parts designed using Solid Edge ST8.

2.2 CAD Parts Rendering Using STL

The STL stands for Standard Tessellation Language. All advanced CAD software supports STL file format. The major industrial usage of it is in CAD/CAM, rapid prototyping machines and 3D printing. In rapid prototyping machines the STL file format is used to transfer CAD data. Triangular mesh is generated on the surface of CAD model by using this format.

In CAM environment the triangulated geometry is imported using STL. Finally this information helps in producing and manufacturing error free industrial products. STL files show the geometrical surface of a 3D CAD model. The information about other attributes of CAD model like texture and color are not represented with this format. The CAD object rendering STL format output is shown in Fig. 3 using MATLAB.

3 Introduction to Speeded Up Robust Features (SURF)

Nowadays speeded up robust features (SURF) have been widely used in machine vision applications. SURF can work efficiently in different tasks like image recognition, detecting objects in a real image, object matching and classification, etc. Scale-invariant feature transform (SIFT) is predecessor of SURF. There are other algorithms available to us with similar capabilities named as KAZE, BRISK,

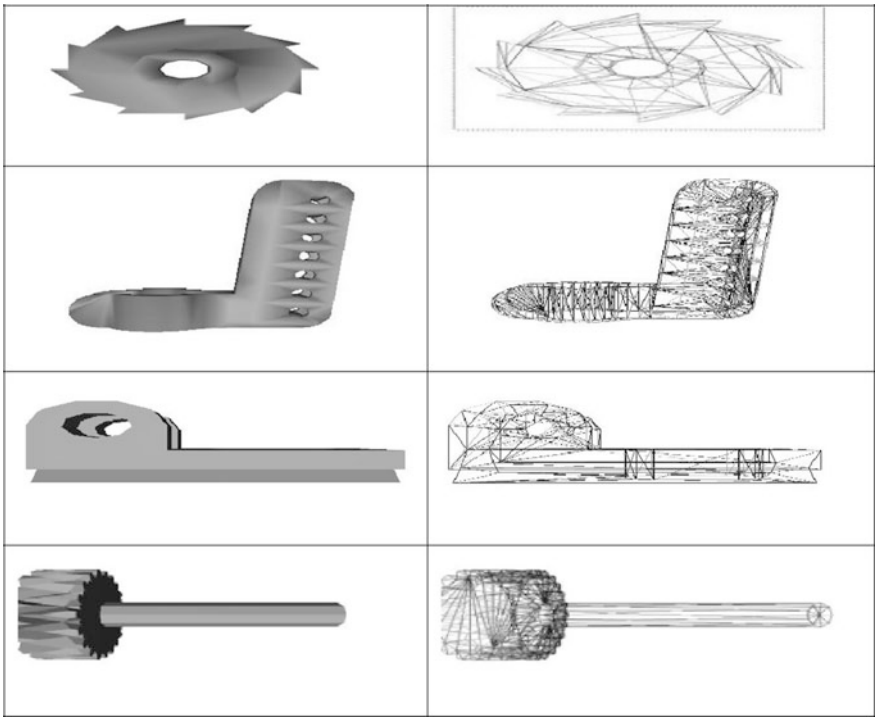


Fig. 3 MATLAB rendering of mechanical CAD parts

FAST, HOG, FREAK and many more. SURF detector worked as local feature extraction for the given image. SURF descriptors are invariant to rotation and scaling means irrespective of position of object on conveyor belt for matching and inspection this algorithm can easily detect that object with accuracy and efficiency. This paper shows this clearly on mechanical CAD parts. As compared to SIFT in feature extraction and object recognition SURF is much faster and robust. SURF algorithm was developed by Bay [3].

4 Literature Survey of Feature Based Techniques

The speeded up robust features (SURF) [3] and scale-invariant feature transform (SIFT) [4] descriptors extracts a specific object in an occluded objects image or to detect exact matching between two images. The features extracted corresponding to a specific object in an image must be invariant to rotation and scaling for perfect matching and recognition. KAZE, SURF and SIFT are the latest feature extraction algorithms that worked on the concept of invariance. In present scenario these techniques are applied to real time object recognition, object matching and

inspection, query image retrieval, etc. SIFT is widely used in different machine vision applications, but at the cost of computationally expensive SIFT feature points calculation for the given object. In contrast to this SURF descriptors are comparatively more computationally efficient in comparison to SIFT [3]. That is why machine vision application areas for object recognition prefers SURF over SIFT. Similarly in other research work more nice usage of SURF methods is shown [5, 6]. The comparison of SURF [3], SIFT [7] and a new descriptor named Maximally Stable Extremal Regions (MSER) [8] is clearly discussed. MSER features extracts regions with uniform intensity and also shows independency about scale. In many situations these feature types shown better results [9–11].

5 Proposed Approach

A non-contact machine vision based CAD pars detection system is proposed in this section. The sequence of steps followed in the proposed system is: image capturing, image preprocessing, contour extraction, features extraction, similarity matching and CAD machine part recognition. These steps are summarized in flow diagram in Fig. 4.

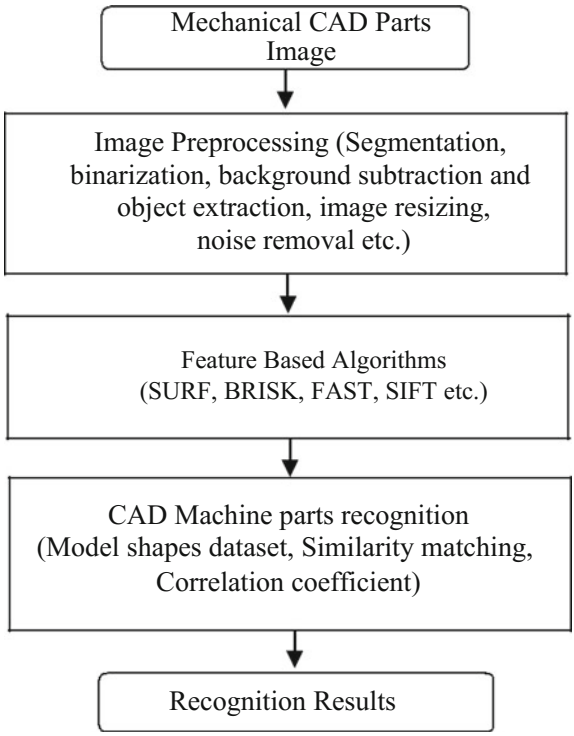


Fig. 4 A flow diagram for the proposed mechanical CAD parts recognition system

The image acquisition system acquires data from the moving machine parts in line which is part of the assembly line setup. To transform the data suitable for further processing the captured machine CAD part image data undergoes image preprocessing techniques like binarization, noise removal, background subtraction, etc. to transform the data suitable for further processing. Then a contour of the machine parts are extracted and normalized by equal part area method to describe the features of the parts. It gives important clues for machine part shape recognition. For experimental purpose a model shape for each machine part is developed in CAD software Solid Edge, the parts recognition is performed with only reference to the model shape.

6 Experimental Results

The experimental results using SURF, BRISK and FAST approach of mechanical CAD parts recognition are presented in this section with relative proposed approach. Figure 5a, b shows the industrial CAD parts first image and second image, respectively, with scaling and rotation of first image so that these two images are compared for CAD parts recognition. Figure 5c, d represents the strongest features of first and second input image using SURF. CAD parts image with matched features and matched points are shown in Fig. 5e, f respectively. Figure 5g represents the final CAD object detected image using proposed SURF method invariant to scaling and rotation that may be the conditions of actual industrial system. As it is very clear that the proposed SURF method gives much better industrial CAD parts detection results.

Figure 6 shows another CAD parts. Figure 6a, b shows the industrial CAD parts first image and second image, respectively, with scaling and rotation of first image so that these two images are compared for CAD parts recognition. Figure 6c, d represents the strongest features of first and second input image using SURF. CAD parts image with matched features and matched points are shown in Fig. 6e, f

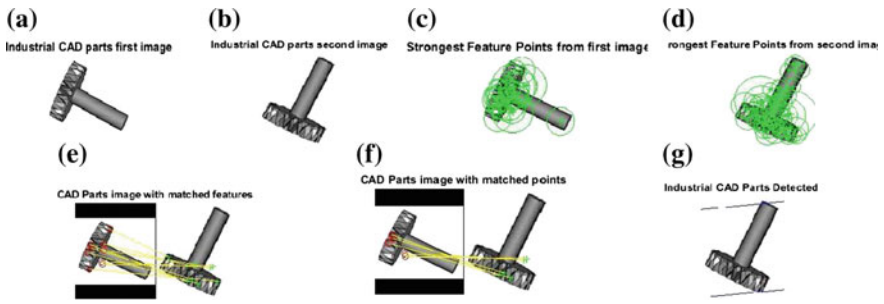


Fig. 5 CAD part 1SURF results

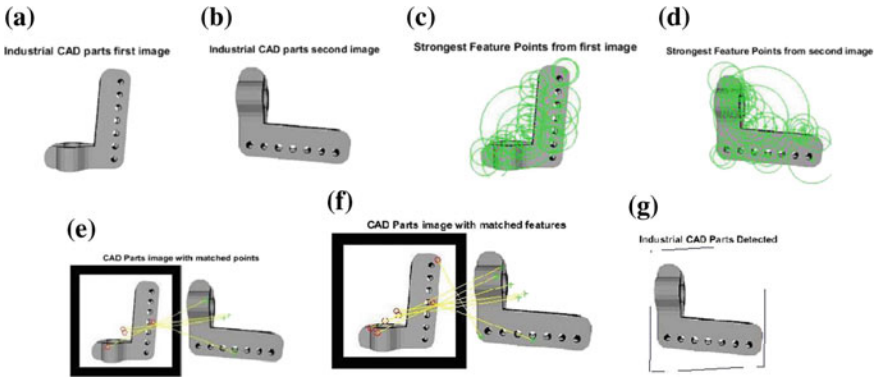


Fig. 6 CAD part 2 SURF results

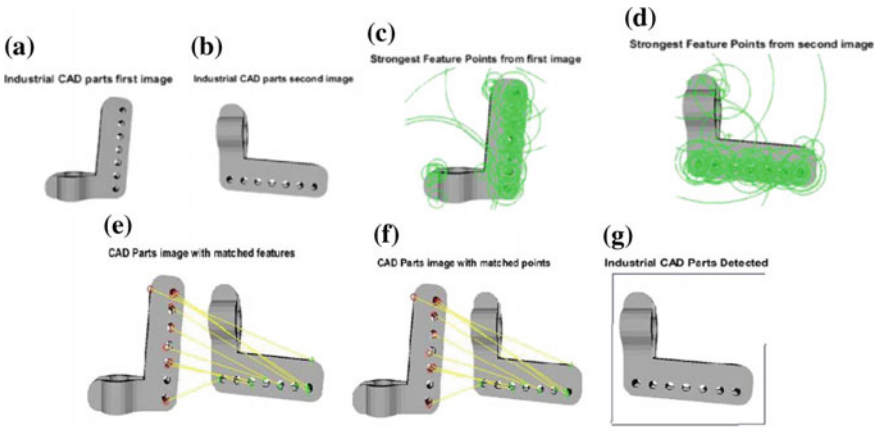


Fig. 7 CAD part 2 BRISK results

respectively. Figure 6g represents the final CAD object detected image using proposed SURF method invariant to scaling and rotation.

Here in Fig. 6 we used SURF for feature extraction whereas in Fig. 7 for same part BRISK algorithm and in Fig. 8 FAST algorithm is used for the same object. The only difference in these algorithms is based on the feature extraction. As we see BRISK algorithm detect BRISK features and return BRISK Points object in the same way FAST technique detect corners and return cornerPoints object. For classification tasks the HOG and SURF techniques are used. BRISK and FREAK binary descriptors algorithms are specifically applied to find point mapping between objects images. Binary descriptors are normally faster but with less accuracy than gradient-based descriptors. For better accuracy of object recognition we have to combine jointly different detection and description techniques as shown in Tables 1 and 2.

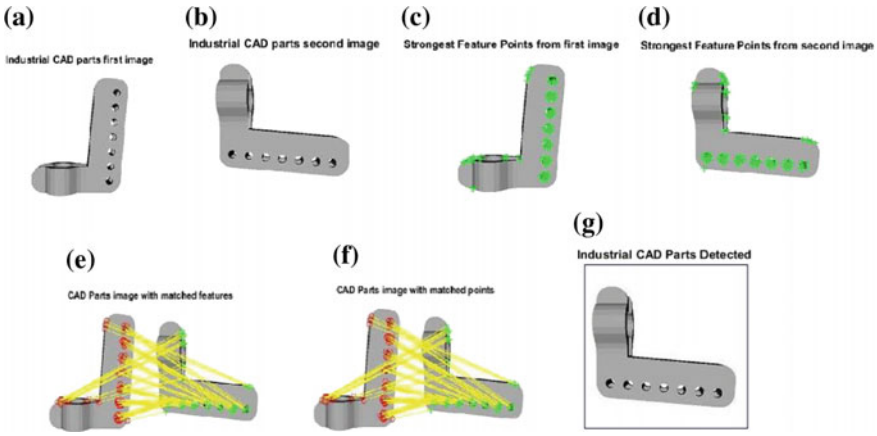


Fig. 8 CAD part 2 FAST results

Table 1 Selection of feature based detector

S. No.	Detection algorithms	Types of feature category	Independency about scale
1	SURF	Blob	Yes
2	BRISK	Corner	Yes
3	FAST	Corner	No
4	MSER	Region with uniform intensity	Yes

Table 2 Selection of description technique

S. No.	Description techniques	Binarization	Invariant		Special purpose	
			Scaling	Rotating	Matching point locations	Classifying ability
1	BRISK	Yes	Yes	Yes	Yes	No
2	SURF	No	Yes	Yes	Yes	Yes
3	FREAK	Yes	Yes	Yes	Yes	No
4	HOG	No	No	No	No	Yes

7 Conclusions and Future Work

This method presents an efficient image recognition algorithm for mechanical CAD parts matching system. SURF is used for extracting features from reference parts and test image. Some uses of this system are the automatic identification of CAD parts on the web. This system is used to detect both near duplicate parts as well as parts with some variability in their appearance. To compare the results mechanical

CAD parts matching systems FAST, BRISK and SURF algorithms are implemented using MATLAB. The performance is also evaluated by changing the scale as well as the rotation angle. The experiment shows that the proposed system consistently outperforms other existing systems in parts matching and recognition. For future work more objects either CAD parts or industrial tools can be taken for recognition and detection of defects in them if any for automated inspection purpose.

References

1. Bauer, J., Sünderhauf, N., Protzel, P.,: Comparing Several Implementations of Two Recently Published Feature Detectors. In Proc. of the International Conference on Intelligent and Autonomous Systems (2007)
2. Shokoufandeh, A., Marsic, I., Dickinson, S. J.,: View-based Object Recognition Using Saliency Maps. (1998)
3. Bay, H., Tuytelaars, T., Gool, L. V.,: SURF: Speeded Up Robust Features. In ECCV, 404–417 (2006)
4. Mikolajczyk, K., Schmid, C.,: Indexing Based On Scale Invariant Interest Points. In Proceedings of ICCV, 525–531 (2001)
5. Li, C., Ma, L.,: A New Framework For Feature Descriptor Based on SIFT. Pattern Recognition Letters, 30(5), 544–557 (2009)
6. Lindeberg, T.,: Scale-Space Theory: A Basic Tool for Analyzing Structures at Different Scales. Journal of Applied Statistics 21, 224–270 (1994)
7. Lowe, D. G.,: Distinctive Image Features from Scale-Invariant Keypoints. International Journal of Computer Vision, 60, 91–110 (2004)
8. Matas, J., Chum, O., Urban, M., Pajdla, T.,: Robust Wide Baseline Stereo from Maximally Stable Extremal Regions. In British Machine Vision Conference, 384–393 (2002)
9. Mikolajczyk, K., Schmid, C.,: A Performance Evaluation Of Local Descriptors. IEEE Transactions Pattern Analysis Machine Intelligence, 27(10), 1615–1630 (2005)
10. Mikolajczyk, K., Tuytelaars, T., Schmid, C., Zisserman, A., Matas, J., Schaffalitzky, F., Kadir, T., Gool, L. V.: A Comparison of Affine Region Detectors. International Journal of Computer Vision, 65 (2005)
11. Moreels, P., Perona, P.,: Evaluation of Features Detectors and Descriptors Based on 3D Objects. 73(3), 263–284 (2007)

Classifiers for the Detection of Skin Cancer

Ginni Arora, Ashwani Kumar Dubey and Zainul Abdin Jaffery

Abstract Diagnosis of skin cancer at an early stage is made possible with the highly advanced medical technology. Researchers are proficient in diagnosing skin cancer which involves the basic preprocessing but problem is faced during selection of a classifier to give best diagnose. This paper will illuminate these classifiers that can be used to detect skin cancer accompanied with their pros and cons. Also, it will throw light on future perspective of various approaches.

1 Introduction

Skin is the only protective covering for the delicate organs inside the human body. It is the first line of defense against germs and foreign bodies [1]. No doubt, human skin when subjected to this much stress accumulates various diseases, amongst which skin cancer is the most threatening. Skin cancer patients are growing every year. Recalling Bob Marley is an update that anybody of any age or skin shading can create melanoma. That is the reason it is so essential to take note of any adjustments in skin. In the event that a mole is new, changing, every now and again drains, does not mend or simply does not appear to be correct, then this is the time to "get up, stand up," and have it checked out [2]. Lack of operative treatment and delay in diagnosis are the major reasons. Classification of this skin condition is difficult to address. Mostly, dermatologists are obligated to perform a surgery to define the tumor as menacing or less threatening. Malignant melanoma is the most communal type of skin cancer which is incurable if found in its later stages, but can be treated in its early stages. To differentiate between melanoma at early stage and

G. Arora (✉)
Amity Institute of Information Technology, Amity University, Noida, UP, India
e-mail: garora@amity.edu

A.K. Dubey
Amity School of Engineering & Technology, Amity University, Noida, UP, India

Z.A. Jaffery
Department of Electrical Engineering, Jamia Millia Islamia, New Delhi, Delhi, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_36

other lesion is not easy for dermatologists; melanoma is underestimated by a lot of physicians which turns into a serious problem later on [3].

Skin lesion classification from a dermatoscopic image after acquiring the image consists of four phases: Image Preprocessing, Image foreground and background Segmentation, appropriate Feature extraction or selection and finally decision-making using Classification. Preprocessing removes irrelevant features, like noise suppression, image resizing, contrast adjustment [4], and others. Afterwards the region of interest (ROI) is separated from the normal skin, through segmentation techniques. After getting region, feature extraction is underwent to designate characteristic properties of the said data; properties like color information, texture properties, or shape descriptors [2]. The final stage is classification of the lesion. Removed features are identified and a decision as to lesion belongs to cancer or not, if yes then of which type of cancer.

2 Forms of Skin Cancer

Skin cancer has various forms. The most honest to goodness is melanoma. Cells which constitute skin are: basal cells, squamous cells, and melanocytes. Skin malignancy sorts are named by cells in which disease create: basal cell carcinoma, squamous cell carcinoma, and melanoma. The synonym for skin cancer is Carcinoma. Basal cell and squamous cell carcinomas are routinely assembled and called "vital" skin cancers [5].

Figure 1 shows various types of cells of human body in which skin cancer can occur [5].

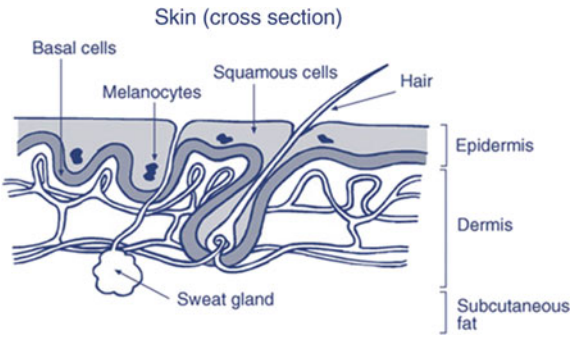


Fig. 1 Types of body cells in which skin cancer occurs [5]

2.1 Melanoma

Melanoma can become rapidly. It can get to be life debilitating in as meager as six weeks and if untreated, it can spread to different parts of the body. It can show up on skin not regularly presented to the sun. It is normally level with an uneven smudgy outline. It might be smeared and more than one shading like: chestnut, dark, blue, red, or gray [5].

2.2 Nodular Melanoma

A very perilous type of melanoma that looks not the same as basic melanomas. They are raised from the benign and even in shading (regularly red or pink and some are cocoa or dark). This sort of melanoma becomes rapidly and can be life undermining if not distinguished and evacuate quickly [5].

2.3 Basal Cell Carcinoma

This is the most widely recognized yet minimum risky type of skin disease. It becomes gradually, normally on the head, neck and upper middle. It might show up as an irregularity or dry, layered range. It is possibly red, pale, or silvery in shading. As it develops, it might ulcerate or seem like a sore that neglects to totally mend or one that heals yet then separates again [5].

2.4 Squamous Cell Carcinoma

This sort of skin cancer is not as unsafe as melanoma but rather may spread to different parts of the body if not treated. It develops over a few months and shows up on skin frequently presented to the sun. It can be a thickened, red, textured spot that may drain effortlessly, outside layer or ulcerate [5].

Images of various types of melanoma skin cancer are illustrated in Fig. 2.

Fig. 2 The examples of melanoma skin cancer [5]

3 Phases of Skin Cancer

3.1 Preprocessing

This is the initial stage after acquisition of the image. In this various types of filtering, resizing and adjustment of images are done. The dermatoscope image may consist of noise, air bubbles, and hair. Filtering helps to reduce noise in the image and increases precision of the classification [6] used. Gamma correction is used for image resizing, contrast and brightness adjustment. Most of the times there is a requirement of hair removal from an image which creates noise for that dull razor technique is used and median filtering for smoothness [7, 8]. Figure 3 demonstrates the outcomes test of three procedures on skin cancer image.

3.2 Segmentation

Segmentation has a great effect on the accuracy of the detection. But the variety of the lesion sizes, colors, and shapes make it more difficult to classify it. Dissimilar skin types and textures also increase the complexity. Lesions with irregular boundaries are also difficult to segment. Thresholding, edge based and region based are algorithms to account for these problems [6, 9]. Figure 4 shows the thresholding segmented image.

3.3 Feature Extraction

To analyze and explore the image, feature extraction is used. It is based on the ABCD (Asymmetry, Border structure, Color variation, and Diameter of lesion) rule of dermatoscopy. Geometric features have been extracted to get accuracy like area, parameter, greatest diameter, circularity index, and irregularity index [6]. Diagnosis of the disease is defined on the basis of extraction of features. GLCM (Gray Level Co-occurrence Matrix) is a method where contrast, correlation, homogeneity, and

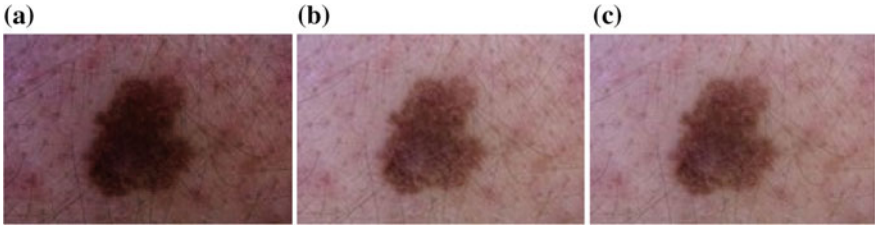


Fig. 3 **a** Gamma correction, **b** dull razor, **c** median filter

Fig. 4 Thresholding

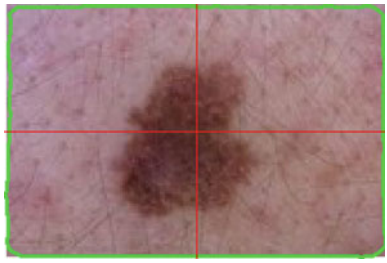


Fig. 5 ABCD feature extraction

energy can be obtained [9]. Statistical descriptions and fractal descriptions used for texture analysis. Figure 5 shows feature-extracted image using ABCD technique.

3.4 Classification

Classification is done to distinguish between melanoma lesions from the non-melanoma ones, done by the histogram of visual words as input. This has been elaborated in the next section.

4 Classifiers for Skin Cancer Detection

4.1 Genetic Algorithms

The preservationist Artificial Neural Network (ANN) classifier with back engendering system to prepare the system. The BackPropagation Neural Network

(BPN) calculation has a disadvantage. Rather than the worldwide minima, the arrangement may get stuck in the neighborhood minima. Undergoing this, the preparation might not be that effective and the results may be corrupted [10]. To eliminate this traditional Artificial Neural Network (ANN) classifier blunder the new cross breed one, which imparts both ANN and Genetic Algorithm (GA) is proposed. This cross breed GA ANN has improved efficiency and gets more precise results over less time. Genetic Algorithm removes the hindrance in merging segmented objects. Numerous parameters are predicted after an improved output for a given number of iterations is received applying Genetic Algorithm [11].

4.2 Artificial Neural Network (ANN)

ANN is a mathematical model enthused by the construction and down to earth parts of natural neural systems. ANN comprises of a brought together gathering of counterfeit neurons preparing data utilizing a connectionist technique for calculation. ANN is dynamic and modifies its structure in view of outer or inside data that courses through the system. Arguably, simplest type of ANN devised was the Feedforward Neural Network [12].

4.3 Neuro-fuzzy System

A field of Artificial Intelligence, Neuro-Fuzzy is a combination of neural networks and fuzzy logic. The object has a human like reasoning, artificial intelligence with the knowledge of neural networks. It combines the AI module with fuzzy sets, and a verbal model entailing of a collection of if-then rules. The main upside of Neuro-Fuzzy systems are the universal estimates with the ability to use IF-THEN rules. After undergoing ANN and mining the results, the output is validated using this system which leads to more accurate results [6].

4.4 Hierarchical Clustering

A theory for the subtypes of a varied disease is provided by Clustering. Irregularities between grouping created by various calculations exist. A straightforward strategy to defeat this is to give the most dependable bunches through three unique calculations. By demonstrating that Silhouette, Dunne's, and Davies–Bouldin's bunch verifications lists are preferred for the proposed

calculation over the ones accomplished by *k*-implies or other bargaining calculations. To get groups in an information set, an exploratory "accord" of various bunching calculations are taken. Every group relates to subtrees of practically identical measurements in various guessed trees which settle over their components. This permits us to dispose of the general strategy of cutting trees at specific statures and finding bunches. This method is regardless of any preceding information about the number of clusters. In the forthcoming, this technique will be further discovered by using more clustering algorithms [4].

4.5 Raman Spectra (RS)

It is an optical strategy in which when vibrating atoms diffuse unbendable light and can convey biochemical fingerprints of cells, biofluids or tissues. The restorative indicative utilizations of RS have expanded because of the high concoction specificity, the capacity to utilize dynamic optical advances and the absence of test planning. The key theory late this field is atomic change in cells that are either the cause or the impact of the said infection, and can be recognized and evaluated by RS. Additionally, the variable institutionalized and characterized models in view of Raman spectra can be produced on extensive preparing datasets and utilized a short time later on tests from new patients to acquire quantifiable and fair determination. Generally, RS is a low flag strategy which requires relatively more obtaining times. Non-straight optical impacts and metallic nanoparticles can be utilized to elevate the signs. Single point estimations should be possible by the upgraded fiber optic Raman tests. To upsurge the obtaining speed and spatial accuracy of investigation, multimodal expansion with other optical systems can control the Raman estimations. These crisp battles have propelled RS to where the analytic exactness and velocity are all around coordinated with clinical use [7].

Various techniques for different phases of skin cancer detection are summarized in Table 1.

Table 1 Techniques for detection

Phases	Parameters	Techniques
Pre processing	Color space [12] Transformation [12] Contrast [12] Enhancement [12] Artifact removal [12]	Karhunen–Love (KL) transformation Independent histogram pursuit (IHP) Gaussian (GF) [12] Median (MF) [12] Anisotropic diffusion(ADF) [12] Weiner (WF)
Segmentation	Luminance Color Texture Discontinuity Region Edge	Thresholding: Histogram, Otsu, adaptive [3] Clustering Morphological Active contours Soft computing: Neural network, fuzzy logic, evolutionary computation Grow cut Mean shift Radial search Laplacian of Gaussian (LoG)
Feature extraction	Signal decomposition Redundancy removal Data compression ABCD [3]	Discrete wavelet transforms (DWT) [12] Principle components analysis (PCA) [12]
Classification	Sensitivity Specificity Accuracy Eccentricity Similarity	Genetic [4] Artificial neural network [4] Neuro-fuzzy Clustering: *K*-NN Support vector machine (SVM) [13] Raman spectra

5 Conclusion

In this paper, we exhibited a complete overview of different methodologies utilized as a part of skin tumor location. We watched that there is an ongoing fight amongst Computer Aided Diagnostic (CAD) and specialists analyze. Because of awesome effect of skin malignancy on group, skin growth location has turned into a key range of examination in both the scholarly world and industry. In this paper, we initially talked about the general periods of skin cancer as trying issue for CAD. We displayed a brief outline of different types of skin cancer and examined different methodologies utilized for skin disease discovery comprehensive of customary and in addition developing methodologies, introducing their basic attributes.

We watched that the above characterized approaches have been fruitful in skin disease discovery in various situations. There are circumstances where one methodology beat the other. Every methodology has its upsides and downsides. There is a cost connected in usage of every methodology which must be utilized with the achievement rate accomplished by it in location. One needs to strike an

exchange off between achievement rate and cost. Likewise, the methodologies could be consolidated to accomplish magnificent precision in skin malignancy discovery.

We found that very little work has been done in skin growth recognition utilizing Multilevel classifier. A Multilevel classifier could be utilized as a part of blend with highlight choice to draw out a powerful answer for skin cancer. Developmental methodology is still in its earliest stages in stadium of skin disease location. Otsu Thresholding with median filtering tends to be the promising one for preprocessing stage of detection. Crossover Genetic and Neuro-Fuzzy being a rising region could be investigated and connected into skin disease recognition. Henceforth, these methodologies are distinguished as promising bearings for future exploration in skin cancer identification. Our trust is that this review can help analysts to have understanding into different methods against CAD and give them an indication for future bearings in battling against Skin growth.

References

1. Skin related information Available: http://science.nationalgeographic.com/science/health-and-human-body/human-body/skin-article/ [Dated: 24/05/2016].
2. Skin cancer foundation Available: http://www.skincancer.org/news/melanoma/marley: [Dated 24/05/2016].
3. S. Jain, V. Jagtap and N. Pise, "Computer aided Melanoma Skin Cancer Detection using ImageProcessing", Proc. Int. Conf. on Intelligent Computing, Communication & Convergence, Odisha, 2015, pp. 735–740.
4. M.A. Kalyankar and N.R. Chopde, "Cancer Detection: Survey", Int. Journal of Advanced Research in Computer Science and Software Engineering, Vol. 3, Issue 11, pp. 1536–1539, Nov. 2013.
5. Types of skin cancer Available: http://www.sunsmart.com.au/skin-cancer/skin-cancer-types#skin-cancer-types [Dated: 24/05/2016].
6. B. Salah, M. Alshraideh, R. Beidas and F. Hayajneh, "Skin Cancer Recognition by Using a Neuro-Fuzzy System", PMC US National Library Medicine National Institutes of Health, Vol. 10, pp. 1–11, Feb. 2011.
7. K. Kong, C. Kendall, N. Stone and I. Notingher, "Raman spectroscopy for medical diagnostics From in-vitro biofluid assays to in-vivo cancer detection", Advanced Drug Delivery Reviews, 2015.
8. K. Madhankumar and P. Kumar, "Characterization of Skin Lesions", Proc. Int. Conference on Pattern Recognition, Informatics and Medical Engineering, pp. 302–306, March 2012.
9. O.S. Murumkar and Gumaste P.P, "Feature Extraction for Skin Cancer Lesion Detection", International Journal of Scientific Engineering and Technology Research, Vol. 04, Issue 08, pp: 1604–1606, 2015
10. Aswin R.B, J.A. Jaleel and S.Salim, "Hybrid Genetic Algorithm - Artificial Neural Network Classifier for Skin Cancer Detection", Proc. Int. Conference on Control, Instrumentation, Communication and Computational Technologies, pp. 1304–1309, July 2014.
11. H. Sood and M. Shukla, "An Approach For Detection Of Skin Lesions From Digital Images Using Genetic Algorithm", Global Journal of Advanced Engineering Technologies, Vol 3, pp. 259–263, 2014.

12. M. Elgamal, “Automatic Skin Cancer Images Classification”, Int. Journal of Advanced Computer Science and Applications, Vol. 4, pp. 287–294, 2013.
13. M. Kruk, B. Świderski, S. Osowski, J. Kurek, M. Słowińska and I. Walecka, “Melanoma recognition using extended set of descriptors and classifiers”, EURASIP Journal on Image and Video Processing, (2015) 2015:43.

Comparison and Analysis of Information Retrieval DFR Models

Parul Kalra, Deepti Mehrotra and Abdul Wahid

Abstract The paper reviews the research of Information Retrieval models of DFR. Tipster Ad hoc Association Press newswire retrieval task is mainly applied in IR systems. The evaluation of the AP (Associated Press) newswire is based on the values obtained in Mean Average Precision (MAP). The purpose of the paper is to come up with the most optimized DFR model for the newswire so that the user can retrieve best results according to their queries. The results reveal that a higher performance of the probabilistic DFR models is achieved in contrast to other IR models.

1 Introduction

Divergence from Randomness Models. DFR is an extension to the Harter's 2-Poisson indexing model [1]. The model depends on the theory that the level of treatment of the elucidative words are validated by nonpareil set of records, where these words occur at a more prominent degree. Moreover, there are some words that do not fall in any record. These words therefore, chase the single Poisson model, i.e. a random distribution. Robertson et al. [2] were the first to scrutinize the Harter's model. Further, it was merged with the probabilistic model, which leads to the discovery of the best match IR [3]. The DFR structure contains 3 components:

P. Kalra (✉) · D. Mehrotra · A. Wahid
Amity School of Engineering and Technology,
Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: parulkalra18@gmail.com

D. Mehrotra
e-mail: mehdeepti@gmail.com

A. Wahid
e-mail: wahidabdul76@gmail.com

P. Kalra · D. Mehrotra · A. Wahid
Maulana Azad National Urdu University, Gachibowli, Hyderabad, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_37

1. Selecting an arbitrariness model
2. Applying the incremental model
3. Incrementing the term frequencies

IR models. In the paper, disparate weighting models have been considered for the evaluation. The weighting models can be categorized into term- and field-based models. Term models are independent of the occurrences of the terms in the corpus. Whereas the field-based models are dependent on the occurrences of terms. The models have been divided into various classes. The class that uses explicit terms for the evaluation of the IDF values comprises of TF_IDF, BM25, LemurTF_IDF, etc. The DFR class consists of PL2, BB2, DFR_BM25, In_expC2, In_expB2, InB2, InL2, etc. The hyper-geometric DFR consists of DLH, DFRee, DFReeKLIM, etc. DFI class consists of DFIC, DFIZ etc. and the language modelling class consists of DirichletLM, Hiemstra_LM etc. Some models crave for the parametric values whereas, others depend upon non-parametric values. All these models have been evaluated in our paper.

2 Experimental Setup

2.1 Outline of the Corpus

The set on which the analysis was carried out has been provided by TREC 2015 [4]. The details of Tipster Text Research Collection Volume 1 dataset Revised March 1994 are cited in Table 1. The cluster of data has been formed from the records of the daily newspaper. The collection includes excerpts from the WSJ (Wall Street Journal—1987, 1988, 1989), FR (Federal Register—1989), AP (Associated Press—1989), DOE (Department of Energy abstracts—1989, 1990), ZF (Ziff-Davis). Associated Press (1989) was used for the evaluation and analysis of the experiment [5]. The experiment was carried out using Terrier [6].

Table 1 Statistics of the TREC volume 1 dataset

Attributes	Statistics
Size of collection	500 MB
Number of text documents for AP	84,678
Number of unique terms	138,809
Number of pointers	13,384,542
Number of tokens	22,290,723

UTF-8 is used for the coding of the corpus record. Here, is an example of a template of the articles:

```
<DOC>
<DOCNO>AP890101-0001</DOCNO>
<FILEID>AP-NR-01-01-89 2358EST</FILEID>
<FIRST>r a PM-APArts:60sMovies    01-01 1073</FIRST>
<SECOND>PM-AP Arts: 60s Movies,1100</SECOND>
<HEAD>You Don't Need a Weatherman To Know '60s Films Are   Here</HEAD>
<HEAD>Eds: Also in Monday AMs report.</HEAD>
<BYLINE>By HILLEL ITALIE</BYLINE>
<BYLINE>Associated Press Writer</BYLINE>
<DATELINE>NEW YORK (AP)</DATELINE>
<TEXT> </TEXT></DOC>
```

2.2 Topic Files

The examination for the IR models was carried against 150 queries for the Association Press. According to the model followed by TREC [7], the query contains many segments (TOP, NUM, DOM, TITLE, DESC, NARR). But as per the need of our analysis we take only three of them (TOP, NUM and TITLE). On the basis of these query tags the recall and precision was reviewed. Further, we analyzed the Mean Average Precision (MAP) of the models. A sample topic file for a single query is

```
<top>
<head>Tipster Topic Description
<num>001</num>
<dom>Domain: International Economics
<title>Topic: Antitrust Cases Pending
<desc>Description:
<narr>Narrative:
<con>Concept(s):
<fac>Factor(s):
<def>Definition(s):
</top>
```

3 Evaluations

Initially, the evaluation parameters for the IR models were Precision, Recall and Fallout [8]. Table 2 contains the basic properties of the evaluation parameters.

Nowadays, for the evaluation of the query set Mean Average precision (MAP) is being used [9, 10].

Table 2 Basic evaluation parameters

Precision	Recall	Fallout
Number of relevant records retrieved from the bulk of relevant and irrelevant records	Number of relevant records retrieved from the bulk of relevant records	Number of irrelevant records retrieved from the bulk of irrelevant records

Table 3 Performance of the retrieval measurement of IR3

Parameters	MAP	*R*-precision	P@k
Definition	It is the average precision of the mean values for every query	It calculates the relevant document for the query	P@k refers to the degree of relevance on the first result retrieved
Formula	$\text{MAP} = \frac{\sum_{q=1}^{Q} AveP(q)}{Q}$	r/R	P@k

Table 4 Status of the relevant retrieved documents

Number of queries	Retrieved	Relevant
150	149,458	46,572

In our analysis, to estimate the performance of the retrieval, the values that have been considered are MAP, Recall Precision (R-Precision) and Precision @k (P@k) in Table 3.

The TREC organization uses the measures mentioned above for the evaluation of system performance. MAP is considered to be one of the best parameters for such analysis.

MAP operates on multiple queries whereas, average precision operates on the top results retrieved (i.e. k documents). If a query q is contained in a set Q (set of queries) and the query exists in the relevant document d then the average precision of the top documents k are calculated according to their rank in the corpus.

4 Results

In Table 5, the MAP values of various DFR IR models are illustrated. We observed that the DFR models (considering top six: InB2, In_expC2, In_expB2, BB2, IFB2 and InL2) have comparatively higher MAP values. Table 4 gives the status of the corpus.

For the analysis, these six models were evaluated at P@k like P@1, P@2, … P@1000. It has been illustrated in Table 6 along with its graph in Fig. 1.

Figure 2 the graph illustrates the Precision of top six DFR IR models. These IR models belongs to the DFR family where InB2 is Inverse Document Frequency, BB2 is the combination of Einstien model, IFB2 is of Inverse Term Frequency

Table 5 MAP and recall precision values of various DFR IR models

IR models	Mean average precision (MAP)	Recall precision
BB2	0.0439	0.0903
BM25	0.0382	0.0848
DFIC	0.0398	0.0859
DFIZ	0.0395	0.0859
DFR_BM25	0.0404	0.0868
DFRee	0.0307	0.0823
DFReeKLM	0.0395	0.0855
DirichletLM	0.0334	0.0782
DIL	0.0072	0.0329
DLH	0.0372	0.0828
XSqrA_M	0.041	0.086
TF_IDF	0.0383	0.0852
Himestra_LM	0.0005	0.0041
IFB2	0.0383	0.0852
In_expC2	0.0446	0.0927
In_expB2	0.0441	0.091
InB2	0.0449	0.0921
InL2	0.0430	0.0909
Js_KLs	0.0381	0.0833
LemurTF_IDF	0.0351	0.0801
LGD	0.037	0.0834
PL2	0.0399	0.0859
DLH13	0.0379	0.0835

Table 6 Some other evaluation metrics of among top DFR IR models

Measures	InB2	In_expC2	In_expB2	BB2	IFB2	InL2
P@1	0.3533	0.3733	0.3533	0.3533	0.3533	0.3067
P@5	0.3187	0.328	0.3013	0.2973	0.2933	0.2787
P@10	0.2873	0.2893	0.284	0.2813	0.2787	0.2613
P@20	0.2577	0.2587	0.2477	0.2473	0.2463	0.2287
P@50	0.2093	0.2101	0.2065	0.2053	0.2047	0.192
P@100	0.1614	0.161	0.1587	0.1589	0.1572	0.1486
P@200	0.1099	0.1089	0.1094	0.1092	0.1084	0.1021
P@500	0.058	0.0584	0.0581	0.0577	0.058	0.0545
P@1000	0.0333	0.0331	0.0331	0.033	0.0331	0.0319

model, In_expB2 and In_expC2 is of Inverse Expected Document Frequency with Bernoulli after-effect and Normalisation 2. InL2 is Inverse Document Frequency model with Laplace after-effect and N2 [3].

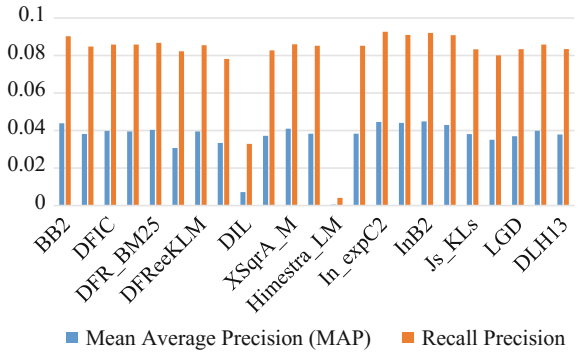


Fig. 1 *Standard DFR IR models* on the *x*-axis and *Mean average precision* and *recall precision* at *y*-axis. The graph shows the variations of precision and recall in the DFR models

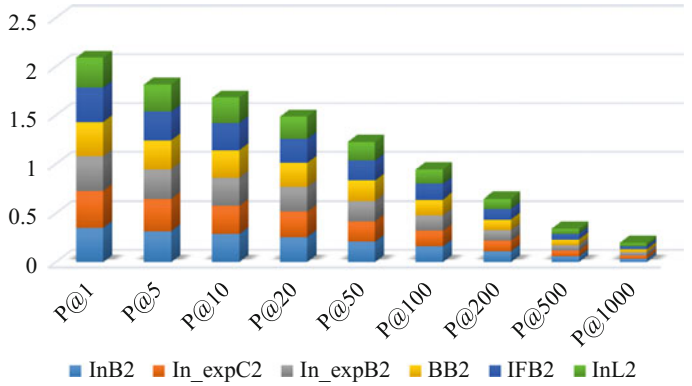


Fig. 2 *Precision@k* of top six DFR models at *x*-axis and the *range of Precision* at *y*-axis. The graph shows that the precision is declining as P@k increases

5 Conclusion

Through this analysis, we conclude that the top six DFR IR models (InB2, In_expC2, In_expB2, BB2, IFB2 and InL2) give enhanced performance as compared to the standard DFR models. The experiment was conducted on the TREC ad hoc data set. For the query analysis we considered TOP, NUM and TITLE. Then, the parameters for the evaluations were chosen, namely MAP, R-Precision and P@k. Moreover, the MAP for the top six models were greater than the rest of the models considered prior in the analysis. The outcome of the analysis can act as a baseline for the DFR IR models for ad hoc data set. In the future work we can re-frame the queries with the help of query expansion and also evaluate the pseudo relevance of the feedbacks.

References

1. S.P. Harter. A probabilistic approach to automatic keyword indexing. PhD thesis, Graduate Library, The University of Chicago, Thesis No. T25146, 1974.
2. S.E. Robertson and S. Walker. Some simple approximations to the 2-Poisson Model for Probabilistic Weighted Retrieval. In Proceedings of the Seventeenth Annual International ACM-SIGIR Conference on Research and Development in Information Retrieval (Dublin, Ireland, June 1994), Springer-Verlag, pp. 232-241.
3. S.E. Robertson, C.J. van Risjbergen and M. Porter. Probabilistic models of indexing and searching. In Information retrieval Research, S.E. Robertson, C.J. van Risjbergen and P. Williams, Eds. Butterworths, 1981, ch. 4, pp. 35–56.
4. TREC, "Text Retrieval Conference", Homepage, http://trec.nist.gov/ (Accessed on 15 March, 2015)
5. https://trec.nist.gov/data.html
6. http://terrier.org/
7. Voorhees, E.M., Harman, D.K. (Eds) : TREC, Experiment and Evaluation in Information Retrieval. The MIT Press, Cambridge (MA), 2005.
8. Cleverdon, C.W., Keen, M.; "Factors Affecting the Performance of Indexing Systems", Vol.2, ASLIB, Uk, pp. 37–59, (1966).
9. Manning, C.D., Prabhakar R., Schtze, H.: "Introduction to Information Retrieval", Cambridge University Press, New York, USA (2009).
10. Sanderson, M.: "Test Collection Based Evaluation of Information Retrieval Systems. Foundations and Trends in Information Retrieval", 4(4), 247–375, (2010).

An Extensive Review on Verbal-Guided Image Parsing

Pankhuri Agrawal, Tanupriya Choudhury, Praveen Kumar and Gaurav Raj

Abstract Verbal-guided image parsing is the window to the coming generation of luxurious ease, when all the remote controls that we need for the array of electronics we own come together at one place, with no need of going through manuals. Basic commands can be given to the program verbally by the user and the same is fulfilled. Electronic devices can be attached to the program which can utilise real-time information and demonstrate the optimisation in a virtual-induced real-time environment.

1 Introduction

ImageSpirit is a program which parses images with just verbal guidance, i.e. without the use of hands. The user can simply talk to their computer and make the changes they wish to. The program is linked to electronic devices then they can be altered as well (Switching screens on/off, changing channels, altering light intensity of lamps, temperature of Air Conditioners, etc.). It uses parsing mechanisms which involve Image Segmentation, Object Detection and Object Recognition [1].

P. Agrawal (✉) · T. Choudhury · P. Kumar · G. Raj
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: pankhuriaeran@gmail.com

T. Choudhury
e-mail: tchoudhury@amity.edu

P. Kumar
e-mail: pkumar3@amity.edu

G. Raj
e-mail: graj@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_38

1.1 Parsing

Parsing (the syntactic examination) is the approach towards fragmenting a chain of picture which is in normal dialect or the coding languages and is fitting inside with tenets of a normal linguistic use. The term parsing is derived from the Latin standards (orationis) that means part.

The word parsing has some special implementation in many segments of software engineering. The conventional sentence parsing is usually executed as a technique for comprehension the right implication of a sentence or a letter and at times with the guide of gadgets, for example, sentence outlines. As most of the part it underlines the importance of the syntactic partition.

Within the computational phonetics, the term is used so as to allude to the formal investigation by a PC of that of a sentence or any other series of letter in its own constituent, hence bringing about a parse tree that represents their syntactic connection to each other, which may likewise contain the semantic and other information or data.

1.2 Image Parsing

Characteristic pictures comprise of a staggering number of visual examples created by extremely assorted stochastic procedures naturally. The aim of picture comprehension is to parse a picture of information into its constituent examples.

Fig. 1 Image parsing segmentation explained by using an image depicting a view of an adventure park

Figure 1 is a parsing case of an adventure-park scene progressively: the human (garments/body and the face), adventure ride (a point procedure, a bend procedure, homogeneous shading areas, content), visitors (surfaces, people), sky, tress and other textures.

2 Related Works

2.1 Image to Text Description

Even in today's world of public sharing of photos and videos, most of the data being searched on Internet search engines corresponds to only the text accompanying them (tags, captions, surrounding text, etc.). Image to Text description parses the image in a way that various parts of the image can be described in words. It segments a particular image into various components which can make the search easier.

Yao et al. [2] has worked on recognition of different objects in an image which are easily described in words. So if a particular image shows a picture of a carnival with various rides, the giant wheel being one of them, the search result for 'Giant wheel' would show this particular image as well, even though it's tags are only of sorts of the word carnival.

2.2 Image Parsing: The Unifying Segmentation, Detection and Recognition

The image goes through three stages to be parsed—Image Segmentation, Object Detection and Object Recognition. Unifying, the three means of efficiency—in terms of performance, time and expense. When the image is to be parsed, it is divided into various segments which are subdivided (man—head + body, grass, sky, trees, buildings, etc.) which are then easily detected by the computer and thus recognised.

Tu et al. [3] explained how images are judged on the basis of the texture of each object within it and parsed accordingly. When these three stages are clubbed it results in a much more practical and time efficient program which cleverly processes images and optimises them accordingly.

2.3 Preferential Image Segmentation

Preferential Image Segmentation is when a particular image is 'preferentially' segmented, i.e. we parse the objects of interest and ignore the background. This method

computes the rough location of candidate objects in the image using part-based object recognition and detection. In this method, the process of image parsing—segmentation, detection and recognition—are also unified. Though it is not as efficient because the computer processes the entire image and not parts of the same.

Kumar [4] explains with the example of a person in a sports field: It is anticipated and guessed where the person would stand in the image—where his leg, elbow, face, shirt, etc., will be. According to these guesses, the image is parsed and the background is ignored; so only a part of the image is parsed and not the complete image, the 'preferential' part is parsed only.

2.4 Parsing Images of Articulated Bodies

Ramanan [5] proposed that images of bodies be parsed with the help of pose estimation—an estimation by the computer of the 'pose' of the protagonist in the image. It is done by two main methods: Edge-based Model computes the edges (body shape—head, torso; background—fence, tree) according to the pose estimation and defines the image accordingly, and the Region-based model in which the image is defined according to different regions by pose estimation (skin-arm, head, leg; white t-shirt, green grass).

2.5 Convolutional Neural Networks

Sudowe [6] worked on Convolutional Neural Networks or CNNs which can answer a particular query in a form more than binary—yes, no and maybe; due to which they easily learn excellent feature recognition, which probably makes them so popular over the recent years. CNN queries can describe images in a text format with complete detail (man, 5′10″, bag on left shoulder, mid-40s).

CNNs are the future of technology since they can judge situations by guesswork (maybe). Sudowe explained his model by making it recognize using attributes of people on the street. The model makes highly accurate suggestions by identification of attributes—height, complexion, age (by posture, skin), colours worn, clothes worn, accessories, etc.

3 Steps of Image Parsing

3.1 Image Segmentation

Image segmentation is the means toward parcelling a computerised image to various portions (sets of pixels, otherwise called super-pixels). The purpose of segmentation is to disentangle and change the representation of an image into

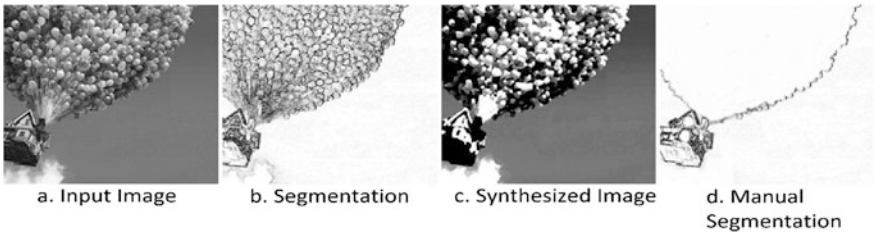


Fig. 2 Segmentation of an image

something which is more significant and simpler way to examine. Image segmentation is commonly utilised to find out the items and limits (lines, bends, and so forth.) in the images. All the more decisively, image segmentation is the way toward assigning a name to each pixel in an image to such an extent that the pixels with a similar mark share the certain qualities.

The outcome of the image segmentation is an arrangement of sections that fully covers the whole image, or an arrangement of shapes which are then separated from the image (see edge identification). Each of the pixels in an area is comparative as for some of the trademark or some registered property, for example, force, shading or the surface. Adjacent districts are really special concerning the same characteristic(s).When they are joined to a pile of images, common in therapeutic imaging, the subsequent shapes after image segmentation can be utilised so as to make the 3D recreations with the help of introduction calculations like Marching 3D squares. The image segmentation is shown in the Fig. 2.

3.2 Object Detection

After Segmentation of an image, it is easy for the computer to detect definitive objects and optimize them if need be. In the verbal-guided image parser, user can speak to the computer and decide on how they would want the image to be optimized [7].

For example, the cotton bed should be optimised, the monitor should be switched on, the glass vase should be taller/shorter, the glossy picture should be shifted to the left/right, etc.

Object detection [8] is easy for us humans as we view the world as a set of various objects but the computer views a particular image in the form of light and dark patches, the texture and that is how it perceives the image; hence identifying different objects can be a difficult task. This is made easier after Segmentation, and after optimizing the picture during detection, it is much easier for the computer to detect various objects skillfully.

3.3 Object Recognition

Our brain makes a vision which appears to be simple. It does not need any exertion for the people to differentiate between a lion and a panther, read a sign, or perceive a human's face. In any of the case, these are the issues to illuminate with a PC: they just appear to be simple in light of the fact that our brain is fantastically grand at comprehension pictures.

In the most recent couple of years the ground of the machine learning has gained colossal ground on tending to these problematic issues. Specifically, we have found that a sort of model which is called a profound convolutional neural system that can achieve a sensible execution on hard visual recognition assignments—coordinating or surpassing the human execution in a few areas.

Analysts have exhibited unfaltering advancement in PC vision by approving their conflict with ImageNet—a scholastic benchmark for PC vision. Progressive models keep on showing upgrades, every time accomplishing another cutting edge outcome: QuocNet, AlexNet, Inception (GoogLeNet), BN-Inception-v2. Scientists both inward as well as outerward to Google have distributed the papers depicting every one of these models, however, the outcomes are still hard to replicate.

4 ImageSpirit: Verbal-Guided Image Parsing

ImageSpirit is a program which parses images with just verbal guidance, i.e. without the use of hands. The user can simply talk to their computer and make the changes they wish to. The program is linked to electronic devices then they can be altered as well (Switching screens on/off, changing channels, altering light intensity of lamps, temperature of air conditioners, etc.).

Whilst developing the same, personnel were faced with major problems: (1) How to define images in words and (2) How to refine these images with verbal ques. To this, it was figured that objects be defined as nouns and their attributes be defined with the help of adjectives. For example, Cotton bed, glossy picture, etc.

After segmentation of a particular image it could be broken down and separately defined into words which when put together form the image.

Verbal-guided [9] image parsing can be used to optimise a given image and make required changes. So when the user says "Optimise the cotton bed", the computer will understand or do the same. Another sample command could be "Switch on the glossy monitor", or "Shift the wooden chair to the right". With this, a human–computer interaction is initiated wherein the user can speak to the computer and state clearly the commands.

5 Analytical Comparisons Between Image Parsing Techniques

5.1 Region Competition Equations (Zhu and Yuille 1995–1996)

This is a variation technique (PDE) that binds together the past calculations, which is similar to that of the region growing, Split-merge, SNAKE/Balloon and so on. As per the strategies of PDE, it cannot deal with the measurement change, (for example, deciding the regions' number and thus exchanging the picture models). This can be altered by the reversible jumps in the MCMC strategy.

The region competition condition indicates the development of a point $v = (x, y)$ on the shape. It comprises of two terms:

(a) A log-probability proportion test between two contiguous models. The region has better fit pushes/massacres the adversary region.
(b) An ebb and flow stream for form smoothness. Both terms act in the ordinary heading of the form.

$$\frac{\mathrm{d}\Gamma(\vec{v})}{\mathrm{d}\vec{v}} = \left(-\mu\kappa(s) + \log\frac{p(I(\vec{v});\alpha_i)}{p(I(\vec{v});\alpha_j)}\right)\vec{n}(\vec{v}) \tag{1}$$

5.2 DDMCMC Model (Tu and Zhu 2000–2003)

Arrangement is broke down to space and outline significance proposition probabilities so as to drive the Markov chain look in complicated space. Thus, it brings together the discriminative methods and the generative process. The generation process make more efficient a perplexing posterior likelihood in the Baye's framework and then the discriminative process inaccurate back utilising nearby components and so forth the last are utilised to drive the previous for quick blending and meeting.

Some examination probes nonexclusive regular image dataset verified that DDMCMC can no doubt beat the chart theoretic (diagram Cuts) algorithms and is importantly broader in definition. Just for instance, it can deal with the worldwide images models, for example, shading model and the ranging surface model, which did not take care by the discriminative process. In the same way, it can manage the different earlier models.

5.3 Graph Partitioning by Swendsen–Wang's Cut (Barbu and Zhu 2002–2003)

It is the primary rigorous (argotic and reversible Markov Chain) graph parcel algorithm that change enormous sub graphs in one move.

This means that it can effectively do the split-merge operations in a basic and skillful way.

The split-merge was proposed around 26 years ago and up to this point, in which no such algorithm can do it in general and proper way. Past algorithms could truthfully flip little sub graphs (2–3 nodes) or extensive subgraphs yet of limited sort (in J.P. Wang PAMI 98, just nearest of a node that are not near to each other can be effectively changed).

Different algorithms can exactly flip the extensive and general sub graphs yet they are confined to unique sorts of the back likelihood and cannot be appropriately connected to PC vision.

6 Results

This world now being dominated by technology not only at our fingertips, but at the mere voice of our questions and requests; where we can typically have conversations with Siri, Alexa, or Google like we used to with our elders; image parsing, too, had to explore in these arenas to be more user friendly.

ImageSpirit is such a program which parses, processes and alters images to a virtual-reality of physicality, such that we can accurately define and design and re-synthesise the given image.

It can cleverly distinguish the various elements in a picture and guess the texture of these elements as well. For example, ImageSpirit would recognise that a Television screen is glossy; so it would fare better to a command which specifies how the user would like to parse the 'glossy television screen in the centre of the wall'; similarly it can recognise that a bedsheet is linen, or cotton.

Parsing programes like ImageSpirit could also be taken up a notch by connecting them with electronic devices which feature in the images to be parsed. Now when we parse them, we can access the real-time data from those devices and even make them implement the user's desires in reality using a simple command.

Swendsen-Wang Cut is the most efficient Image Parsing Technique as it not only solves an age-old conflict of split-merge but also processes both general and extensive subgraphs. Following is a graph demonstrating the Analytical Comparison between various Image Parsing Techniques. In Fig. 3 Graph demonstrating comparative study between Image Parsing Techniques has been shown.

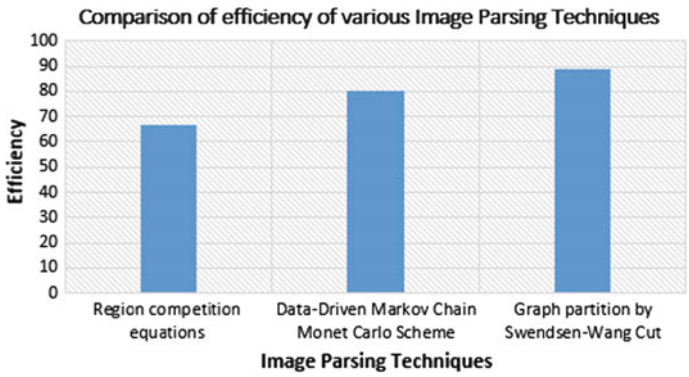


Fig. 3 Graph demonstrating comparative study between image parsing techniques

7 Applications

There are multiple applications of verbally guided image parsing:

1. Images can be optimised to see what arrangements will look like when made: This could be utilised in interior designing without physically having to move around furniture users can change the décor and textures and settle on what they want before actually having to buy.
2. Electronics can be connected to the program and operated with verbal ques—varying light/air conditioner/fan intensities, switching devices on or off, changing channels on a monitor screen, etc.
3. CNNs can be used to parse images for recognition purposes.

8 Future Work

An algorithm can be worked upon in which images could be parsed and optimised to such that we could change the light settings in it as well. This could improve the efficiency of cameras at night and prevent crimes committed even in low/no light since we would be able to change the settings and bring criminals to justice. The entire concept of "the night is for the thieves" would finally be able to put to an end.

Now there are settings to increase or decrease brightness, but to actually optimise low-light images to be at par with daylight or well-lit images is still under covers; images can be optimised such that the setting of objects in the image could be altered and we must use this technology to progress forward while making this world a better place.

References

1. Deepti Bhagwani, “Object Detection and Reorganization by Image Parsing using Wavelet Technique”, NCAICN, 2013
2. Z. Yao, Xiong Yang, Liang Lin, Mun Wai Lee and Song-Chun Zhu, “I2T: Image Parsing to Text Description Benjamin”, International Journal of Enhanced Research Publications, 2013
3. Zhuowen Tu, Xiangrong Chen, Alan L. Yuille, and Song-Chun Zhu, “Image Parsing: Unifying Segmentation, Detection, and Recognition”, IEEE, 2003
4. Sasi Kumar.S, “Preferential Image Segmentation Using Level Set Methods Based On Color, Boundary and Texture” IJETTCS, 2013
5. Ramanan, D. “Learning to Parse Images of Articulated Bodies.” *Neural Info. Proc. Systems* (NIPS), 2006.
6. Patrick Sudowe, Hannah Spitzer, Bastian Leibe, “Person Attribute Recognition with a Jointly-trained Holistic CNN Model”, IEEE, 2015
7. Anurag Kumar Mishra, Dr. Sipi Dubey, “An Analytical Study on Image Parsing”, IJARCSSE, 2012
8. A. Barbu, S.C. Zhu, “Graph Partition By Swendsen-Wang Cuts”, IEEE, 2003
9. Stephen Gould, Tianshi Gao, Daphne Koller, “Region-based Segmentation and object Detection”, NIPS, 2009
10. Joseph Tighe, Svetlana Lazebnik, “Finding Things: Image Parsing with Regions and Per-Exemplar Detectors”, IEEE, 2013

Analysis of External Content Plagiarism Using Character Swarm Optimization

Sudeshna Chakraborty, Vivek Kumar and Tanupriya Choudhury

Abstract A maneuver on plagiarism is the theft on intellectual property. A considerable apprehension on the problem of plagiarism in course assignments by students has caused academicians and students to advocate a number of devices which instructors use in an effort to control the plagiarism problem. In an effort, this paper shows the classification supports using character swarm optimization, which results in very deep understanding of various linguistic patterns, for example changing the texts into semantically equivalent but with dissimilar words and organization, shortening texts with concept simplification and specification, and gaining ideas and vital contributions of others. Some literature overview on prevalent system is also reviewed like Turnitin Detection Software, Plagchecker, etc. The paper encompasses the nomenclature which supports a deep understanding of various dialectal, textual patterns in committing the plagiarism. A plagiarism revealing system with the help of an algorithm is put forward which was recently implemented as conceptualized software in an institution. The primary aim of the conceptualized system is to spot similarities in academic processes for student assignments and to assist in detecting possible instances of plagiarism. In this paper, the concerns with evaluation of tools were discussed that motivated this work to generate a character swarm optimization (CSO).

S. Chakraborty (✉)
Jagannath University, Jaipur, India
e-mail: tumpamishti@gmail.com

V. Kumar
DCTM-Palwal, Palwal, India
e-mail: profvivekkumar@rediffmail.com

T. Choudhury
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: tchoudhury@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_39

1 Introduction

An expected parameter that matches with the sufficiently well education system and other amenities are to provide the performance on assignment and paper evaluation in an eminent role in the educational process. In this contemporary world, there is always an exclamation to attend on the aspect of parameters of standardized assignment that advances from labour-intensive to automatic systems for different aspects of modules. At every stage of edification, test is the major process of education system. Moreover, the main problem is instructors need to share a lot of time and energy in assignment correction. So, automation is required in generation of assignment correction. Exploring plagiarism on character swarm optimization patterns that explore the level of cheating in and around the assignment submission which is useful to schools, institutes, students and test paper setters who want to have a control on the pilfering with ease for example, altering the texts into a semantically comparable but with dissimilar words and organization, shortening texts with concept overview and specification, and thus adopting ideas and important assistance of others. This concept can be implemented in various faculties of engineering, medical and applied sciences. This article introduces usage of character swarm optimization pattern algorithm in submitting assignment performance detection. The main part of the algorithms is to obtain randomization technique in assignment submission, thus different sets of module wise assignment submission could be evaluated without repetition and duplication. User can obtain correction generation scheme depending upon the system storage, capacity and as per the requirement.

This is of great help for copying services. In this paper, we provide an analysis of various techniques and algorithms used to attain plagiarism check. In automatic plagiarism detection the main document is taken and the information is entrenched into it using an algorithm as embedding function and a copy is obtained. Also a key is produced in the scan procedure [1]. For original text, usually the reverse embedding function is implied. If the keys match the copied text is recovered. In this paper, we provide an analysis of various techniques and algorithms used to attain the plagiarized text image and the information is embedded into it using an algorithm as embedding function and a local and global similarity on text is obtained. Also a key is produced in the detection procedure. For term occurrence analysis, usually the reverse embedding function is implied. If the keys match the term occurrence in input and provides the stylometry technique in output analysis for detection when message is recovered (Fig 1).

2 Related Work

2.1 Turnitin

The idea Turnitin Detection Software (TDS) is a milestone on plagiarism [2]. It confirms that by diverging other plagiarism systems, the major focus of it is

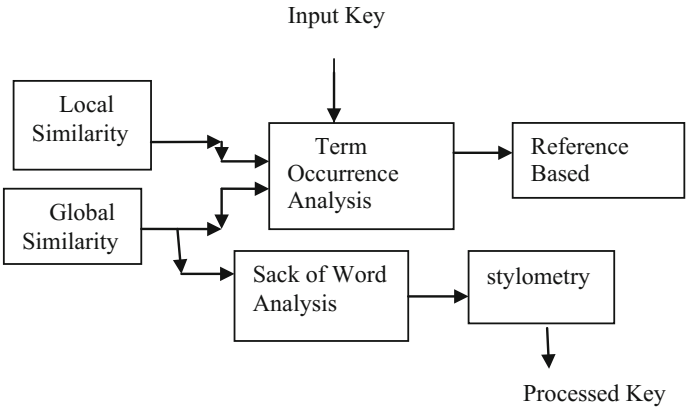


Fig. 1 Flowchart of performance-based plagiarism technique

additionally at allied distinct characteristics instead of the form of connected ones. Nevertheless, this does not imply that TDS is nonresponsive on recognized aspects, that is, punctuation and grammar, in an essay, it considers the scoring and response on grammar, style and mechanics as well [3] pre-scored essays of other students, the knowledge of source materials and standard model essays.

According to study conducted during the analysis of subject as briefed by 75% respondents Turnitin software helps the students to build a better writing skills, 72% become better instructors, 8% save time as compared to the conventional and 7% conserve printer paper and ink.

2.1.1 Drawback

Synonym and sentence structure checking is less maintained by the software. The Turnitin resourcefulness report presents on the left side simply traced one passage that is analogous to one of the documents in its storehouse. The faculty's comments face the inaccurate and incoherent documentation (parenthetical citations) of the learner as well as incited proper credentials for claims that were not merely "stock understanding" material. This latter limitation thus reaffirms the idea that the software is presently a tool [4], but the teacher is still very much at the controls of the writing class since the former is not programmed to "think" in as sophisticated a manner as an authentic writing teacher. Hence, the need is that the faculty must still carefully screen and evaluate the drafts guided by the cautions elevated by the software. Even students differentiate to observe the results obtained by Turnitin. One student (S28) remarked: "The faculty should also read it individually so that it wouldn't be appalling for the student who worked hard on it." This reminder is also emphasized in the investigation on the efficacy of the various popular plagiarism detection software used in various university [5].

2.2 PlagAware

It is used in finding plagiarisms of scholar's academic documents and thus study them. Nevertheless, it is utilized to gauge plagiarism and also to follow and prove the originality of the works which includes all of the academic documents. It generates a report that helps them to detect fast for plagiarism. The proof of authorship is also given by the PlagAware so as to become more momentous to the authors and also to ensure that the authorization granted to their publication, counting all the types of publication (which gives them additional boundary and study on this paper) shows 70% increase in the assessment of your work [6].

2.2.1 Drawbacks

The main shortcoming is the foremost idea of checking software essay like a robot for the sentences which are plagiarized and then grading it for frequency of plagiarized phrases found within the research paper that would maneuver any scholar insane while they aspire for information retrieval.

Some reports exists with two experiments which examines the unintentional plagiarism in new and old grown-ups [7]. New and old ones which select producing small group of exemplars. After very little period of retention the recall was verified and after that the subjects were told to create new exemplars (which is, exemplars not earlier generated) and when told to create new exemplars, the old contributors were much prone to repeat again and gain the exemplars that was already generated by others (that is to, generate-new plagiarism). When they were told to recall the exemplars which they had generated before, the adults were more prone to claim

Table 1 Various stylography algorithms used in plagiarism detection software

S. No.	Technique/algorithm	Proposed by	Improved factors
1	SCAM algorithm	Anzelmi [9]	Easy and highly secure
2	Vector space model algorithm	Muhr, Zechner [10]	External and intrinsic plagiarism detection
3	Longest common subsequence of semantically equivalent basic blocks	Luo, Ming et al. [11]	Improved privacy and reduced confusion of data
4	N-version technique	Zhang, Fangfang, et al. "A first step towards algorithm plagiarism detection"	High detecting parameter and less distortion
5	Karp Rabin string matching	Karp Rabin [3]	High identifying capacity and secure due to complex structure
6	Scalable document fingerprinting	Hintze [12]	Very low chances of error in the data

that they had generated exemplars that had been already generated by others (i.e., recall-own plagiarism), and were also more likely to recall exemplars that was never generated (i.e., recall-own plagiarism) (Table 1).

3 Proposed Design, Algorithm and Working Model

Character swarm optimization (CSO) is a computational technique.

It optimizes an issue by sporadically trying to progress an entrant description with the reflection to a given all-round assess on quality parameters. It solves a problem by having an occupant's concept of candidate solution, here called characters, and thus moving these characters around in the search-space in accordance with the uncomplicated mathematical formulae over the position and frequency of the character. Each association of the character is influenced by its own partial best known location. Furthermore, it is also assisted toward the best possible known positions in the search-space, as are organized again in some other enhanced position are found by other characters. The best solution is expected to move swarm on the desired direction.

Algorithm 1 = character swarm optimization for plagiarism detection

For each character m=1, …, S do

1: Initialize the character's location with a uniformly distributed random vector: ui $\sim$ l(b_lo, b_up)
2: Initialize the character's best suitable known location to its initial location to: ci $\leftarrow$ mi
3: if f(ci) < f(g) then
And then update the swarm's best known location: g $\leftarrow$ ci
4: Initialize the character's velocity: vi $\sim$ U(-|bup-blo|, |bup-blo|)
5: while a termination criterion is not met do:
for each of the character i = 1, …, S do
for each of the dimension d = 1, …, n do
6: Click the random number: rp, rg $\sim$ U(0,)
7: Then Update the character velocity to: vi,d $\leftarrow$ ω vi,d + φp rp (ci,d-xi, d) + φg rg (gd-xi,d)
Update the character's location to: xi $\leftarrow$ xi + vi
if f(xi) < f(ci) and then
8: Update the character known location: ci $\leftarrow$ xi
if f(ci) < f(g) then.
9: Update the swarm known location: g $\leftarrow$ ci and can catch or detect text or character's copied (Fig 2).

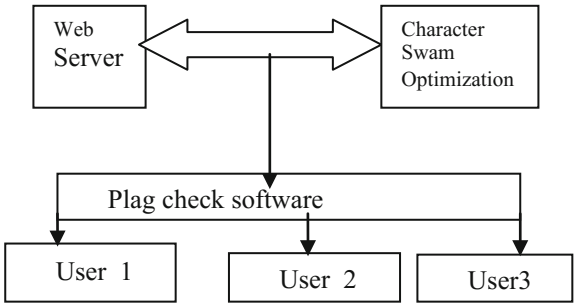


Fig. 2 System architecture

4 Aim of the Performance-Based Plagiarism System

As a universal plagiarism detection system for the basic computer operation, it must meet the following requirements: realistic text storage, which must be conventional to the general outline of the textual data. An array of assignment on practicable question types, such as objective questions, conceptualized questions, and design questions, group testing, etc., leads to a safety and consistent examination system.

4.1 Components of Performance-Based Plagiarism System

A Semantic-Based Plagiarism Evaluation on Assignment Systems for institutions purposes is analyzed and proposed with a solution which accept an input in type of questions from the admin and check for answer solution into assignment format based on the Bloom's taxonomy [8]. The merit of generating the questions based on Bloom's taxonomy helps to endow with the answer solutions on the assigned questions that help to measure the learning ability of the students [3]. The proposed framework enables in question cohort by the use of weightage implementations by deploying agents, the agents will perform different operations like the intelligent document processing with information classification and the detection of plagiarism. Thus, the system may also be termed as a multi-agent system. To remove the human process document processing tree tagger tool and building process is done too. Information classification has a list of keyword spawned by the data privilege and finds out the Bloom's category of those words, by probing an appropriate action verb in the depot which more or less matches with the given keyword. Assignment plagiarism check generation module takes the outcome of the Information classification as an input so as to cause copied text. It is a model-based approach, which fits the chosen keywords in the question template in accordance with the Bloom's levels.

5 Conclusions

The primary rationale of this relevance is to illustrate assignment and learner's plagiarism detection using algorithm for arbitration. This system is web-based as well as static-based application system with numerous features mainly producing unduplicated sets of exam paper. Also there is no possibility of paper leaks and wide portion weight age module-wise coverage. So this system is very useful to academic institutes and universities. From usability point of view, this technique is user friendly and prepares test paper in very less time in easy steps.

Our future effort is to make use of different types of randomization as well as different defense techniques can be added. Login page for user on the basis of the references used such as Creative Technique with highly developed software plagiarism on finger printing that can be effectively used by the experienced academicians and the users.

References

1. Tian, Zhenzhou, et al. "Software plagiarism detection with birthmarks based on dynamic key instruction sequences." IEEE Transactions on Software Engineering 41.12 (2015): 1217–1235.
2. Bertrand, Claude Jean. Media ethics and accountability systems. transaction Publishers, 2000.
3. Gonnet, Gaston H., and Ricardo A. Baeza-Yates. "An analysis of the Karp-Rabin string matching algorithm." Information Processing Letters 34.5 (2001): 271–274.
4. Zhang, Fangfang, et al. "A first step towards algorithm plagiarism detection." Proceedings of the 2012 International Symposium on Software Testing and Analysis. ACM, 2012.
5. Hiremath, S. A., and M. S. Otari. "Plagiarism Detection-Different Methods and Their Analysis: Review." International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN (2014): 2349–2163.
6. Ali, Asim M. El Tahir, Hussam M. Dahwa Abdulla, and Vaclav Snasel. "Overview and Comparison of Plagiarism Detection Tools." DATESO. 2011.
7. Ercegovac, Zorana, and John V. Richardson. "Academic dishonesty, plagiarism included, in the digital age: A literature review." College & Research Libraries 65.4 (2004): 301–318.
8. Hattingh, Frederik, Albertus AK Buitendag, and Jacobus S. Van Der Walt. "Presenting an alternative source code plagiarism detection framework for improving the teaching and learning of programming." Journal of Information Technology Education 12 (2013): 45–58.
9. Anzelmi, Daniele, et al. "Plagiarism detection based on SCAM algorithm." Proceedings of the international multiconference of engineers and computer scientists. Vol. 1. 2011.
10. Zechner, Mario, et al. "External and intrinsic plagiarism detection using vector space models." Proc. SEPLN. Vol. 32. 2009.
11. Luo, Lannan, et al. "Semantics-based obfuscation-resilient binary code similarity comparison with applications to software plagiarism detection." Proceedings of the 22nd ACM SIGSOFT International Symposium on Foundations of Software Engineering. ACM, 2014.
12 Heintze, Nevin. "Scalable document fingerprinting." USENIX workshop on electronic commerce. Vol. 3. No. 1. 2002.

13 Baird, Jr., John S. 1980. “Current trends in college cheating.” Psychology in the Schools 17.4 (1980): 515–522.
14 Broad, William, and Nicholas Wade. 1982. Betrayers of the Truth: Fraudand Deceit in the Halls of Science. New York: Simon and Schuster.
15 Burnheim, John.1985. Is Democracy Possible? The Alternative to Electoral Politics. London: Polity Press.

A Data Flow Pipeline and Logical View for Enterprise Big Data Architecture

Pooja Pant, Praveen Kumar and Seema Rawat

Abstract Building a Big Data Platform tops the priority list in every organization. But building architecture becomes the biggest challenge for them by dividing Big Data architecture into different stages and using these stages for building a logical view. Creating a logical view of a Big Data architecture can helps in understanding which types of tools and applications will be required and will best fit for our architecture requirement. Creating a logical view using different stages requires connecting the stage for complete information flow, which can be done by creating a pipeline structure for the architecture.

1 Introduction

The past decade witnessed the generation of enormous amount of data. Leading to the emergence of the term Big Data. There is no formal definition for Big Data. In the beginning, Big Data was sometimes referred to as large amount of data in terabytes and petabytes. Researchers used the concept of V's to elaborate the nature of Big Data.

Managing of large data requires building of a view of the data flow, data processing and information delivery. This research [1] article is divided into sections. Section 2 provides a brief about Big Data characteristics and there importance at each stage of a Big Data Architecture. In Sect. 3, we discuss about the misconception about Big Data Architecture and a Framework. Section 4 provides a logical

P. Pant (✉) · P. Kumar · S. Rawat
Amity University, Noida, UP, India
e-mail: ashima81k@gmail.com

P. Kumar
e-mail: pkumar3@amity.edu

S. Rawat
e-mail: srawat1@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_40

view of Big Data architecture and our proposed staging of our Big Data architecture. In Sect. 5, we propose a data flow pipeline for enterprise Big Data architecture.

2 What Is Big Data?

Doug Laney in 2001 proposed the 3 V's concept, these three V's comprised of volume, variety and velocity. These 3 V's were used around the world for defining Big Data [2]. Many researchers believed that the three v's weren't sufficient for understanding Big Data. Over the years more V's were added to explain the concept. The following are the various V's used for defining Big Data

Variety: Variety describes the different types and different sources of [1] data. Data is not generated from a single source but a number of sources: machines generated or transactional. Data generated is in different data types only 10% of the data present or generated is structural data whereas 90% of the data present is unstructured data (unstructured, semi-structured and quasi structured).

Volume: Volume describes the amount of data. Data in with volume in gigabytes or less is not considered as Big Data. Data ranging in between terabytes (10^{12} bytes) and geopbyte (10^{30} bytes) is considered as Big Data.

Velocity: Velocity describes the volume of data being generated with unit time. Velocity in Big Data is defined by three dimensions. The first dimension of data defines the motion in data which means the speed in which the data is to [3] be processed and displayed example stock exchange data processing and displaying. The second dimension of velocity is the lifetime of data meaning the choosing the data which will be important for your organization and discarding the data which can be misleading.

Veracity: Veracity describes the correctness and accuracy of data [1]. Data is generated from different sources and different formats by the time data is processed it quality gets degraded because of accumulation of errors. Knowing the source of generation source and extension of data becomes a matter of concern.

Value: Value describes what value of profit the data can provide to the organization [4]. Organizations needs to build a new platform for storing and processing Big Data, if the data fails to provide profit to the organization then building a Big Data technology framework becomes a liability.

Visualization: Visualization describes the ways of displaying the knowledge discovered.

Variability: Variability describes the context of the raw word. Many organizations are based on Natural Language processing or uses user input. Getting the real value and meaning of data, this is possible when the context of the word is understood as words may be static but the context may vary.

The involvement of each characteristic can be viewed in the various stages of Big Data processing as seen in Fig. 1.

Fig. 1 Characteristic of Big Data over various stages

3 Current Scenario

Managing and processing Big Data has topped the priority list. An organization chooses its framework as per its requirements in data acquisition ways. Hadoop is the most widely used framework which uses distributed file system [5, 6] and Map Reduce. After Google proposed the first version of Hadoop in 2006 a number of frameworks were built and made available.

Today we have a number of frameworks available for processing Big Data. The selection of the processing framework is decided by analyzing the source of the data and the processing [5]. There are three types of frameworks available: batch processing, real-time processing and hybrid processing Big Data framework.

Batch Processing Framework: When the data present is static in nature and the result processing time is acceptable after the complete processing apache Hadoop is the most widely used batch processing framework.

Real-Time Processing Framework: When the source of data is live streaming the operations need to be defined on each data ingested into the system. These frameworks provide the ability to process infinite amount of data ingested. Apache storm is the most widely used real time processing Big Data framework.

Hybrid Processing Framework: When the organization need to deal with large amount of stored data as well as live streaming data they use Hybrid Processing Frameworks [7]. Apache Spark is the most widely used hybrid frame work in the industries.

Most of the current Big Data Architectures are misinterpreted with Big Data Frameworks. For a few systems or for personal large data analysis connecting a few PCs and storing the files in a distributed manner for a single cycle is considered a Big Data Architecture but this is not true as it just forms a framework.

But when it comes at applying Big Data Technologies and framework at large scale or at organizational level proper designing of architecture needs to be done. Most of these framework used for working on Big Data becomes merely a stage in the entire Big Data Architecture.

4 Proposed Big Data Logical Architecture

The logical Big Data architecture needs to be viewed in different stages: vertical stages and horizontal stages. Each vertical stage has a specific set of technologies which can function separately and maintain their individuality whereas a horizontal stage is used along with more than one vertical stage.

Big Data architecture of any enterprise either big or small can be divided into various stages each stage requiring different tools and techniques. These technologies vary as per the architecture requirement of the organization [3].

4.1 Vertical Stage

Data Acquisition Technology: Many analytics and reports are being generated in order to predict the growth rate of data. The data being generated is broadly classified into transactional and non-transactional data. Transactional data can be the live streaming data, whereas no transactional data is the data present in the enterprise data warehouse. Transactional data gets converted to non-transactional data when the live stream is send to the architecture storage.

Data Storage Technologies: There exist two file systems: secondary memory and in-memory file system. HDFS is a secondary file system which uses distributed data whereas in in-memory file system the data is transferred [3] into the RAM and processed apache is the most widely used. In-memory technologies enable fast processing and Flipkart uses In-memory system with 5 TB RAM. HDFS is not built for live streaming but it can be used along with Apache Alluxio for fast in-memory processing.

Computational Technologies: The frameworks like Apache Spark as discussed in Sect. 3 can be used as the computing stage of the Big Data architecture.

Database Technologies: Traditional database are not suitable for handling large amount of growing unstructured data. Information giants like Amazon, Google are capturing exponent number of bytes every minute storing this type of data is not possible with SQL database. In order to deal with this problem, NOSQL databases were made which are capable of handling unstructured and semi-structured data. There are 4 types of NoSQL databases key-value database, columnar database, document database and graph database; selection of a database for any enterprise is based on the structure type of the data to be stored. In 2011 a new database technology was introduced and the term NewSQL Database was also introduced. NewSQL followed the ACID properties of Big Data with in-memory processing.

Data Visualization Technologies: Today data visualization has gone beyond using Excel. The need presenting complex concept and relationship for decision makers and higher authority in every domain raise the need of better graphical presentation. Data visualization is not just presenting information in lines and charts but presenting of maximum information with the least ink and less space. The visualizations tools available like D3.js, Tableau, etc., enable the enterprise to visualize both transactional and non-transactional data.

4.2 Horizontal Stages

Big data architecture is not just built by installing application at each vertical stage as seen in the vertical stages. Storing large amount of data and processing it for solution through different vertical stages calls for technologies for managing these phases and for coordinating the flow of data through them.

Resource and Service Management Technologies: Data in enterprise Big Data architecture is distributed over nodes managing of the nodes and maintaining clusters of nodes is in the computation engine. In order to maintain the base property of NoSQL a number of task and resources has to be assigned and maintained. Tracking whether the job was complete and scheduling of the [8] work among resources becomes a key for the success of the architecture. Managing the clusters of nodes is done by cluster management technology like Apache Yarn.

Node Management: In HDFS data is stored in data nodes. These nodes are slave to name nodes. The job tracker in the master node assigns the task to the task tracker in the slave node. The task tracker is allocated resource. Making sure that the job is done and the conversation is maintained is the job of the responsibility of the node manager. Apache Yarn is a node manager which provides the report of the task to its master (Resource manager).

Cluster Management: A cluster is built of a number of slave nodes where as two master nodes (name node and secondary name node). Apache Spark [9] allows cluster management in 3 ways. Standalone mode where there is just a single cluster. Apache Mesos where the master in spark is replaced by Mesos master as the cluster management and Hadoop yarn which enables cluster management at scheduled time.

Coordination Technologies: Coordination applications like zookeeper enables centralized services like maintaining, synchronization, naming and message flow through the entire architecture.

Security Technology: Data is the most valuable resource of an organization securing it is the top priority. In Big Data architecture there is flow of data from various ports, there are a number of ways for securing of the data for example authentication, encryption at rest encryption at motion, auditing, authorization, etc. There are a few technologies like gateway protection and cluster security providing tools for which enable overall architecture security.

5 Proposed Pipeline for Data Flow

All the organizations have large amount of data stored in their data warehouse or in their legacy system they have been using a business intelligence tool for getting the output for information consumption. The pipeline proposed below in Fig. 3 is of processing both legacy and live data together as well as effectively using them separately. The Data flow through architecture is shown in Fig. 3. This proposed flow architecture represents data flow pipeline of Big Data architecture [4]. In this

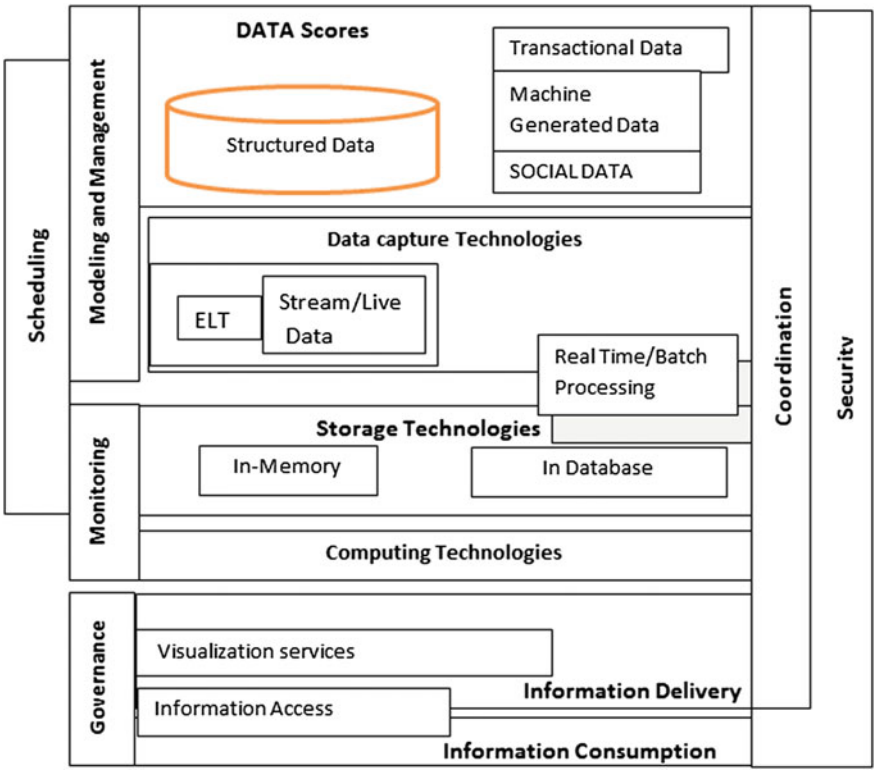


Fig. 2 Logical view of Big Data architecture

article, the data flow pipeline can be viewed as connectivity among different stages shown in Fig. 2. Different enterprise can have different architectures as per their requirements but the pipeline of their architecture is same as proposed in this research article.

In an enterprise irrespective of its size have two main data sources the live streaming data and the already stored data or sometimes called legacy data, the live streaming data passes through the data capture stage where the data can be either Apache logs or Tomcat. The Apache logs follow the JASON format. This data captured can be discarded or stored into the storage stage as per the organization storage capacity. The data from these stages flows into the computational stage or computing engine the computing engine then process the data this processed data this normalized data then flows into database stage which then flows through the business intelligence tool used by the enterprise. If in case the data stored in the legacy data storage is normalized then there is a little or no need of passing through the computing engine, the normalized data can be directly send through the database stage into the BI tool.

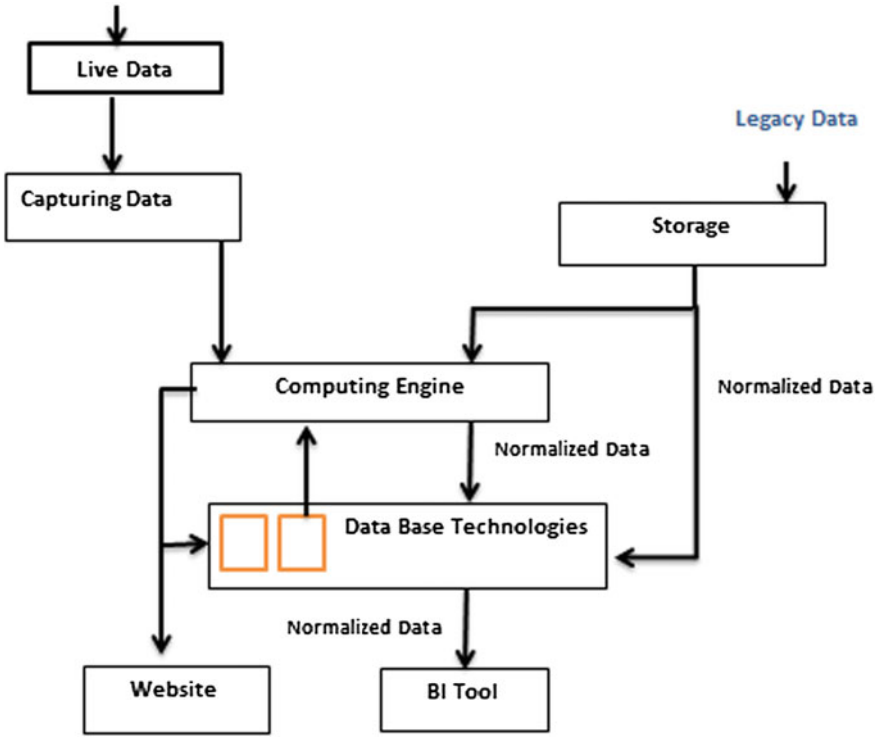


Fig. 3 Proposed Big Data architecture pipeline

If the organization needs to uses machine-learning algorithm or do sentiment analysis then they need to create a new pipeline connection [10] which not only ingest live data by real-time or batch time processing but also processed data in the database stage. But also uses machine learning library and direct its flow directly back into the computing stage. And then making it available for information delivery and consumption. The data send as the output is usually stored back the storage phase. Instead of sending this processed data back into the storage stage one should store it in the database stage this will not only reduce the access time but also increase the processing time as one more process cycle would require to access the data. While using the database stage for any machine learning process it's better to create a replica of the database. Containing only those attributes which will be required by the algorithm this will serve two purposes: first the creation of a replica act as a backup of the computed data as well as protect the computed data from being altered and updated. Since organization prefer fast processing or in-memory processing it is better to create replicas of the data in the database stage and use it for later purpose.

6 Conclusion

Building an entire Big Data Architecture requires skills as configuration, placing them, preparing and preparing of architecture for Big Data, requires expert level skills and a thorough knowledge of application requirement and hardware requirement. In this research paper, we proposed a pipeline and logical view consideration for an enterprise Big Data Architecture.

References

1. Vorhies B (2017) How Many "V"s in Big Data – The Characteristics that Define Big Data. In: Data-magnum.com. http://data-magnum.com/how-many-vs-in-big-data-the-characteristics-that-define-big-data/. Mar 2016.
2. Pant P, Tanwar R (2016) An Overview of Big Data Opportunity and Challenges. Smart Trends in Information Technology and Computer Communications.
3. Praveen Kumar, Dr. Vijay S. Rathore "Improvising and Optimizing resource utilize tion in Big Data Processing" in the proceeding of 5th International Conference on Soft Computing for Problem Solving (SocProS 2015) organised by IIT Roorkee, INDIA (Published in Springer), Dec 18–20, 2015. PP 586–589. http://link.springer.com/book/10.1007%2F978-981-10-0448-3.
4. Information O (2017) Understanding the 7 V's of Big Data - Optimus Information Inc. In: Optimus Information Inc. http://www.optimusinfo.com/understanding-the-7-vs-of-big-data/. 2016.
5. (2015) Survey on Frameworks for Distributed Computing: Hadoop, Spark and Storm. Doctoral Symposium in Informatics Engineering 95–105.
6. (2016) Analysis of Big Data with Hadoop Framework. International Journal of Advanced Research in Computer Science and Software Engineering 6:167–169.
7. Shubham Gupta, Seema Rawat, Praveen Kumar "A novel based security architecture of cloud computing" in proceeding of 3rd International Conference on Reliability, Infocom Technologies and Optimization (ICRITO) (Trends and Future Directions), 2014, held in AIIT, Amity University, Noida (will Published in IEEE Explorer) 8–10 Oct. 2014, Page 1–6. ISBN No. 978-1-4799-6895-4 DOI 10.1109/ICRITO.2014.7014676.
8. (2017) How to Install Hadoop in Stand-Alone Mode on Ubuntu 16.04 | DigitalOcean. In: Digitalocean.com. https://www.digitalocean.com/community/tutorials/how-to-install-hadoop-in-stand-alone-mode-on-ubuntu-16-04. 2016.
9. Eliminating Homogeneous Cluster Setup for Efficient parallel Data Processing in International Journal of Computer Applications Volume 64, No.17 in 2013.
10. Seema Rawat,Payal Mittal, Praveen KUMAR, Bhawna "Dissection and Proposal of Multitudinal Security Threats and Menace in Cloud Computing" in the proceeding of Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference organised by ABES Ghaziabad, INDIA (Published in IEEE Explorer), 13–14 Feb. 2015. PP 123–128, DOI 10.1109/CICT.2015.130.

A SIR Epidemic Model with Primary Immunodeficiency

Elizabeth Sebastian and Priyanka Victor

Abstract In this paper, we construct a SIR epidemic model where a small number of the susceptible individuals have low immunity levels. We divide the susceptible population into two groups based on their immunity levels and apply the transmission rate for these two populations. We derive the basic reproduction number denoted by R_0. We have two equilibria namely the disease-free and endemic equilibrium. We analyze the stability of the equilibrium points both locally and globally. Finally, we have simulated our model through MATLAB and have proved our theoretical results using numerical simulations. From the simulations, we observe that by decreasing the primary immunodeficiency, we can decrease the infection.

1 Introduction

Our immune system is an intricate system of cells, tissues and organs to keep us strong and battles off viruses and diseases. The immune system consists of two main parts: inborn κ and adaptive immune system. The primary defense against infections is done by the innate immune system. Hence, the inborn immune system has a vital task in the commencement of adaptive immune responses and since the adaptive immune responses take some time to initiate, the inborn immune system protects the body from infections until then. Immunodeficiency (or immune deficiency) is a condition in which the capacity of the immune system to fight against infections is lacking or deficient.

Primary immunodeficiency is a case in which the immunodeficiency is caused due to genetic disorders. Secondary immunodeficiency is caused due to diseases,

E. Sebastian (✉) · P. Victor
Department of Mathematics, Auxilium College (Autonomous),
Vellore, Tamil Nadu, India
e-mail: elizafma@gmail.com

P. Victor
e-mail: priyankavictor2@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_41

treatment or ecological contact with toxins. Majority of primary immunodeficiency diseases are diagnosed in children. Primary immunodeficiency is diagnosed in 1 out of every 500 people in the United States.

People with primary immunodeficiency are more prone to infections. So in case of an epidemic, people with primary immunodeficiency are more likely to be infected than other people [1–3].

2 Mathematical Model

Before constructing the model, we presume that:

- $\eta_1 < \eta$.
- $\beta_1 > \beta$.
- Due to mixing of population, the people of compartment A come in contact with the people in compartment S at a rate q.

The mathematical model provided below [4]:

$$\begin{aligned} S_{n+1} &= bp\kappa + (1-\mu)S_n - \frac{\beta\eta f S_n I_n}{1+cI_n} \\ A_{n+1} &= b(1-p)\kappa + (1-\mu)A_n - \frac{\beta_1\eta_1 A_n I_n}{1+cI_n} \\ I_{n+1} &= I(t) + \frac{\beta\eta f S_n I_n}{1+cI_n} + \frac{\beta_1\eta_1 A_n I_n}{1+cI_n} - (\mu+\gamma+\delta)I_n \\ R_{n+1} &= (1-\mu)R_n + \gamma I_n \end{aligned} \tag{1}$$

We have divided the model into four classes: S_n denotes the Susceptible members of the population without primary immunodeficiency at time n, A_n denotes the Susceptible members of the population with primary immunodeficiency, I_n denotes the infected people, R_n denotes the recovered. b is the birth rate. η and η_1 denote the immunity rate of population S and A respectively. κ denote the constant population. μ is the natural death rate. δ is the death due to infection. f is the rate at which population A comes in contact with population S. c is the saturation constant. γ is the recovery rate. β and β_1 are the transmission rates of S and A respectively. p is denotes rate of population without primary immunodeficiency.

Let us take $M(t)$ be the total population. From (1), we acquire

$$M(t) = b(p+p_1) - \mu M(t) - \delta I(t) \leq b(p+p_1) - \mu M(t)$$

For our model, we get the equilibrium point $M^* = \frac{b(p+p_1)}{\mu}$, which is globally asymptotically stable as $\lim_{t\to\infty} M(t) = M^*$.

The above system can be condensed to

$$\begin{aligned} S_{n+1} &= bp\kappa + (1-\mu)S_n - \frac{\beta\eta f S_n I_n}{1+cI_n} \\ A_{n+1} &= b(1-p)\kappa + (1-\mu)A_n - \frac{\beta_1\eta_1 A_n I_n}{1+cI_n} \\ I_{n+1} &= I(t) + \frac{\beta\eta f S_n I_n}{1+cI_n} + \frac{\beta_1\eta_1 A_n I_n}{1+cI_n} - (\mu+\gamma+\delta)I_n \end{aligned} \tag{2}$$

Let us presume that all the parameters lie between 0 and 1 and should satisfy

$$0 < \mu + \gamma + \delta < 2 \tag{3}$$

3 Basic Reproduction Number

It is denoted by R_0, is an important epidemiological measure, which helps us to find out the rate of disease spread in an epidemic [5, 6]

$$R_0 = \frac{\beta bp\kappa f\eta + \beta_1 b(1-p)\kappa\eta_1}{\mu+\gamma+\delta} \tag{4}$$

4 Equilibrium Points

- **Disease-free equilibrium**: Disease-free equilibrium is the condition in which the disease dies out in the population. $E^0 = \left(\frac{bp}{\mu}, \frac{bp_1}{\mu}, 0\right)$
- **Endemic equilibrium**: Endemic equilibrium is the condition in which the disease persists in the population. $E^* = (S^*, A^*, I^*)$

where

$$S^* = \frac{bp(1+cI^*)}{\beta f\eta I^* + \mu(1+cI^*)}, \quad A^* = \frac{bp_1(1+cI^*)}{\beta_1\eta_1 I^* + \mu(1+cI^*)}$$

and I^* is a positive root of the quadratic equation given below:

$$A_1 {I^*}^2 + A_2 I^* + A_3 = 0$$

where

$$A_1 = \frac{\beta\beta_1 p + \beta pc\mu + \beta_1 c\mu + c^2\mu^2}{\mu^2}$$
$$A_2 = \frac{\beta p\mu + \beta_1\mu + 2c\mu^2}{\mu^2} - cR_0 - \frac{\beta\beta_1 pb(A\eta + A_1\eta_1)}{\mu^2(\mu+\gamma+\delta)}$$
$$A_3 = 1 - R_0$$

5 Local Stability Analysis

Theorem 1 *E^0 is locally asymptotically stable if the condition (3) is satisfied.*

Proof Consider the Jacobian matrix of (2) under E^0. Consider $|J^0 - \lambda I| = 0$. We get the eigen values $\lambda_1 = 1 - \mu, \lambda_2 = 1 - \mu, \lambda_3 = 1 - (\mu + \gamma + \delta)$. By the condition in (3), we see that the eigen values $|\lambda_i| < 1$ for $i = 1, 2, 3$. Therefore E^0 is locally asymptotically stable under condition (3) [6].

Theorem 2 *E^* is locally asymptotically stable if the conditions*

$$\mu + \frac{\beta f\eta I^*}{1+cI^*} > 1, \mu + \delta - \frac{\beta f\eta S^*}{(1+cI^*)^2} > 1, (\mu + \eta + \kappa) > 1$$

are satisfied.

Proof Consider the Jacobian matrix of (2) under E^*. Consider $|J^* - \lambda I| = 0$. We get,

$$\phi(\lambda) = \lambda^3 + \Omega_1\lambda^2 + \Omega_2\lambda + \Omega_3 = 0 \tag{5}$$

$$\Omega_1 = -\left\{1 - (\mu+\eta+\kappa) + \left[1 - \left(\mu + \frac{\beta f\eta I^*}{1+cI^*}\right)\right] + \left[1 - \left(\mu + \delta - \frac{\beta f\eta S^*}{(1+cI^*)^2}\right)\right]\right\}$$

$$\Omega_2 = [1 - (\mu+\eta+\kappa)]\left[1 - \left(\mu + \frac{\beta f\eta I^*}{1+cI^*}\right)\right] + [1 - (\mu+\eta+\kappa)]$$
$$\left[1 - \left(\mu + \delta - \frac{\beta f\eta S^*}{(1+cI^*)^2}\right)\right]\left[1 - \left(\mu + \frac{\beta f\eta I^*}{1+cI^*}\right)\right]\left[1 - \left(\mu + \delta - \frac{\beta f\eta S^*}{(1+cI^*)^2}\right)\right]$$

$$\Omega_3 = -[1 - (\mu+\eta+\kappa)]\left[1 - \left(\mu + \frac{\beta f\eta I^*}{1+cI^*}\right)\right]\left[1 - \left(\mu + \delta - \frac{\beta f\eta S^*}{(1+cI^*)^2}\right)\right]$$

Then we see that,

$$\phi(1) = 1 + \Omega_1 + \Omega_2 + \Omega_3 > 0, \phi(-1) = -1 + \Omega_1 - \Omega_2 + \Omega_3 < 0, |\det J^*| < 1$$

If the conditions

$$\mu + \frac{\beta f \eta I^*}{1 + cI^*} > 1, \mu + \delta - \frac{\beta f \eta S^*}{(1 + cI^*)^2} > 1, (\mu + \eta + \kappa) > 1$$

and the condition (3) are satisfied. Hence, by Jury's conditions, the theorem is proved [2].

6 Global Stability Analysis

Let us define the Lyapunov function,

$$W_n = h\left(\frac{S_n}{S}\right) + h\left(\frac{A_n}{A}\right) + h\left(\frac{I_n}{I}\right) \tag{6}$$

where $h(y) = y - 1 - In(y) \geq h(1) = 0$ is defined for $y > 0$. We consider the lyapunov functions W_n^0 and W_n^* to prove the global asymptotic stability of E^0 and E^* respectively.

$$\begin{aligned} W_n^0 &= \lim_{I \to 0, S \to S^0, A \to A^0} W_n = h\left(\frac{S_n}{S^0}\right) + h\left(\frac{A_n}{A^0}\right) + I_n \\ W_n^* &= \lim_{I \to I^*, S \to S^*, A \to A^*} W_n = h\left(\frac{S_n}{A^*}\right) + h\left(\frac{A_n}{A^*}\right) + h\left(\frac{I_n}{I^*}\right) \end{aligned} \tag{7}$$

Theorem 3 E^0 of system (2) is globally asymptotically stable if $R_0 \leq 1$.

Proof The Lyapunov function is given below:

$$W_n^0 = h\left(\frac{S_n}{S^0}\right) + h\left(\frac{A_n}{A^0}\right) + I_n = W_{1n}^0 + W_{2n}^0 + I_n \tag{8}$$

$$\begin{aligned} W_{1(n+1)}^0 - W_{1n}^0 &= \frac{[S_{n+1} - S^0]}{S^0 S_{n+1}} \left[-\frac{\beta p S_n I_n}{1 + cI_n} - \mu(S_n - S^0) \right] \\ W_{2(n+1)}^0 - W_{2n}^0 &= \frac{[A_{n+1} - A^0]}{A^0 A_{n+1}} \left[-\frac{\beta_1 A_n I_n}{1 + cI_n} - \mu(A_n - A^0) \right] \\ I_{n+1} - I_n &= \frac{\beta \eta f S_n I_n}{1 + cI_n} + \frac{\beta_1 \eta_1 A_n I_n}{1 + cI_n} - (\mu + \gamma + \delta) I_n \end{aligned} \tag{9}$$

Substituting the Eqs. (9) in (8) implies, $W_{n+1}^0 - W_n^0 \leq 0$. Then, we have $\lim_{n\to\infty} W_{n+1}^0 - W_n^0 = 0$. From this, we attain that $\lim_{n\to\infty} I_{n+1} = 0, \lim_{n\to\infty} S_{n+1} = S^0, \lim_{n\to\infty} A_{n+1} = A^0$ for all $n \geq 0$ [5].

Theorem 4 If $R_0 > 1$ $R_0 > 1$, then E^* of system (2) is globally asymptotically stable.

Proof The Lyapunov function is given below:

$$W_n^* = h\left(\frac{S_n}{S^*}\right) + h\left(\frac{A_n}{A^*}\right) + h\left(\frac{I_n}{I^*}\right) = W_{1n}^* + W_{2n}^* + W_{3n}^* \tag{10}$$

We have,

$$\begin{aligned}
W_{1(n+1)}^* - W_{1n}^* &= \frac{[S_{n+1} - S^*]}{S^* S_{n+1}} \left[bp\eta \left[1 - \frac{S_n}{S^*} \right] - \beta p S_n \left[\frac{I_n}{1 + cI_n} - \frac{I^*}{1 + cI^*} \right] \right] \\
W_{2(n+1)}^* - W_{2n}^* &= \frac{[A_{n+1} - A^*]}{A^* A_{n+1}} \left[bp_1\eta_1 \left[1 - \frac{A_n}{A^*} \right] - \beta_1 A_n \left[\frac{I_n}{1 + cI_n} - \frac{I^*}{1 + cI^*} \right] \right] \\
W_{3(n+1)}^* - W_{3n}^* &= \frac{[I_{n+1} - I^*]}{I^* I_{n+1}} \left[\beta p I_n \left[\frac{S_n}{1 + cI_n} - \frac{S^*}{1 + cI^*} \right] + \beta_1 I_n \left[\frac{A_n}{1 + cI_n} - \frac{A^*}{1 + cI^*} \right] \right]
\end{aligned} \tag{11}$$

Substituting the Eqs. (11) in (10) implies, $W_{n+1}^* - W_n^* \leq 0$. Then, we have $\lim_{n\to\infty} W_{n+1}^* - W_n^* = 0$. From this, we attain that $\lim_{n\to\infty} I_{n+1} = I^*, \lim_{n\to\infty} S_{n+1} = S^*, \lim_{n\to\infty} A_{n+1} = A^*$ for all $n \geq 0$ [5].

7 Numerical Simulations

We use the set of parametric values provided below (Fig. 1):

$$\begin{aligned}
&b = 0.6, p = 0.8, \kappa = 100, \eta = 0.97, \delta = 0.147, \beta = 0.15 \\
&c = 0.23, \beta_1 = 0.5, \gamma = 0.7, \mu = 0.2, \eta_1 = 0.1, f = 0.5
\end{aligned}$$

Now keeping the above set of values, we change the value of $p = 0.91$ which denotes rate of population without primary immunodeficiency. We get the numerical simulation given below (Fig. 2).

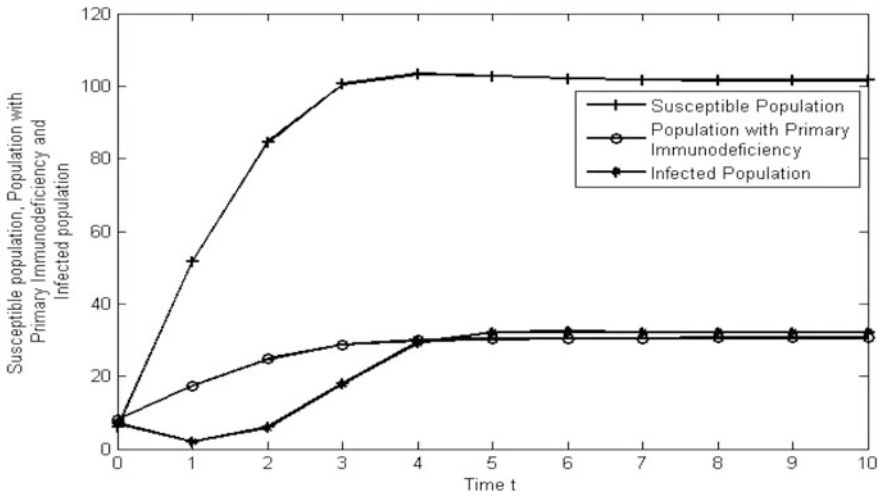


Fig. 1 SIR model with primary immunodeficiency $p = 0.8$

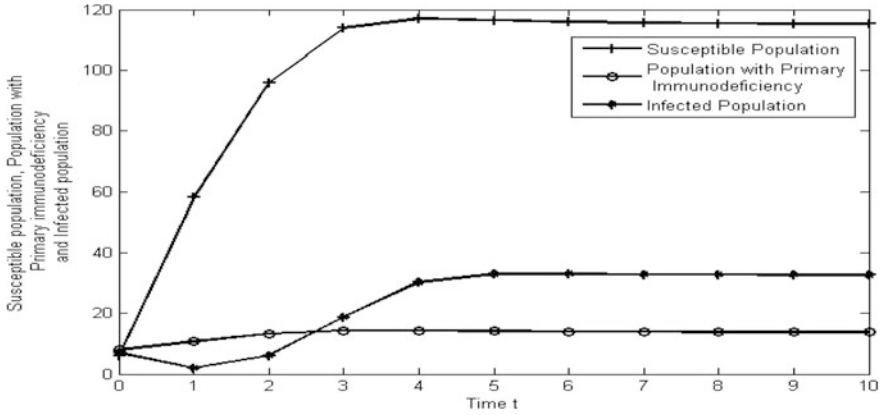


Fig. 2 SIR model with primary immunodeficiency $p = 0.91$

8 Conclusion

We have proposed a SIR epidemic model with primary immunodeficiency and have analyzed its dynamical behavior. We have derived the R_0 of the model. For this model, we have analyzed the stability of E^0 and E^* both locally and globally for $R_0 \leq 1$ and $R_0 > 1$ respectively. Finally, we have provided numerical simulations for the model using MATLAB.

References

1. M. Madkaikar, A. Mishra and K. Ghosh, “Diagnostic Approach to Primary Immunodeficiency Disorders”, Indian Pediatrics, Vol 50, (2013).
2. K.B. Blyuss and Y.N. Kyrychko, “Stability and bifurcations in an epidemic model with varying immunity period”.
3. Carin E. Reust, “Evaluation of Primary Immunodeficiency Disease in Children”, American Family Physician, Vol. 87, No. 11, June 1, (2013).
4. R.P. Agarwal, “Difference Equations and Inequalities”, New York: Marcel Dekker, (2000).
5. Yoichi Enatsu, Yukihiko Nakata and Yoshiaki Muroya, “Global stability for a discrete SIS epidemic model with immigration of infectives”, Journal of Difference Equations and Applications, Vol. 18, pp:1913–1924, (2012).
6. Sophia Jang and Saber Elaydi, “Difference Equations from Discretization of a Continuous Epidemic model with Immigration of Infectives”, Canadian Applied Mathematics Quarterly, Vol. 11, No. 1, Spring (2003).

American Sign Language Character Recognition Using Convolution Neural Network

Sarfaraz Masood, Harish Chandra Thuwal and Adhyan Srivastava

Abstract Communication is an important part of our lives. Deaf and dumb people being unable to speak and listen, experience a lot of problems while communicating with normal people. There are many ways by which people with these disabilities try to communicate. One of the most prominent ways is the use of sign language, i.e. hand gestures. It is necessary to develop an application for recognizing gestures and actions of sign language so that deaf and dumb people can communicate easily with even those who don't understand sign language. The objective of this work is to take an elementary step in breaking the barrier in communication between the normal people and deaf and dumb people with the help of sign language. The image dataset in this work consists of 2524 ASL gestures which were used as input for the pre-trained VGG16 model. VGG16 is a vision model developed by the Vision Geometry Group from oxford. The accuracy of the model obtained using the Convolution Neural Network was about 96%.

1 Introduction

Unlike communication through speech which uses sound to express one's thoughts, a sign language uses facial expressions and movement of lips, hand movements and gestures, alignment and positioning of the hands and body. Similar with spoken dialects, sign-based languages vary from one area to another like ISL—Indian Sign Language, BSL—British Sign Language and ASL—American Sign Language. Being a vision-based language, it can be categorized into three types which are as follows: use of fingers to spell each alphabet of the word called, sign vocabulary for

S. Masood (✉) · H.C. Thuwal · A. Srivastava
Department of Computer Engineering, Jamia Millia Islamia, New Delhi 110025, India
e-mail: smasood@jmi.ac.in

H.C. Thuwal
e-mail: hthuwal@gmail.com

A. Srivastava
e-mail: adhyan2095@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_42

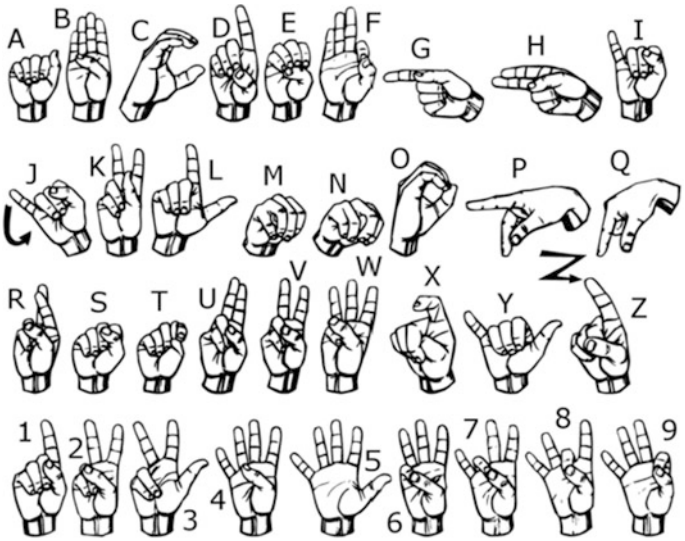


Fig. 1 ASL 36 hand gestures [12]

words (used for most of the communication), use of mouth and lip movements, facial expressions and hand and body positions. American Sign Language is prominently used by the deaf population of the United States of America along with some parts of Canada. It is an advanced and completely standardized language that uses both the shape of the hand gesture and its position and movement in the three-dimensional space. It is the primary mode of communication between the people who are deaf and their relatives.

Fundamentally, two methodologies are used for recognizing hand gestures: one that is based on sight, i.e. vision and another one that is based on sensory data measured by using gloves. The primary objective of this work is to create a system based on vision to identify finger-spelled letters of ASL. The fact that the vision-based system offers a cleaner and innate mean of interaction and communication between a human and computer is the primary reason we chose it. In this work, 36 different categories have been considered: 26 categories for English Alphabets (a–z) and 10 categories for Numerals (0–9) (Fig. 1).

The rest of the paper sdescribes the remaining five sections of the paper. Section 2 focuses on the related previous research work and their contribution, Sect. 3 describes the image augmentation and resizing of images, Sect. 4 deals with CNN, Sect. 5 deals with the results and Sect. 6 finally concludes the paper.

2 Literature Review

Trigueiros et al. [1] discussed a design, where Kinect Camera was use to obtain features corresponding to hand gestures of Portuguese sign Language. They used multiclass SVM to perform the training and testing of the gestures. Their approach required special hardware Kinect Camera which may not be available to everyone.

Tavari Neha and Deorankar [2] in their work implemented an algorithm to extract HOG features. These features were then used to train an artificial neural network, which was later used for the purpose of recognizing hand gestures and actions.

Hasan and Abdul-Kareem [3] have proposed a technique for hand gesture recognition based on shape analysis. They used neural network based approach to classify among six static hand actions to perform various tasks like maximizing and minimizing the current window, opening and closing objects etc. They used a backpropagation-based algorithm on specially designed neural network that consisted of several layers. They were able to achieve an accuracy of 86.38%.

Pigou et al. [4] in their paper proposed a system to perform recognition of gestures of Italian Sign Language. Their system combines the above works and uses Microsoft Kinect alongside GPU (Graphic processing unit) accelerated convolutional neural networks. Their system gave a high accuracy for 20 actions and they achieved across validation accuracy of nearly 92%.

Gupta et al. [5] have used HOG and SIFT to extract feature for image. These features are then combined into a single matrix. They calculated the correlation for the above matrices and used the output as an input for the classifier based on KNN. Out of 200 gestures 179 were identified correctly.

Nagarajan and Subashini [6] in their approach performed feature extraction by using Edge-Oriented Histogram in which every input image of the hand gesture is represented by the count of edge histogram. They obtained an overall accuracy of 93.75% by using multiclass SVM as the classifier.

3 Image Augmentation and Resize

The image dataset consists of ASL gestures from [7]. The dataset consists of 2524 images with 70 images per category. Each category represented a different character of ASL. This dataset was then augmented to create a dataset of 14,781 images. Out of this dataset 75%, i.e. 11,085 images were used for training and remaining 25%, i.e. 3696 images were used for testing (Figs. 2 and 3).

The images in the data set [7] were of different dimensions. Therefore, first of all we resized each image to a common resolution of 224 by 224 pixels. Once every image corresponding to each gesture was resized to a common standard resolution then they can be used as input for training of the convolutional neural network.

Fig. 2 Gesture for numeral "1" [7]

Fig. 3 Gesture for alphabet "a" [7]

To increase the size of the training dataset, new images were synthesized from the existing images thereby escalating the number of images. This not only added more images to the dataset, but also helped in dealing with the common obstacle of overfitting. One point to be kept in mind while creating new images was to ensure that the original group or class to which the image belongs remains preserved. In order to do this arbitrary and random amount of transformations such as scaling the image, translation in multiple directions, zoom and shear were applied to produce new images. These random values must be limited by properly deciding upper and lower bounds to ensure that the generated images belong to same class as the original image.

Image augmentation ensures that the classifier is strong and classifies poorly captured images with greater accuracy.

4 Convolutional Neural Network Model

Convolutional Neural Network Model was proposed by LeCun et al. [8], and has proved to be a significant milestone in the area of detection and classification of images. Deep CNNs decrease the aspect of the input images as they consist of several layers which are hidden within the network. This Depth allows the CNN to obtain low density image features in low-dimensional space. Our training model was inspired from the VGG16 [9] model.

4.1 Image Preprocessing

From each pixel mean value of the RGB pixel is subtracted. In the first pass, the model will compute the mean pixel value of each channel over the entire set of pixels in a channel and in the second pass it will modify the images by subtracting the mean from each pixel value. The mean value is subtracted to ensure that data is centered. This is done because the model involves multiplying weights and adding biases to the initial inputs to cause activations which are then backpropogated [10] with the gradients to train the model.

To stop the gradients from losing control every feature must have a similar range. Also in CNN parameters are shared therefore if images are not raised to have similar range sharing of parameters cannot be done easily because different parts of image will have unbalanced value of weights.

4.2 VGG16 Model

VGG16 [9] model shown in Fig. 1 represents a deep convolutional neural network model proposed by Simonyan and Zisserman in their work [9]. The model achieved a top-5 test accuracy of 92.7% in ImageNet.

Figure 4 depicts its macro architecture. The convolutional neural network takes as input RGB images of predefined size 224 by 224. This is why we resized every image to a size of 224 by 224. Each image is passed through multiple convolutional layers. A 3×3 receptive field size is used at every layer. The convolution stride of 1 pixel is used. To preserve the resolution after convolution appropriate spatial padding must be chosen for the convolution. The spatial padding of convolutional layer is selected such that the resolution is preserved after convolution. Some of the convolutional layers are tailed by max pooling layers which perform spatial pooling.

Convolutional layers are tailed by three FC layers (Fully Connected). A total of 4096 channels are used in initial two FC layers. 1000-way ILSVRC categorization is performed by the third FC layer. A soft-max layer acts as the last FC layer. All hidden layers have the rectification (ReLU) nonlinearity [11].

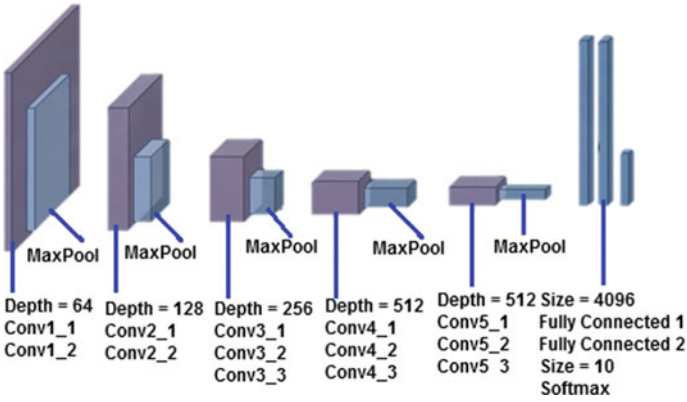


Fig. 4 VGG16 architecture

Table 1 Validation loss and accuracy for each epoch

Epoch	Validation loss	Validation accuracy
1	0.7627	71.06
2	0.2387	91.25
3	0.1634	93.96
4	0.1295	94.68

From the ImageNet database, pre-trained weights were attained to perform the initialization of the model. Since the model was originally designed to categorize images into 1000 groups the soft-max channel consisted of 1000 channels. But for our purpose we needed only 36 categories (26 categories for alphabets and 10 for numerals). Therefore, we deleted the last layer from the model and inserted a layer which would be able to categories 36 different types of images. The rest of the model remained untouched.

Stochastic gradient descent [13] with momentum was used to train the model. Batch size of 128 images and momentum of 0.9 was used. The learning and decay rates were initialized to 0.001 and 10^{-6} respectively.

It was observed that model required very few epochs to converge irrespective of the fact that it was a very deep model. This is because it was initialized using a pre-trained model. ImageNet database was used to train the pre-trained model because it contains around 1.2 million images. More the number of images, more different initial features will be discovered and there will be a greater probability of input image features to be matched.

Table 1 depicts the validation loss and accuracy obtained during each epoch of training the model. During the first four epoch loss decreased and accuracy increased at each epoch. After the fourth epoch, the loss started increasing and the model started overfitting.

5 Result

The samples were tested on the VGG16 model. The testing accuracies are tabulated below for 4 epochs.

Overall, out of the 3696 images used for testing 3531 images were classified into correct categories and the remaining 165 images were misclassified resulting in an average accuracy of 95.54%.

Table 2 shows the number of samples that were correctly classified and misclassified for each symbol and the corresponding accuracy. Figure 5 graphically depicts the accuracy obtained for each symbol. These however do not provide a complete metric to analyze the work. The table shows that while most of the symbols are classified correctly with high accuracy, zero and the alphabet 'W' are misclassified as alphabet 'O' and six respectively in significant cases (Fig. 6).

Table 2 Results obtained for each character

Characters	Total samples	Correct predictions	Incorrect predictions	Percentage accuracy
0	109	59	50	54.13
1	91	87	4	95.60
2	101	91	10	90.10
3	106	105	1	99.06
4	106	96	10	90.57
5	107	104	3	97.20
6	101	93	8	92.08
7	99	99	0	100.00
8	101	99	2	98.02
9	96	95	1	98.96
A	107	106	1	99.07
B	111	111	0	100.00
C	105	105	0	100.00
D	93	92	1	98.92
E	83	83	0	100.00
F	103	103	0	100.00
G	105	105	0	100.00
H	101	101	0	100.00
I	113	108	5	95.58
J	107	105	2	98.13
K	103	102	1	99.03
L	110	110	0	100.00
M	91	91	0	100.00
N	121	109	12	90.08

(continued)

Table 2 (continued)

Characters	Total samples	Correct predictions	Incorrect predictions	Percentage accuracy
O	111	107	4	96.40
P	100	100	0	100.00
Q	104	104	0	100.00
R	102	98	4	96.08
S	100	100	0	100.00
T	84	83	1	98.81
U	99	98	1	98.99
V	110	103	7	93.64
W	97	66	31	68.04
X	93	90	3	96.77
Y	114	114	0	100.00
Z	112	109	3	97.32

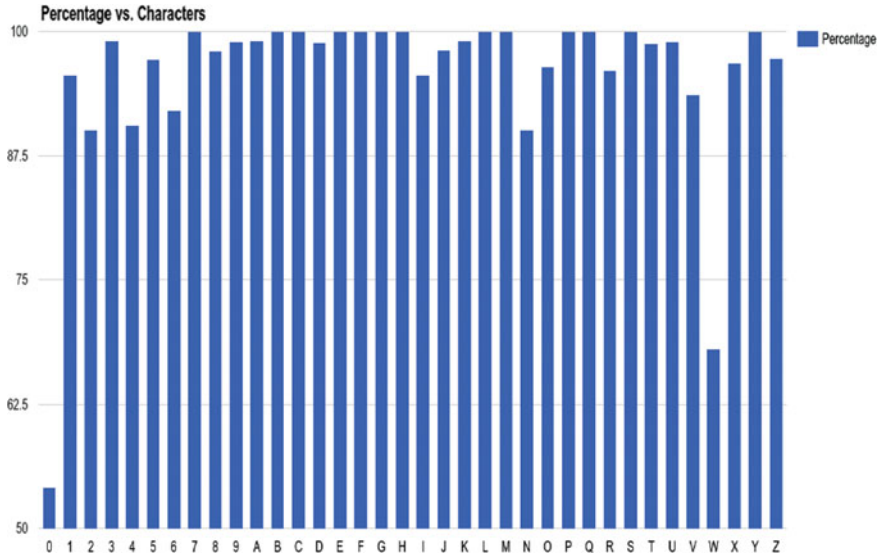


Fig. 5 Percentage accuracy for each character

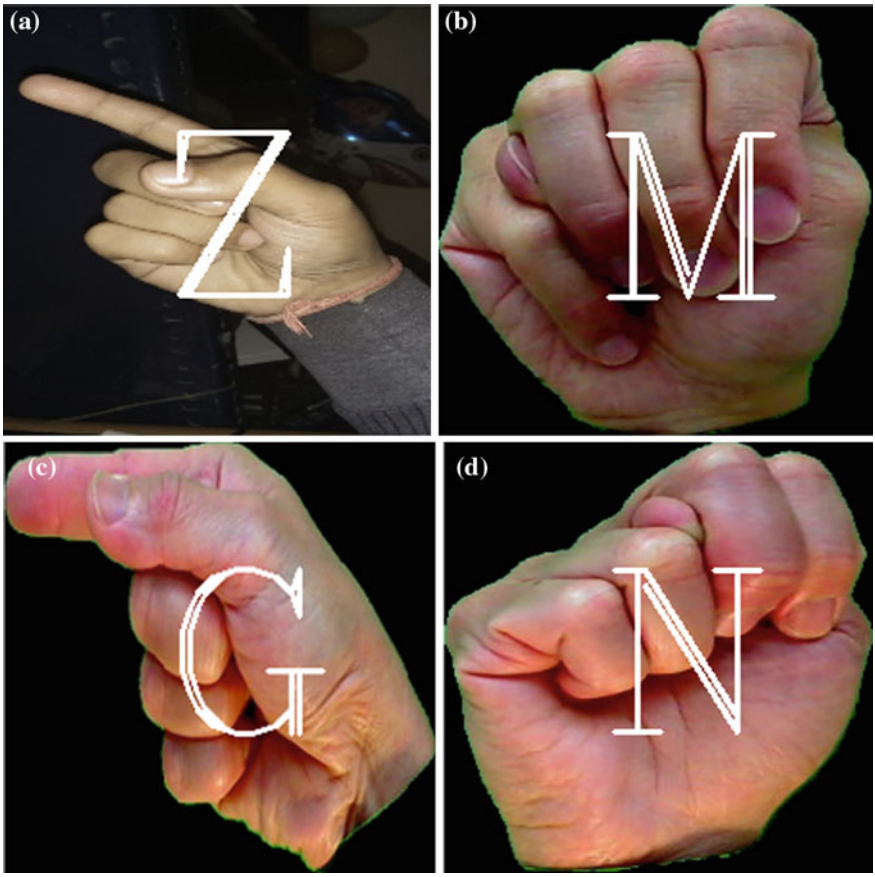


Fig. 6 **a–d** Shows the prediction of the CNN overlayed on the test images [7]

6 Conclusion

This work dealt with the application of Convolution Neural Network for recognizing the hand gestures. One of the vital applications of hand gesture recognition is to identify the sign language. Sign Language is one of the methods of communication for physically impaired, deaf and dumb people. This tool will help to bridge the gap between normal, deaf and dumb people.

From the above results, we can conclude that Convolutional Neural Network provides a significant accuracy in identifying the sign language characters. This work can be further extended to building a real-time application which can identify the sign language and including words, sentences to recognize instead of just characters.

References

1. Trigueiros, P., Ribeiro, F. and Reis, L.P.: "Vision-based Portuguese sign language recognition system". In New Perspectives in Information Systems and Technologies, 2014 Volume 1 (pp. 605–617). Springer International Publishing.
2. Tavari, Neha V., and A.V. Deorankar.: "Indian Sign Language Recognition based on Histograms of Oriented Gradient." International Journal of Computer Science Information Technologies 5 (2014).
3. Hasan, Haitham, and S. Abdul-Kareem.: "Static hand gesture recognition using neural networks." Artificial Intelligence Review 41, no. 2 (2014): 147–181.
4. Pigou, Lionel, Sander Dieleman, Pieter-Jan Kindermans, and Benjamin Schrauwen.: "Sign language recognition using convolutional neural networks", In Workshop at the European Conference on Computer Vision 2014, pp. 572–578. Springer International Publishing.
5. Gupta, Bhumika, Pushkar Shukla, and Ankush Mittal.: "K-nearest correlated neighbor classification for Indian sign language gesture recognition using feature fusion." In 2016 International Conference on Computer Communication and Informatics (ICCCI), pp. 1–5. IEEE, 2016.
6. Nagarajan, S., and T.S. Subashini.: "Static hand gesture recognition for sign language alphabets using edge oriented histogram and multi class SVM." International Journal of Computer Applications 82, no. 4 (2013).
7. Barczak, A.L.C., N.H. Reyes, M. Abastillas, A. Piccio, and T. Susnjak.: "A new 2D static hand gesture colour image dataset for asl gestures." (2011). http://mro.massey.ac.nz/bitstream/handle/10179/4514/GestureDatasetRLIMS2011.pdf.
8. LeCun, Yann, Léon Bottou, Yoshua Bengio, and Patrick Haffner.: "Gradient-based learning applied to document recognition." Proceedings of the IEEE 86, no. 11 (1998): 2278–2324.
9. Simonyan, Karen, and Andrew Zisserman.: "Very deep convolutional networks for large-scale image recognition." arXiv preprint arXiv:1409.1556 (2014).
10. Rumelhart, David E., Geoffrey E. Hinton, and Ronald J. Williams.: "Learning representations by back-propagating errors." Cognitive modeling 5, no. 3 (1988): 1.
11. Hahnloser, Richard HR, Rahul Sarpeshkar, Misha A. Mahowald, Rodney J. Douglas, and H. Sebastian Seung.: "Digital selection and analogue amplification coexist in a cortex-inspired silicon circuit." Nature 405, no. 6789 (2000): 947–951.
12. Copyright © William Vicars, Sign Language resources at LifePrint.com, http://lifeprint.com/asl101/topics/wallpaper1.htm.
13. Bottou, Léon.: "Large-scale machine learning with stochastic gradient descent." In Proceedings of COMPSTAT'2010, pp. 177–186. Physica-Verlag HD, 2010.

Analysis of Classical and Quantum Computing Based on Grover and Shor Algorithm

Gaurav Raj, Dheerendra Singh and Abhishek Madaan

Abstract Quantum Computing is the study of evolving computing technology. It works with qubits (quantum bits), unlike classical computing (which works on classical bits). A quantum computer can do multiple tasks at a time and that's why they are more efficient than traditional computers. In this paper, it has been thoroughly discussed about qubits, Superposition of qubits, gates, Superdense Coding, quantum programming languages and specially algorithms and how they are better than the best known classical algorithms. There is an exponential speedup in many of the operations performed by quantum algorithms as compared to classical algorithms. They are compared on their complexities. Most highly recognized algorithms in the field of quantum computing are: Grover's algorithm for database search and Shor's algorithm for factoring large integers into two prime numbers efficiently. In future, if quantum computers are made, it would be easier to encrypt the information that should not be revealed such as government databases in a new and secure way. Here, we will discuss about the commands used in quantum computing language (QCL) and mathematical proofs of few of the algorithms such as Deutsch–Jozsa algorithm, etc.

G. Raj (✉)
Punjab Technical University, Kapurthala, Punjab, India
e-mail: er.gaurav.raj@gmail.com

D. Singh
Chandigarh College of Engineering & Technology,
Sector-26, Chandigarh, India
e-mail: professordsingh@gmail.com

A. Madaan
Amity University, Noida, India
e-mail: abhishekmadaan717@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_43

1 Introduction

Quantum Computing is the study of evolving computer technology, which is based on the principles of quantum theory and its mechanical phenomenon, such as entanglement and quantum superposition, which help to operate computing on data. Quantum computers work on qubits or further superposition of qubits. For interpretation of qubits, we can start with the help of particles having two spin states at a time such as electrons etc.: "up" and "down". And it can be written as $|0\rangle$ and $|1\rangle$ respectively. Quantum computer works similarly as a non-deterministic computer and probabilistic computer. Many of the quantum algorithms explained in this paper are exponentially faster than the classical algorithms (such as quadratic sieve algorithm and discrete Fourier transform).

2 Quantum Computing

Quantum Computing is the study of evolving computer technology which is based on the principles of quantum theory and its mechanical phenomenon, such as entanglement and quantum superposition, which helps to operates computing on data. In classical computing, information is always stored in bits (either 0 (off/false) or 1 (on/true) at a time). It totally relies on principles expressed by Boolean algebra. While quantum computing, it works on the basis of quantum bits, also known as qubits. As we know, a bit has usually 2 states (0 or 1)—each at a time, but a single qubit represents a one, zero, a quantum superposition of 0 and 1. The quantum computing works along with a two-mode logic gate and a mode called Q01, representing its ability of changing 0 into a superposition of 0 and 1 [1–3] .

For interpretation of qubits, we can start with the help of particles having two spin states at a time such as electrons etc.: "up" and "down". And it can be written as $|0\rangle$ and $|1\rangle$ respectively. Quantum computer works similarly as a non-deterministic computer and probabilistic computer. In a deterministic computer, it is only in one of the states having probability of one (1). While in any probabilistic computer, then there is a chance of it being in any of the states. Here, we are considering a classical computer with three bits having bit strings: 000, 001, 010, 011, 100, 101, 110 and 111. And we shall describe this probabilistic state by stating eight numbers A, B, C, D, E, F, G and H {A represents the probability of computer being in the state 000, B represents the probability of computer being in the state 001 and so on}. And obviously, these probabilities should equal 1.

And the state of 3-qubit quantum computer, it is then explained by 8-dimensional vectors a, b, c, d, e, f, g and h which are also known as kets. These vectors can also be complex in nature. The sum of the square of the magnitudes of these vectors should be equal to one. That is

$$|a|^2 + |b|^2 + |c|^2 + |d|^2 + |e|^2 + |f|^2 + |g|^2 + |h|^2.$$

This indicates the fundamental difference between quantum computing and classical computer. So, the probability of measuring 000 is $|a|^2$ and so on. Ket notation is usually used to represent these states as follows:

$$a|000\rangle + b|001\rangle + c|010\rangle + d|011\rangle + e|100\rangle + f|101\rangle + g|110\rangle + h|111\rangle.$$

And here, for ex: $|100\rangle$ represents (1, 0, 0, 0, 0, 0, 0, 0).

3 Quantum Gates

It is basically a circuit which works on a small number of qubits. Unlike classical logic gates (Boolean algebra), logic gates in quantum computing are reversible in nature and can perform all the operations which can be performed by classical gates.

Hadamard Gate []: [4–6]

This gate acts on a qubit as follows:

$$|0\rangle = \left\{|0\rangle + 1|/\left(\sqrt{2}\right)\right\}|0\rangle + |1\rangle/\sqrt{2} \quad \text{and} \quad |1 = \left\{-|0\rangle - 1|/\left(\sqrt{2}\right)\right\}$$

Its matrix representation is as follows:

[]: $= \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$

Paul-X gate, Paul-Y, Paul-Z gate:

$$X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad Y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad Z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

Controlled not Gate(CNOT)

$$\text{CNOT} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Universal quantum gate

Universal quantum gates are those gates on which any computation can be made and those universal quantum gates are Phase gates, CNOT gate, hadamard (H) gate and $\pi/8$ gate.

4 Superdense Coding

It is a technique which is used to send classical bits using one quantum bit (qubit). It is the reverse of quantum teleportation. It requires quantum entanglement between sender and receiver in the form of bell pairs. Furthermore, sender and receiver in this technique share an entangled pair of qubits. Here, the term superdense refer to doubling the efficiency. Let us take an example:

Suppose John would like to send classical information to Allen using qubits, i.e. using superdense coding. John would encode the classical bits in a qubit and send it to Allen. And after receiving the qubit, Allen will be able to recover the classical information via measurement [7–9].

Suppose parts of a bell pair are distributed among John and Allen (Fig. 1$|B = \frac{1}{\sqrt{2}}(|0_J\rangle + |1_J\rangle)$).

1. When John have to send the 00 classical bits. Then he will perform identity unitary operation on her particle. The entangled state of qubit will not change. The resultant entangled qubit comes out to be

$$|B = \frac{1}{\sqrt{2}}(|0_J\rangle + |1_J\rangle).$$

2. When John wants to send the 01 classical bits. Then he will perform quantum **NOT** gate. The resultant entangled quantum state comes out to be

$$|B = \left(|1_J\rangle + |0_j\rangle\right).$$

3. When John wants to send the 10 classical bits. Then she will perform **Z** unitary operation. The resultant entangled quantum state comes out to be

$$|B = \left(|0_j\rangle + |1_j\rangle\right).$$

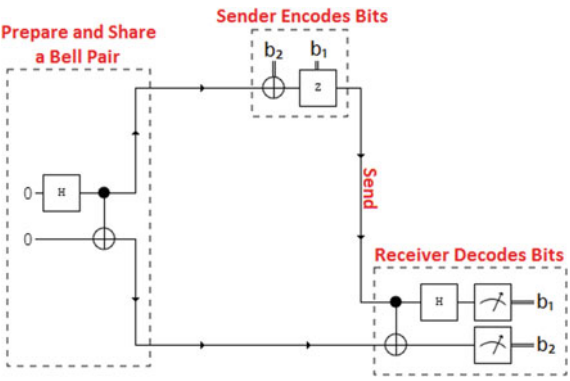


Fig. 1 When sender and receiver share an entangled state, two classical bits can be carried into one [10–12]

4. When John wants to send the 11 classical bits. Then he will perform **XZ** unitary operation. Hence, the resultant entangled quantum state comes out be:

$$|B = \left(\left|1_j\right\rangle - \left|0_j\right\rangle\right)$$

5 Quantum Algorithm

We can show the difference between capabilities of classical computers and quantum computers by discussing about the following three approaches:

1. *Non exponential speed up*:
   There are few quantum algorithms that are faster and give better speed up than the best known classical algorithms (but not exponentially faster). And, these algorithms can demonstrate the difference between the tasks performed by classical computers and quantum computers.
   Example: *Grover's algorithm* (quantum speed up of the search of an unsorted data base).
2. *Relativized exponential speed up*:
   Consider a problem of analysing the oracle (quantum black box), which performs unitary transformation. After preparing the input for the black box and measuring its output, we have to find the task done by oracle.
   Example: *Simon's exponential speed up* for finding the periodicity of any function.
3. *Exponential speed up for apparently hard problems*:
   We can have quantum algorithm which helps to solve the problem in polynomial time, where the problem seems to be hard for classical algorithm.
   Example: *Shor's factoring algorithm* [13–15].

6 Quantum Programming

Quantum programming allows the expression of quantum algorithm and it provides a tool for researchers so that they understand how quantum computation actually works [16].

Actually, QPLs are regarded as meta-programming languages because it runs on a classical or probabilistic computer which then commands the quantum computer. In other words, QPLs works on a computational model of classical computer with a quantum oracle [17, 18].

The most important programming language is QCL (quantum computing language). Its syntax is same as that of C, i.e. it contains features of any classical programming language such as loops, data types, branching, variables, etc. [19].

6.1 Variables and Data Types

Data types of this language are mentioned as follows:

Arithmetic	Complex, real, int
General	Strings and Boolean

Consider the following examples that demonstrate the use of data types, variables and constants in QCL [19]:

```
qcl> int i = 5;
Here, int is the data type of 'i' indicating that it is an integer.
qcl> complex x;    // declaring the variable
qcl> x= (0,2.7);   // setting x to 2.7
qcl> printx;
    : (0.000000, 2.700000)
qcl> print 5+2;
    : 7
qcl> print 3+ (4.6, 0.1); //evaluates complex
    : (7.600000, 3.100000)
```

QCL contains user defined or built-in functions such as:

Trignometric functions	
sin(y)	Sine of y
cos(y)	Cosine of y
tan(y)	Tangent of y
cot(y)	Cotangent of y

Logarithmic and exponential type functions	
exp(a)	Exponential of a
log(x)	Log of x
log(y, m)	Log of y with base m
sqrt(x)	Square root of x

Other functions	
lcm(a)	Least common multiple of a
gcd(x)	Greatest common divisor of x
random(x)	Any value from [0,1)
Conj(b)	Means conjugate of b
Im(b)	Imaginary part of b
Re(b)	Real part of b
Abs(b)	Means magnitude of b

Hyperbolic functions	Such as: sinh, cosh, tanh, coth

While using the assignment operator =, we should keep in mind that right value must have same data type as that of the variable, otherwise error will be generated as follows:

```
qcl> complex x;
qcl> x= hello world! ;   // variable of diff. data
type : Type mismatch: Invalid assignment
```

6.2 Loops

Loops and conditional branching are also used in QCL as follows: [20, 7]

```
a. qcl> if random>=0.3
       {print "WHITE"; }
        else
         { print "RED";}
     : WHITE
b. qcl> int x= 6;
 {  if x%2== 0
      { print "EVEN";}
   else
     {  print "ODD";}
 }
     : EVEN
```

QCL works on both classical as well as quantum commands or function. Quantum Data types used in QCL are: qureg, quvoid, qucond, etc.

Here, qureg is referred to quantum register which is also known as arrays of qubits.
Procedures used: dump, measure, etc.
Built-in functions used are: Swap, Not, CNOT, etc.

QCL works on the approach of quantum registers. Quantum registers are used as operands while working on machine state. There is an allowance of $\frac{n!}{(n-m)!}$ different m quregs by n qubit quantum computer, which means any operation done on m quregs, results in $\frac{n!}{(n-m)!}$ unitary or measurement operations.

The dump command is used to display the current state of machine state. It is used for inspecting the simulated machine state.

```
$qcl→b10 #start with 8 qubits
A. qcl> qureg α[3]; // allocating 3 qubit register
  qcl> qureg β[2]; // allocating 2 qubit register
  qcl> print α, β;   // printing the actual qubits
     : |...210>|...01>



qcl> qureg ϒ[4]; // try to allocate 4 qubits
     ! error: quantum memory not enough.
B. qcl> qureg a[3]; // allocating 3 qubit register
   qcl> mix a;
   qcl> dump; // shows current state of machine
    : state: 3/8 qubits registered, 5/8 qubits free
```

An example of command *floor*:

```
int i;
qcl> x= q[log(i, 10)];
qcl>
print x;
  : 2.146128
qcl> print floor(x);
  : 2
```

7 Grover's Algorithm

In classical computer, brute force search algorithm is used to search a unique element that matches a given condition C. Let us suppose we have knowledge about the condition, then the N no. of elements are compared $\frac{N}{2}$ times to find the perfect match with that condition [19].

But, Grover gave an algorithm which only needs $\sqrt{N}$ steps to fulfil the condition by using the concept of quantum interference and parallelism.

It is used to search database with a quadratic speedup. In other words, it is used to invert a function, i.e. let a function $y = f(x)$ that could be solved on a quantum computer. This algorithm helps us to find x when y is given. Searching of a database is related to inverse of a function because a function can be produced that gives a value of y where x matches the preferred entry in database [16] (Fig. 2).

To perform Grover's algorithm on the database:
Step 1: Let us consider a quantum superposition state $|\Psi\rangle$.

So, initialize with $|\Psi\rangle = \sum_{x=0}^{N-1} |x\rangle$.

Step 2: Then, perform the following Grover Diffusion operator O ($N^{\frac{1}{2}}$) times {complexity of the algorithm}.

A. First, apply U_w, where $U_w|\Psi\rangle = -|\Psi\rangle \; \mathrm{O}\, f(x) = 1$ or $|\Psi\rangle \; \mathrm{O}\, f(x) = 0$
B. Second, apply U_s where, $U_s = |\Psi\rangle\langle\Psi| - 1$

Step 3: Perform measurement on the former state.

8 Shor's Factoring Algorithm

This algorithm was formulated in 1994 by Dr. Peter Shor to solve prime factorisation. It takes exponentially less time to solve this problem as compared to the quadratic sieve (the best known classical algorithm to solve this problem) [22].

The complexity of the classical algorithm, quadratic sieve is O $\left(\exp\left(\frac{64}{9}\right)^{1/3} N^{1/3} (\ln N)^{2/3}\right)$, which means factoring N no. of binary bits takes exponentially more time with input size [16] (Fig. 3).

Following are the functions which are used to implement Shor's algorithm in quantum computing language: 'boolean testprime(int n)' is used to test that n is a prime number or not. 'int powmod(int x, int a, int m)' is used to calculate mod m. 'Boolean testprimepower(int n)' is used to test that whether n is a prime power or not.

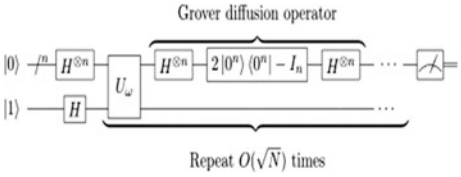


Fig. 2 Quantum circuit which represents Grover's algorithm [21]

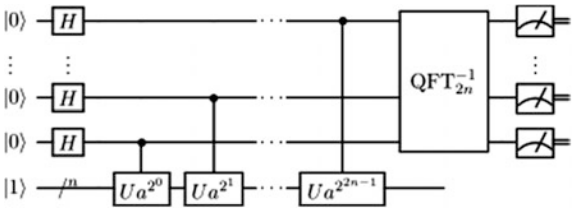


Fig. 3 Quantum circuit for shor's algorithm [23]

9 Conclusion

We can conclude that classical computers can never be able to perform quantum mechanical processes without using quantum algorithms and processes. Algorithms like Shor's factoring helps to factorize a large integer into two prime no's with complexity of log N which makes it exponentially faster and it helps to save the memory of the computer. These computations would help to encode one billion operations at a time. The mixture of quantum mechanics, physics and computing has created a rich evolving field which has changed our minds and thinking about computing and physics.

References

1. E. Aïmeur, G. Brassard, S. Gambs, Machine learning in a quantum world, in: L. Lamontagne, M. Marchand (Eds.), Proceedings of Canadian AI 2006, in: LNAI, vol. 4013, Springer, 2006, pp. 431–442.
2. S.L. Andresen, John McCarthy: Father of AI, IEEE Intelligent Systems (September/October 2002) 84–85.
3. A. Baltag, S. Smets, LQP: The dynamic logic of quantum information, Mathematical Structures in Computer Science 16 (2006) 491–525.
4. A. Barenco, C. Bennet, R. Cleve, D.P. DiVincenzo, N. Margolus, P. Shor, T. Sleator, J.A. Smolin, H. Weinfurter, Elementary gates for quantum computation, Physical Review A 52 (1995) 3457–3467.
5. P.A. Benioff, The computer as a physical system: A microscopic quantum mechanical Hamiltonian model of computers as represented by Turing machines, Journal of Statistical Physics 22 (1980) 563–591.
6. S.C. Benjamin, P.M. Hayden, Multiplayer quantum games, Physical Review A 64 (2001), art. no. 030301.
7. S. Bettelli, T. Calarco, L. Serafini, Toward an architecture for quantum programming, The European Physical Journal D 25 (2003) 181–200.
8. G. Cattaneo, M.L. Dalla Chiara, R. Giuntini, R. Leporini, An unsharp logic from quantum computation, International Journal of Theoretical Physics 43 (2004) 1803–1817.
9. R.Y. Duan, Y. Feng, M.S. Ying, Entanglement is not necessary for perfect discrimination between unitary operations, Physical Review Letters 98 (2007), art. no. 100503.
10. E. Bernstein, U. Vazirani, Quantum complexity theory, SIAM Journal on Computing 26 (1997) 1411–1473.
11. Wilde, Mark (18 April 2013). Quantum Information Theory. Cambridge University Press. p. 181. ISBN 978-1-107-03425-9.
12. Nielsen, Michael A.; Chuang, Isaac L. (9 December 2010). "2.3 Application: superdense coding". Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge University Press. p. 97. ISBN 978-1-139-49548-6.
13. A. Bertoni, C. Mereghetti, B. Palano, Quantum computing: 1-way quantum automata, in: Z. Esik, Z. Fulop (Eds.), Proceedings of 7th International Conference on Developments in Language Theory, in: LNCS, vol. 2710, Springer, 2003, pp. 1–20.
14. G. Birkhoff, J. von Neumann, The logic of quantum mechanics, Annals of Mathematics 37 (1936) 823–843.

15. R. Bonner, R. Freivalds, A survey of quantum learning, in: R. Bonner, R. Freivalds (Eds.), Proceedings of the 3rd Workshop on Quantum Computation and Learning, 2002, pp. 106–119.
16. T. Altenkirch, J. Grattage, A functional quantum programming language, in: Proceedings of the 20th Annual IEEE Symposium on Logic in Computer Science (LICS), 2005, pp. 249–258 Dr Iain Styles], "The Quantum Fourier transform" .
17. O. Brunet, P. Jorrand, Dynamic quantum logic for quantum programs, International Journal of Quantum Information 2 (2004) 45–54.
18. R. Chadha, P. Mateus, A. Sernadas, Reasoning about imperative quantum programs, Electronic Notes in Theoretical Computer Science 158 (2006) 19–39.
19. T. F. Havel, C. J. L. Doran, "A Bloch-Sphere-Type Model for Two Qubits in the Geometric Algebra of a 6-D Euclidean Vector Space", PROC. SPIE THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING Vol.5436, 93-106 (2004), 2nd Conf. Quantum information and computation; arXiv:quantph/0403136
20. Bennett, C.; Wiesner, S. (1992). "Communication via one- and two-particle operators on Einstein-Podolsky-Rosen states". Physical Review Letters. 69 (20): 2881. PMID 10046665. doi:10.1103/PhysRevLett.69.2881
21. Julian Brown, "Minds, Machines and Multiverse: The Quest for the Quantum Computer"
22. P. Shor, 'Quantum computing', proceedings of the International Congress of Mathematicians, 1998.
23. Stephane Beauregard, "Circuit for Shor's algorithm using 2n+3 qubits", Quantum Information and Computation, Vol. 3, No. 2 (2003) pp. 175–185.
24. P. Bruza, K. Kitto, D. Nelson, C. McEvoy, Extracting spooky-activation-at-a-distance from considerations of entanglement, in: P. Bruza, et al. (Eds.), Proceedings of Third International Symposium on Quantum Interaction, in: LNCS, vol. 5494, Springer-Verlag, 2009, pp. 71–83.

A Mathematical Model on Deforestation Due to Human Population and Its Effect on Farm Fields: Role of Technology in Its Conservation

Elizabeth Sebastian and Preethi Victor

Abstract In this paper, a mathematical model is projected and analyzed to study the deforestation due to human population and its effect on farm fields and role of technology in its conservation. We consider the variables namely, density of human population, density of trees, farm fields and degree of endeavour of technology used for the preservation of trees. Density of trees is assumed to be depleted by human population, but it is conserved by technological endeavour. Further this affects the growth rate of crops in farm fields. We discretize the model by applying backward Euler scheme and analyze the stability of the model. Finally, we have simulated our model for the deforestation and its effect on rice crops in India for the year 2005, and have considered reforestation techniques for its conservation and have provided numerical simulations using MATLAB.

1 Introduction

Human ecology is a study about the interaction between human beings and their environment. "Deforestation, is the elimination of a forest or a set of trees. Deforestation means altering the forestland and using it for various purposes. Due to industrialization, many forests have been ruined and lot of animals have been dying out. Forests envelop almost a third of the earth's land surface. Forests provide many remuneration namely the hydrologic phase, avoidance of climate change and safeguarding of biodiversity."

About 1.6 billion people depend on the profits that forests offer, including food, fresh water, clothing, traditional medicine and shelter. But forests are under danger, besides these benefits. Indian forests are under stress caused by human population.

E. Sebastian (✉) · P. Victor
Department of Mathematics, Auxilium College (Autonomous),
Vellore, Tamil Nadu, India
e-mail: elizafma@gmail.com

P. Victor
e-mail: preethivictor2@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_44

A large number of people live in rural areas and most of them have land-based financial system.

As a consequence of deforestation, sinks are no longer capable of sustaining and regulating water pour from rivers to streams. Trees are efficient in water mass intake. The forests acts as an envelop against corrosion. Forests carryout an important task by taking in the rainwater and distributing it to rivers that supply water for cities and agriculture. When there are no forests there is no absorption of rainwater by soil and hence it flows causing floods.

Crops in the farm fields are irrigated by water that flow from the hills. Due to floods caused by deforestation, the farm fields receive water that are contaminated with mud. This deterioration in water quality affects the production of crops. This in turn affects the human beings by causing many health problems. Therefore, we need to analyze the use of technology in preserving trees and farm fields.

J.B. Shukla, Kusum Lata and A.K. Misra analyzed on modelling the depletion of a renewable resource by population and Industrialization: Effect of Technology on its conservation [1]. In this paper, we have constructed a mathematical model to analyze the use of technology on preserving the trees. In Sect. 2, A mathematical model is considered and discretized. In Sect. 3, we list the equilibrium points of the model. We analyze the stability of the model in Sect. 4. Section 5 consists of numerical simulations through MATLAB. Conclusion is given in Sect. 6.

2 The Mathematical Model

The Mathematical model of deforestation due to human population is given below [2–5]

$$\begin{aligned}
\frac{dH}{dt} &= r\left(1-\frac{H}{L}\right)H + r_0HF + r_1HB - r_2H \\
\frac{dB}{dt} &= s\left(1-\frac{B}{K}\right)B - r_1HB - s_1B + \theta BT \\
\frac{dF}{dt} &= (s_2 + s_3B)F - r_0HF \\
\frac{dT}{dt} &= \mu(K-B) - \mu_0T
\end{aligned} \tag{1}$$

where

H Density of the Human population.
B Density of the Trees.
F Density of the crops in Farm fields.
T The degree of endeavour of technology used for conservation of Trees.
r Intrinsic growth rate the human Population.
r_0 Rate of increase in Human population due to the crops.
r_1 Rate of increase in Human population due to Trees.

r_2 Natural death rate of Human population.
s Intrinsic growth rate of the trees.
s_1 Natural death rate of the trees.
s_2 Intrinsic growth rate of the crops.
s_3 Growth rate of crops due to the irrigation formed by Trees.
μ Growth rate of technological endeavour.
μ_0 Depletion rate of technological endeavour.
θ Growth rate of trees due to technological endeavour.
L Carrying Capacity of the human population.
K Carrying Capacity of the trees.

We discretize the above system of differential equations using backward Euler scheme and we obtain the following system of difference equations.

$$\begin{aligned} H_{n+1} &= H_n + rH_{n+1}\left(1 - \frac{H_{n+1}}{L}\right) + r_0 H_{n+1}F_{n+1} + r_1 H_{n+1}B_{n+1} - r_2 H_{n+1} \\ B_{n+1} &= B_n + sB_{n+1}\left(1 - \frac{B_{n+1}}{K}\right) - r_1 H_{n+1}B_{n+1} - s_1 B_{n+1} + \theta B_{n+1}T_{n+1} \\ F_{n+1} &= F_n + (s_2 + s_3 B_{n+1})F_{n+1} - r_0 H_{n+1}F_{n+1} \\ T_{n+1} &= T_n + \mu(K - B_{n+1}) - \mu_0 T_{n+1} \end{aligned} \tag{2}$$

3 Fixed Points

i. $E_0 = \left(\hat{H}, 0, 0, 0\right)$

where $\hat{H} = \frac{K(r-r_2)}{r}$

ii. $E_1 = (\bar{H}, \bar{B}, 0, 0)$

where

$$\bar{H} = \frac{K\{Lr_1(s - s_1) + s(r - r_2)\}}{\left(KLr_1^2 + sr\right)}, \quad \bar{B} = \frac{L(s - s_1)}{s} - \frac{Lr_1}{s}\bar{H}$$

iii. $E_2 = \left(\tilde{H}, \tilde{B}, \tilde{F}, 0\right)$

where

$$H^* = \frac{(s - s_2)}{r_1} - \frac{sB^*}{Lr_1}$$
$$B^* = \frac{Lr_0 r_1}{(Lr_1 s_3 + r_0 s)}\left[\frac{(s - s_2)}{r_1} - \frac{s_2}{r_0}\right]$$
$$F^* = \frac{K(r_2 - r_1 B^* - r) + rf(B^*)}{Kr_0}$$

. iv. $E_3 = (H^*, B^*, F^*, T^*)$

where,

$$rH^*\left(1 - \frac{H^*}{K}\right) + r_0 H^* F_{n+1} + r_1 H^* B^* - r_2 H^* = 0$$
$$sB^*\left(1 - \frac{B^*}{K}\right) - r_1 H^* B^* - s_2 B^* + \theta B^* T^* = 0$$
$$(s_2 + s_3 B^*)F^* - r_0 H^* F^* = 0, \mu(K - B^*) - \mu_0 T^* = 0$$

The Jacobian matrix of the system (2) is given by

$$J = \begin{pmatrix} 1 + r - \frac{2rH}{K} + r_0 F + r_1 B - r_2 & r_1 H & r_0 H & 0 \\ -r_1 B & 1 + s - \frac{2sB}{L} - r_1 H - s_2 & 0 & \theta \\ -r_0 F & s_3 F & 1 + (s_2 + s_3 B) - r_0 H & 0 \\ 0 & -\mu & 0 & 1 - \mu_0 \end{pmatrix} \tag{3}$$

4 Stability of the Mathematical Model

Theorem 1 *The fixed point* $E_0 = \left(\hat{H}, 0, 0, 0\right)$ *is stable if*

$$r < 2 + r_2, s_2 < 2 + s - r_1\left(\frac{K(r - r_2)}{r}\right), r_0 < \frac{(2 + s_2)r}{K(r - r_2)}, \mu_0 < 2 \tag{4}$$

Otherwise unstable [6].

4.1 Local Stability of the Fixed Point $E_1 = (\bar{H}, \bar{B}, 0, 0)$

Consider the Jacobian matrix of the system (2) with respect to the fixed point E_1. The Jury conditions are satisfied when the conditions given below hold [7].

$$\begin{aligned} 1 + \Omega_1\Omega_2 + \Omega_2\Omega_3 + \Omega_1\Omega_3 + \Omega_4 + \Omega_5 &> \Omega_1[\Omega_2\Omega_3 + \Omega_5 + 1] + [\Omega_4 + 1]\Omega_3 + \Omega_2 \\ 1 + \Omega_1\Omega_2 + \Omega_2\Omega_3 + \Omega_1\Omega_3 + \Omega_4 + \Omega_5 &< \Omega_1\Omega_2\Omega_3 - [\Omega_1 + \Omega_2 + \Omega_3] - \Omega_1\Omega_5 - \Omega_3\Omega_4 \\ \Omega_1\Omega_2\Omega_3 &< 1 - \Omega_1\Omega_5 - \Omega_3\Omega_4 \end{aligned} \tag{5}$$

where

$$\begin{aligned} &\Omega_1 = 1 + r - \frac{2r\bar{H}}{L} + r_1\bar{B} - r_2, \quad \Omega_2 = 1 + s - \frac{2s\bar{B}}{K} - r_1\bar{H} - s_2 \\ &\Omega_3 = 1 - \mu_0, \quad \Omega_4 = r_1^2\bar{H}\bar{B}, \quad \Omega_5 = \theta\mu\bar{B} \end{aligned}$$

Theorem 2 *The fixed point* $(E_1 = (\bar{H}, \bar{B}, 0, 0))$ *is stable if the conditions given in* (5) *hold. Otherwise it is unstable.*

4.2 Local Stability of the Fixed Point $E_2 = \left(\tilde{H}, \tilde{B}, \tilde{F}, 0\right)$

Consider the Jacobian matrix of the system (2) with respect to the fixed point E_2. The Jury conditions are satisfied when the conditions given below hold [7].

$$\begin{aligned} 1 + [3 + \sigma_2(\sigma_3 + \sigma_4) + \sigma_3(\sigma_4 + \sigma_1) + \sigma_1(\sigma_2 + \sigma_4)] + [\sigma_4(\sigma_1\sigma_2\sigma_3 + \sigma_3\sigma_5 - \sigma_6 + \sigma_2\sigma_7) + \sigma_1\sigma_3\sigma_8] > \\ [\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4] + [(\sigma_1\sigma_2 - \sigma_5)(\sigma_3 + \sigma_4) + \sigma_1(\sigma_3\sigma_4 + \sigma_8) - \sigma_6 - \sigma_7(\sigma_2 + \sigma_4) + \sigma_3\sigma_8] \end{aligned}$$

$$\begin{aligned} 1 + [3 + \sigma_2(\sigma_3 + \sigma_4) + \sigma_3(\sigma_4 + \sigma_1) + \sigma_1(\sigma_2 + \sigma_4)] + [\sigma_4(\sigma_1\sigma_2\sigma_3 + \sigma_3\sigma_5 - \sigma_6 + \sigma_2\sigma_7) + \sigma_1\sigma_3\sigma_8] > \\ [\sigma_6 + \sigma_7(\sigma_2 + \sigma_4)] - [\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4] + [(\sigma_5 - \sigma_1\sigma_2)(\sigma_3 + \sigma_4) - \sigma_1(\sigma_3\sigma_4 + \sigma_8) - \sigma_3\sigma_8] \end{aligned} \tag{6}$$

$$\sigma_1\sigma_2\sigma_3\sigma_4 < 1 - \sigma_1\sigma_3\sigma_8 - \sigma_3\sigma_4\sigma_5 - \sigma_2\sigma_4\sigma_7 + \sigma_4\sigma_6$$

where

$$\begin{aligned} \sigma_1 &= 1 + r - \frac{2r\tilde{H}}{L} + r_0F^* + r_1\tilde{B} - r_2, \quad \sigma_2 = 1 + s - \frac{2s\tilde{B}}{K} - r_1\tilde{H} - s_2 \\ \sigma_3 &= 1 + \left(s_2 + s_3\tilde{B}\right) - r_0\tilde{H}, \quad \sigma_4 = 1 - \mu_0, \quad \sigma_5 = r_1^2\tilde{H}B^* \\ \sigma_6 &= r_0r_1s_3\tilde{H}\tilde{B}\tilde{F}, \quad \sigma_7 = r_0\tilde{F}, \quad \sigma_8 = \mu \end{aligned}$$

Theorem 3 *The fixed point* $E_2 = \left(\tilde{H}, \tilde{B}, \tilde{F}, 0\right)$ *is stable if the conditions given in* (6) *hold. Otherwise it is unstable.*

4.3 *Local Stability of the Fixed Point* $E_3 = (H^*, B^*, F^*, T^*)$

Consider the Jacobian matrix of the system (2) with respect to the fixed point E_3. The Jury conditions are satisfied when the conditions given below hold [7].

$$\begin{aligned}
&1 + [3 + \eta_2(\eta_3 + \eta_4) + \eta_3(\eta_4 + \eta_1) + \eta_1(\eta_2 + \eta_4)] + [\eta_4(\eta_1\eta_2\eta_3 + \eta_3\eta_5 - \eta_6 + \eta_2\eta_7) + \eta_1\eta_3\eta_8] > \\
&\quad [\eta_1 + \eta_2 + \eta_3 + \eta_4] + [(\eta_1\eta_2 - \eta_5)(\eta_3 + \eta_4) + \eta_1(\eta_3\eta_4 + \eta_8) - \eta_6 - \eta_7(\eta_2 + \eta_4) + \eta_3\eta_8] \\
&1 + [3 + \eta_2(\eta_3 + \eta_4) + \eta_3(\eta_4 + \eta_1) + \eta_1(\eta_2 + \eta_4)] + [\eta_4(\eta_1\eta_2\eta_3 + \eta_3\eta_5 - \eta_6 + \eta_2\eta_7) + \eta_1\eta_3\eta_8] > \\
&\quad [\eta_6 + \eta_7(\eta_2 + \eta_4)] - [\eta_1 + \eta_2 + \eta_3 + \eta_4] + [(\eta_5 - \eta_1\eta_2)(\eta_3 + \eta_4) - \eta_1(\eta_3\eta_4 + \eta_8) - \eta_3\eta_8]
\end{aligned} \tag{7}$$

$$\eta_1\eta_2\eta_3\eta_4 < 1 - \eta_1\eta_3\eta_8 - \eta_3\eta_4\eta_5 - \eta_2\eta_4\eta_7 + \eta_4\eta_6$$

where

$$\begin{aligned}
\eta_1 &= 1 + r - \frac{2rH^*}{L} + r_0F^* + r_1B^* - r_2, \quad \eta_2 = 1 + s - \frac{2sB^*}{K} - r_1H^* - s_1 + \theta T^* \\
\eta_3 &= 1 + (s_2 + s_3B^*) - r_0H^*, \quad \eta_4 = 1 - \mu_0, \quad \eta_5 = r_1^2H^*B^* \\
\eta_6 &= r_0r_1s_3H^*B^*F^*, \quad \eta_7 = r_0F^*, \quad \eta_8 = \mu
\end{aligned}$$

Theorem 4 *The fixed point* $E_3 = (H^*, B^*, F^*, T^*)$ *is stable if the conditions given in* (7) *holds. Otherwise it is unstable.*

5 Numerical Simulations

We analyze the model through simulations using MATLAB. According to the data from 2005, the total land area in India is 297,319,000 ha and the forest area is 67,701,000 ha. Percent of forest cover in India is 22.77%. The change in forest cover from 2000 to 2005 is 29,400 ha which is 0.04%. Rice is the major crop produced in India. So, we take rice crop into consideration. Growth rate of rice crop in India for the year 2005 is 10.57%.

In the year 2005, consumption of rice in India is 87771.62 tonnes. We make use of technology to conserve the forests. Here the technology considered is

reforestation technique. Between 1990 and 2005, India gained an average of 361,500 ha of forest per year. The amounts to an average annual reforestation rate of 0.57%.

We consider the following set of parametric values (Figs. 1 and 2):

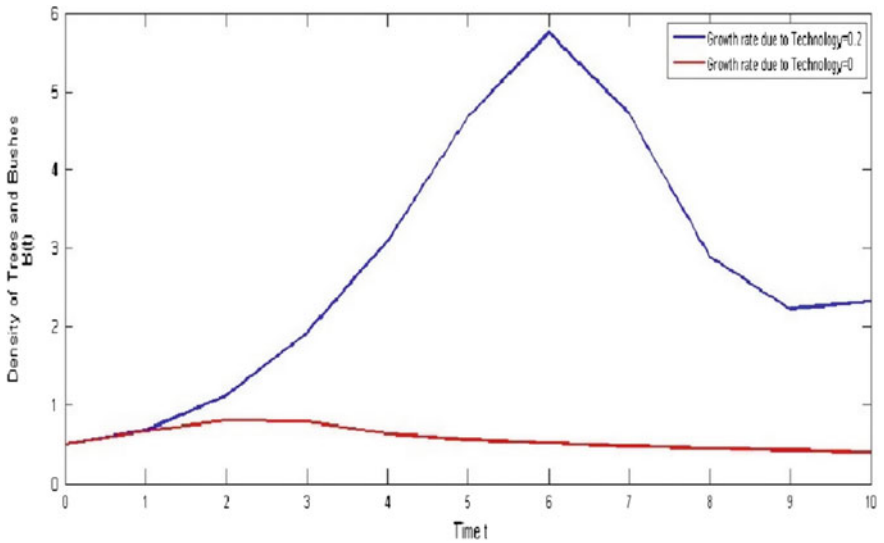


Fig. 1 Density of trees for different values of θ

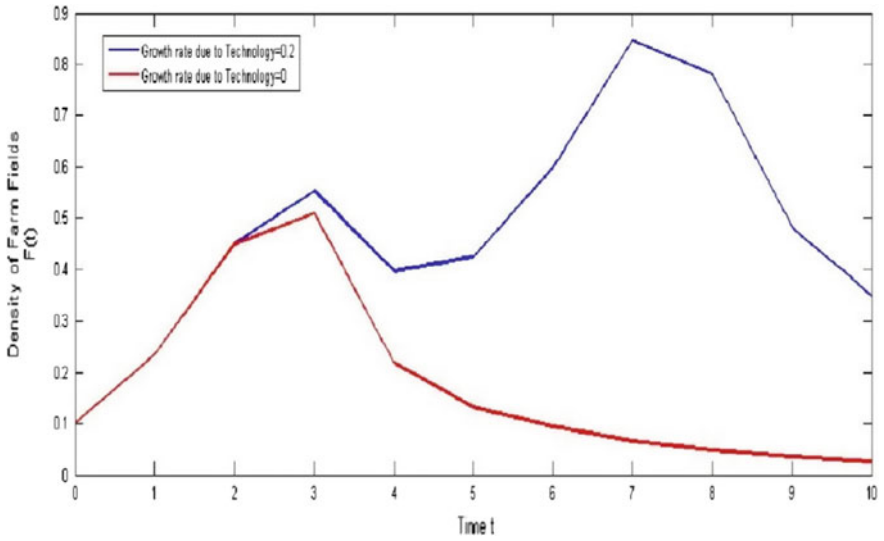


Fig. 2 Density of crops in the farm fields for different values of θ

$$r = 1.5, s = 0.2277, \quad L = 5, K = 5, \quad r_0 = 0.4, \quad r_1 = 0.04, \quad r_2 = 0.07,$$
$$s_1 = 0.01, \quad s_2 = 0.1057, \quad s_3 = 0.3, \quad \mu = 0.5, \quad \mu_0 = 0.3$$

6 Conclusion

In this paper, we have constructed a mathematical model on deforestation due to human population and its effect on farm fields and role of technology in its conservation using a system of Difference equations. We have considered the growth rate of human population and the trees to be logistic. And also the growth rate of human population depends on density of trees and farm fields. We analyze the stability of the model about each fixed point. We have provided numerical simulations using MATLAB by considering different values for growth rate of trees due to technological endeavour.

References

1. J.B. Shukla, Kusum Lata and A.K. Misra, Modeling the depletion of a renewable resource by population and Industrialization: Effect of Technology on its conservation, Natural Resource Modeling, Volume 24, Number 2, May 2011.
2. Vivi Ramdhani, Jaharuddin and Nugrahani E.H.: Dynamical System of Modelling the Depletion of Forestry Resources Due to Crowding by Industrialization, Applied Mathematical Sciences, Vol. 9, no. 82, 4067–4079, (2015).
3. Manju Agarwal and Rachana Pathak: Conservation of Forestry Biomass and wildlife population: A Mathematical Model, Asian Journal of Mathematics and Computer Research, 4 (1): 1–15, (2015).
4. Dubey, B., Sharma, S., Sinha, P., and Shukla J.B: Modelling the depletion of forestry resources by population and population pressure augmented industrialization, Applied Mathematical Sciences, 33, 3002–3014, (2009).
5. Manju Agarwala, Tazeen Fatimaa and Freedman H.I.: Depletion of forestry resource biomass due to industrialization pressure: a ratio-dependent mathematical model, Journal of Biological Dynamics, Vol. 4, No. 4, 381–396, (2010).
6. Canan Celik and Oktay Duman: Allee effect in a discrete-time predator–prey system, Chaos, Solitons and Fractals, 40, 1956–1962, (2009).
7. J.D. Murray, Mathematical biology. New York: Springer-Verlag, (1993).
8. Unal Ufuktepe, Sinan Kapcak and Olcay Akman: Stability Analysis of the Beddington Model with Allee Effect, Appl. Math. Inf. Sci. 9, No. 2, 603–608, (2015).

An Approach to Analyze Cyberpsycho Attacks Enabled Using Persuasive Messages

Prashant Gupta and Manisha J. Nene

Abstract The study in this paper discusses and analysis the Cyberpsycho Attack, where an attacker uses end-user's cyber space and social connections to affect his or her mindset or psychological sensibility to achieve short-term or long-term goals. The strategies in these attacks persuade decision-making ability of an individual or society or community to attain certain objectives by disseminating the persuasive messages in the form of texts/multimedia messages to accomplish political, religious, economical, social gains using cyberspace. The work in this paper explains the role of persuasive technology; and proposes a model to understand Cyberpsycho effects, describes the elements and phases of Cyberpsycho attacks, an approach along with a model for identification and analysis of Cyberpsycho attacks; emotions and sentiments analysis, rigorously. The results show that the persuasive messages may lead to Cyberpsycho attacks launched with an objective of attaining economical/political/social gains. The work in this paper is a step toward proposing a method to analyse emotions and sentiments forwarded using persuasive environments.

1 Introduction

Cyber world is a lawless and unchecked marketplace, where ideas become part of our lives. They keep everyone and everything connected through its services. Further, the revolution of Internet-enabled devices plays a significant role to increase its usage. One can take health advises, learn new skills, view new places, showcase his or her skills, purchase household or business products, banking, news reporting, and many other activities. These all activities can be done and dissem-

P. Gupta (✉) · M.J. Nene
Department of Computer Science & Engineering,
Defence Institute of Advanced Technology (DIAT),
Pune 411025, Maharashtra, India
e-mail: prashant_mce15@diat.ac.in

M.J. Nene
e-mail: mjnene@diat.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_45

inate worldwide on-the-go. It is observed that whatever incidents take place in the real world, the true or false information or messages or opinions related to it are shared using social media without any delay. Presence of different celebrities, leaders or government officials on these platforms make these platforms more valuable hence suitable for use and misuse of it; and misuse leading to cyber attacks. Since these high-profile users using these services attract millions of followers and every news or information shared by them will reached too many users at a time. The act of information sharing makes leaves impact in the mindset of social media users. Hence, to counter any large impact due to this it becomes essential to analyze the messages disseminate over social media.

In current environment, people make more friends through social media online rather than offline as a result of this, it makes bigger platform for communication and information exchanges. They also have faith on the facts and information on the messages forwarded by the connected ones which affect their perception or opinions or decisions.

In this paper, the author analyzes the texts based on current trending topics or personalities using Twitter which may influence user's action or perception towards someone's desirable goals.

The sentiment analysis on social media data mostly used to identify the customer feedback, review analysis, etc., about the particular products or services. In [1], the authors analyze the text content of social media sites related to pizza industries. Further, it is also used by the authors to analysis the political trends during elections to study the opinion of the users for political benefit [2].

In [3], the author analyzes social media to find out malicious links, spam and accounts to study online campaigns which contains spam links or texts. In [4], the authors analyze the static social network graph to detect random link attacks.

Contribution: The study in this paper analyzes the texts based on current trending topics or personalities using Twitter which may influence user's action or perception towards someone's desirable goals. Further, the work in this paper explains the role of persuasive technology and proposes a model to understand Cyberpsycho effects and its relation with new class of attacks termed as Cyberpsycho attacks. The work describes the elements and phases of Cyberpsycho attacks and describes an approach along with a model for the identification and analysis of emotions and sentiments, rigorously. The analysis intends to identify the trend of message-exchange to observe and predict whether it leads to Cyberpsycho attacks. The work in this paper is a step toward proposing a method to analyze emotions and sentiments forwarded using persuasive environments.

Outline of the paper: Sect. 2 describes the proposed work, Sect. 3 results and observations and Sect. 4 concludes the work along with the future directions enumerated.

2 Proposed Work

2.1 Motivation

Cyber attacks are mostly performed by the legitimate users. They are skilled to use the required hardware or software tools, but to deploy *Cyberpsycho attack* there is no need of any good programming skills or tools; the only requirement is to access Internet. Lots of false information, facts, and so-called rumors are disseminated over social media everyday. Since many celebrities, leaders or government officials are also on these platforms, it is necessary to observe the information flows, and study how it leaves its impact in the mindset of social media users.

In author's work [5], the author defines this behavior as a *Cyberpsycho effect* which leads to *Cyberpsycho attack,* where cyberspace is used to impact the psychology of an individual/group/community.

2.2 Proposed Cyberpsycho Model and Its Parameters

Figure 1 represents the proposed model which describes the crucial parameters that are instrumental in invoking the Cyberpsycho Attack [5]. These parameters play an important role to enable Cyberpsycho effects, leading to build an environment by the adversary to affect the mindset or change the opinion of public.

Captology is the term where *persuasive technology* is used to analyze, research and design the synergistic computer products, developed for the intention of changing someone's actions or perception through social influence and persuasion [6, 7].

Persuasive technology or captology mostly used in improving business, medical and lifestyle are found to be quite impressive in diverting people's actions and perceptions. But nowadays and in future too, it may deliberately be used to affect

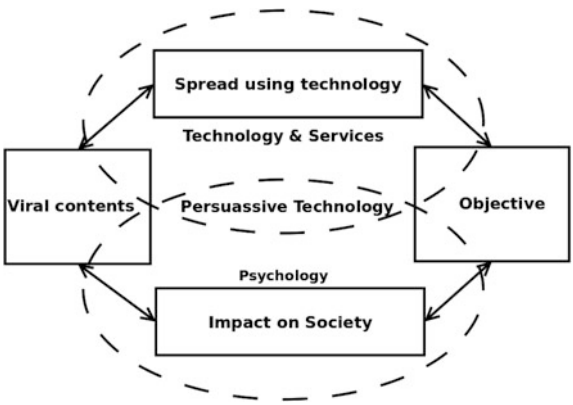


Fig. 1 Cyberpsycho effect and parameters

people's mind towards certain objective either in positive or negative direction to attain some gain.

Viral contents are in different digital format like texts, pictorial images, or video, etc., *Objective of Cyberpsycho attack* depends upon the adversary's need and the intensions to attain advantage of using the cyberspace [5].

The social media service providers provide *technical tools and services* which makes easy to upload information on-the-go and provide features to users to observe the insights of shared contents. Hence, it is not required to have any technical knowledge to use them. They provide good documentation and interactive tutorials for users free of cost to better use their applications.

2.3 Phases of Cyberpsycho Attack

Figure 2a represents the involvement/role of various entities to realize a *Cyberpsycho attack*. The stages of realizing *Cyberpsycho attack* on cyber space, when the persuasive messages are used to launch is represented in Fig. 2b. Figure 2c describes the target/destination of *Cyberpsycho attacks*.

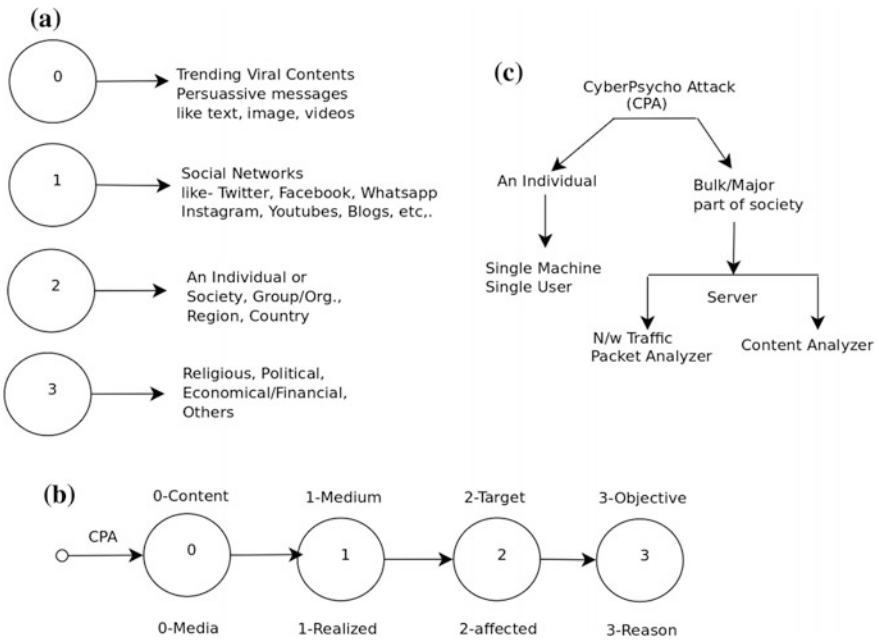


Fig. 2 Details of Cyberpsycho attack with all the elements during enabling phase

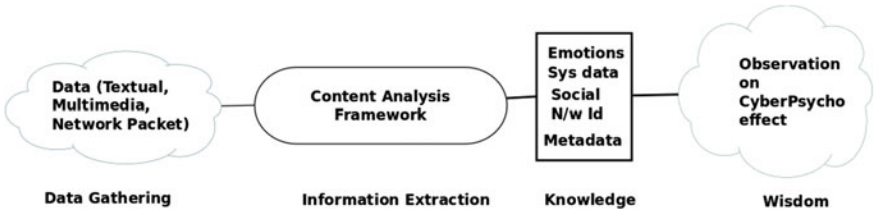


Fig. 3 Model for identification and analysis of Cyberpsycho attacks

2.4 Model to Analyze Cyberpsycho Attack

The Cyberpsycho attacks fall under different categories according to possible beneficiaries after the effect like political, religious, economical or financial, business, region, terrorism, international, or others. The effect and causes are different according to the objectives or motives.

An approach to analyze Cyberpsycho attack is described in the section. Figure 3 represents the generic phases to analyze Cyberpsycho attack, enumerated as follows:

1. First observed the trending topics and news events.
2. Register an Twitter application using a Twitter account.
3. Establish a secure authentication between Twitter application and API in *R*.
4. Collect tweets based on the keywords related to trending news.
5. In database, user id, device information, metadata, etc., were also imported with the tweets for further analysis.
6. Notice and save emotions, sentiment of texts by using packages of *R*.
7. Find out most frequent words within the collected texts.

3 Results and Observation

Environment used for the analysis of the proposed model described in Fig. 3 is as follows:

Ubuntu 14.04 Linux x86_64 machine with 8GB RAM, *R* version 3.3.2, and RStudio 1.0.44 with twitteR [8] and sentiment [9] packages with dependent libraries.

In the collected Twitter data, the information acknowledged are the keywords, metadata like date, time, user id, browser, device details, etc. Analyze the knowledge which is obtained by steps described in Sect. 2.4 and relate it to the Cyberpsycho effect categories and can identify using psychological aspects, the observation of *before* and *after* effect and possible cause of attack.

There are different kinds of emotions in the messages observed over Twitter messages which triggered Cyberpsycho effect. Plot Figs. 4 and 5 facilitate the

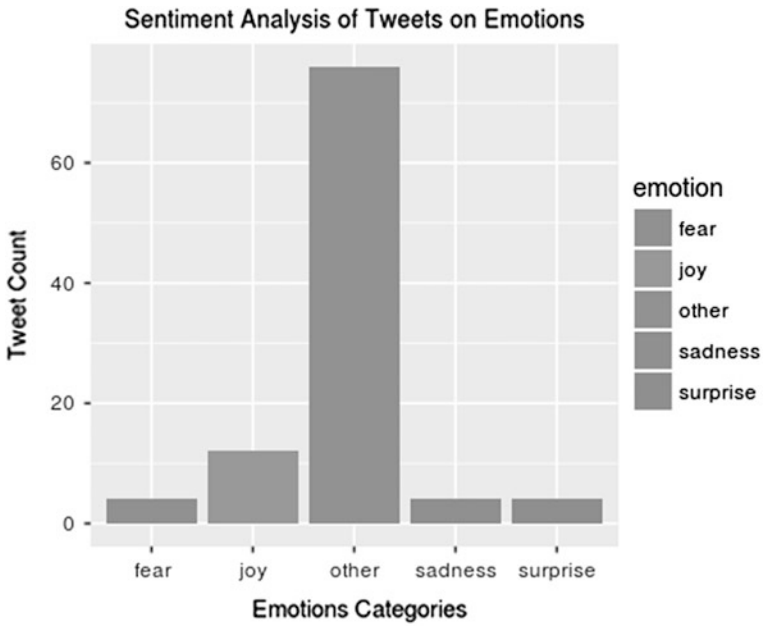


Fig. 4 Sentiment analysis of tweets on emotions

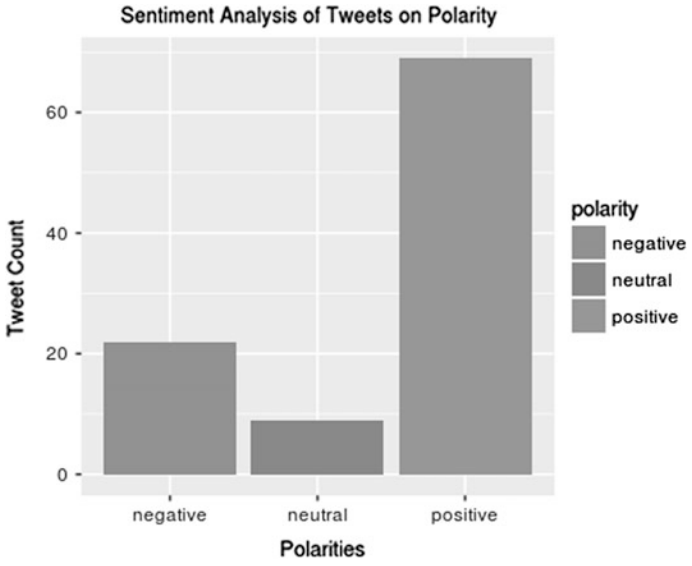


Fig. 5 Sentiment analysis of tweets on emotions

interpretations of the emotions in the messages. Maximum number of tweets falls under *other* category, which shows limitations of sentiment package as well as the format of the collected text data in which most of the tweets does not contain complete English words. The objective of this sample analysis was to identify and analysis the sentiment contents with respect to tweets based on the current trending news and events and extend the definition and recommendations in [5] by using an approach using existing packages and framework to categorizing the contents, in the form of texts and may produce an observatory view or report for psychological analysis of different impact over attitude or behavior of an individual or community.

4 Conclusion

The study in this paper analyzes the texts based on current trending topics or personalities using Twitter which may influence user's action or perception toward someone's desirable goals. Further, the work in this paper explains the role of *persuasive technology* and proposes a model to understand *Cyberpsycho effects* and its relation with new class of attacks termed as *Cyberpsycho attacks*. The work describes the *elements and phases of Cyberpsycho attacks* and describes an approach along with a model for the identification and analysis of emotions and sentiments, rigorously. The analysis intends to identify the trend of *message-exchange* to observe and predict whether it leads to *Cyberpsycho attacks*.

The results show that the persuasive messages may lead to Cyberpsycho attacks launched with an objective of attaining economical/political/social gains. The work in this paper is a step toward proposing a method to analyze emotions and sentiments forwarded over social media and may motivate researchers, authors, psychologists to analyze the content over social media with different perspective.

References

1. He W, Zha S, Li L. Social media competitive analysis and text mining: A case study in the pizza industry. International Journal of Information Management. 2013 Jun 30;33(3):464–72.
2. Wani GP, Alone NV. Indian Election Using Twitter. In Proceedings of the International Conference on Data Engineering and Communication Technology 2017 (pp. 251–261). Springer Singapore.
3. Gao H, Hu J, Wilson C, Li Z, Chen Y, Zhao BY. Detecting and characterizing social spam campaigns. InProceedings of the 10th ACM SIGCOMM conference on Internet measurement 2010 Nov 1 (pp. 35–47). ACM.
4. Shrivastava N, Majumder A, Rastogi R. Mining (social) network graphs to detect random link attacks. In Data Engineering, 2008. ICDE 2008. IEEE 24th International Conference on 2008 Apr 7 (pp. 486–495). IEEE.
5. Gupta P, Nene MJ. CyberPsycho Attacks: Techniques, Causes, Effects and Recommendations to End-Users. International Journal of Computer Applications. 2016 Jan 1;156(11).

6. Fogg BJ. Persuasive technology: using computers to change what we think and do. Ubiquity. 2002 Dec 1;2002(December):5.
7. Fogg BJ, Cuellar G, Danielson D. Motivating, influencing, and persuading users: An introduction to captology. Human Computer Interaction Fundamentals. 2009 Mar 2:109–22.
8. Gentry J. twitteR: R based Twitter client (Version 1.1. 8). https://CRAN.R-project.org/package=twitteR.
9. Jurka TP. Sentiment: Tools for Sentiment Analysis. R package version 0.2. https://CRAN.R-project.org/package=sentiment.

An Analytical Survey on Smart Electricity Meter Using GSM

Shobhit Mendiratta, Mukul Garg, Jitender Singh Jadon and Neha Arora

Abstract Electrical metering instrument innovation has made some amazing progress from what it was over 100 years prior. From the first massive meters with substantial magnets and loops, there have been numerous developments that have brought about size and weight lessening notwithstanding change in components and particulars. Today, utilization and appropriation has turned into a major subject for examination by gigantic distinction in generation and utilization. Thus, to limit the power slices and to appropriate the vitality similarly to all territories, some limitation ought to have over the power utilization of every single vitality purchaser, and as per that the Government ought to execute a strategy, by presenting Smart Meters. They can take readings, we can diminish the miss utilization of force, and furthermore here we significantly diminish the bill of client by alarming them with a ready message before multiplying the unit charge.

1 Introduction

Smart meters speak to the new era of open utility gadgets intended to spare vitality and offer more prominent accommodation to mortgage holders. The smart electricity meter as a main segment for the Smart system depends upon to give financial, shared, and natural points of interest for various accomplices. The key principle segments that will choose the accomplishment of smart meters is smart electricity meter figures examination, which oversees statistics getting, transmis-

S. Mendiratta (✉) · M. Garg · J.S. Jadon · N. Arora
Amity University, Noida, Uttar Pradesh, India
e-mail: shohit.mediratta@studet.amity.edu

M. Garg
e-mail: mukul.garg1@student.amity.edu

J.S. Jadon
e-mail: jsjadon@amity.edu

N. Arora
e-mail: narora2@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_46

sion, taking care of, and understanding that pass on favorable circumstances to all accomplices [1]. Smart Grids have been a key engaging operator for sharp essentialness, which insinuates control masterminds that can cleverly fuse the practices and exercises of all accomplices connected with it, e.g., generators, customers, and those that do both—remembering the ultimate objective to capably pass on viable, money related, and secure influence supplies. However there are various explanations for Smart Grids, one normally recognized framework is that of the [2]. National Institute of Standards and Technology (NIST) describes seven key spaces: mass period, transmission, scattering, customers, expert centers, operations, and markets. Scratch imaginative challenges go up against SGs fuse brokenness of RE period that impacts control quality; broad scale frameworks of little scattered time segments mechanical degree concerning to smart electricity meters expands to a different extent of ICT headways, Overseeing SGs to pass on Smart imperativeness require pushed data examination for obtaining exact data and automatic decision support and dealing with events in a favorable way. Fundamental advances have been achieved for utilizing area information acquired from cautious gadgets exhibited in feeders, unmistakable substation databases, and models over the value undertakings [3]. Run of the mill information sources consolidate advertise figures, lighting figures, control land figures; atmosphere figures, which can be dealt with and changed over into statistics, and discovering that may be used for state approximation, situational care, accuses recognizable proof and forewarning, soundness examination, wind or sun based deciding. Data obtaining is a key for good information recognizing, prepare, and learning extraction. Thusly, the most inspected data about power create operations is from information gathered from Smart electronic contraptions exhibited in substations and unmistakable portions of the broadcast and dispersal systems [4]. Of late, smart electricity meters are being presented in households and diverse premises in various locale of the world. An article by Pike Research assesses the overall brilliant meter foundations to threefold from 10.3 million in 2011 to 29.9 million units approximately by 2019. This structure, if unleashed truly, can give more than just recording use of force or a judgement support gadget to reinforce essentialness use via customers.

2 Overview

Since imperativeness sources are limited and it has transformed into our need to save, however, much essentialness as could be normal. In this circumstance, Smart meter comes into the edge [5]. A Smart meter gets unit ate up in a specific time distribution, demonstrate comes to fruition and along these lines give consistent commitments to the charging unit. The use of such splendid meters has been growing rapidly recently. Honestly, certain market observers assess the overall market for Smart meters will revive from $4 billion in 2011 to generally $20 billion in 2018. Coordinate US fares of smart electricity meters likewise have demonstrated strong development as of late, in spite of the fact that from a little base,

ascending from an expected $180 million to $240 million amid 2008–13. For quite a while, utility providers have been stressed over the quality and economy of the imperativeness system. Security and assurance remains a key factor for them. Smart electricity meters are far superior to those electromechanical meters utilized beforehand by the clients. This review introduces the structure of the proposed recognition technique.

3 Effective Smart Meter

The expression "Smart Meter" at first alluded to the usefulness of measuring the power utilized or potentially created and the capacity to distantly control the supply and cut-off when fundamental [6]. Control conveyance frameworks that utilization electrical cables can speak with other electrical frameworks, screen the nature of electrical vitality, and give an efficient answer for programmed meter perusing (AMR). Smart electricity meters can be associated with a low-voltage control framework by electrical cable bearers for all buyers. Unlawful power use in the power conveyance framework can be effectively distinguished if AMR is introduced in the framework, which comprises of a terminal Smart meter (TSM) and an entryway smart meter (GSM). This review proposes a novel remote identification strategy for unlawful power use that utilizes both TSM and GSM, where the TSM and the GSM are introduced on the power arrangement of every purchaser and on the hub of the power framework feeder, individually. TSM and GSM at the same time disengage an electrical hotspot for a brief timeframe. After this, the proposed location strategy sends a low-voltage motion with a high recurrence from the TSM to the GSM amid the season of disengagement. Once the flag has passed, the proposed recognition technique distinguishes illicit power utilization by measuring the measure of time it was separated. In this paper, we look at these improvements from an all-encompassing information systematic perspective. The expression "smart electricity meter" at first alluded to the usefulness of measuring the power utilized and additionally produced and the capacity to distantly monitor the supply and cut-off when important [4]. It was known as automatic meter reading that utilized simplex communication correspondence, equipped for mechanized month-to-month understands, simplex communication blackout (or last wheeze), and alter identification, and straightforward load profiling. After some time, the automatic meter reading (AMR) ability was reached out into fleeting interim (hourly or less) information catch, on-request peruses and connecting into and perusing different wares. A noteworthy update of usefulness happened after incorporation of the meters with full duplex correspondence innovation, which has been called progressed metering coordinated [7]. The redesign incorporated the joining of administration exchanging, time-based proportions, distant programming, control grade measure, and a dashboard-sort UI for continuous utilization checking into the AMR. In spite of the fact that the word smart meter began to be

utilized simply after the Smart Grid activities, it can be seen that the usefulness and elements of the meters advanced from the physically read meters of the past to the advanced metering infrastructure meters within dashboard port and the full duplex communication correspondence ability. In this way, the current in, a meter is required to have the accompanying abilities to be classified as a smart electricity meter:

1. Catch of force usage and possibly passed on period.
2. Capturing the probability of remote and neighborhood examining of the meter.
3. Distant manageability of the meter empowering control and to even abandon the supply.
4. Ability to catch events, for instance, contraption status and power quality.

4 Smart Measurement

The Smart meter is the estimation and statistics-getting device and, as a rule, connected with the specific gadget called sharp meter portal to set up a protected imperativeness information sort out. The entry could get and give continuous information from supplier, be a condition of control for contraptions, start, and stop essentialness supply. It could be like manner have a UI called the "In-Home-Appear" (IHD), which demonstrates essentialness usage, cost, charges with the Smart electricity meter is the estimation and statistics get device, and as a rule, connected with the specific contraption called sharp meter gateway to set up a sheltered imperativeness data sort out. The entry could get and grant progressing data from dealer, be a condition of regulator for mechanical assemblies, begin and end imperativeness supply, et cetera [2]. It could be in like manner have a UI called the "In-Home-Appear" (IHD), which indicates essentialness use, rate, and charges, with consistent overhaul (Fig. 1).

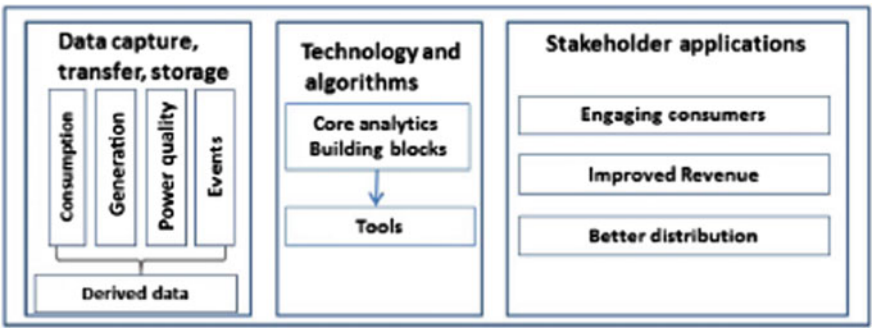


Fig. 1 Fundamentals of advanced

The SG gives the fundamental space and framework for the smart electricity meters to capacity, and Smart electricity meters have been portrayed by the main driving square of the SG [8]. One of the main parts of the Smart Grid engineering is to empower continuous basic leadership, which is conceivable just if information can be restrained without idleness as it is produced and connected toward particular goal. This constant or "dynamic" information can be bridled to set aside a few minutes choices. Smart meters can include nonstop correspondences if necessary with the goal that checking should be possible continuously and can be utilized as a door to request reaction mindful gadgets and smart attachments in the household. Inside the matrix, the smart meters may likewise just supplant the gadgets essential at detecting focuses whose expansive amount is unrealistic for price and strategic reasons, by alerting. Example: voltage and current estimations straightforwardly to an information procurement framework; for example, a smart energy metering stage. It can likewise estimate future needs and patterns of interest administration, organize tax enhancement, and resource support prerequisites.

5 Advantages of Smart Meters

Smart electricity meter is solitary of the utilizations of progression in innovation. It archives the utilization and sends the evaluations to the utility office and to the client on standard reason for observing and charging. For a long-lasting, conventional electromechanical meters have been utilized Meter readings were noted down on the month-to-month premise. Presently with the development of smart vitality meters, things are evolving.

Advantages of Smart vitality meter above customary electromechanical meters:

1. Smart imperativeness meters are less inclined to botches. The customers and utility providers get correct readings.
2. Readings can be directed distantly over the web to the utility providers. Agents require not being physically present at the site.
3. Modifying of these meters can be adequately perceived through the experts.
4. Smart meters when modified with home machines can be used to control the power use.

6 Challenges of Smart Metering

The European Union (EU) is advancing the normalization of smart framework security as a piece of Smart network institutionalization all through the venture "Smart Grids: European Technology Platform," which contained 19 nitty gritty reviews. Sorts of Attack COA (Cipher text just assault): The aggressor tries to reason unscrambling key from the cipher text. KPA (Known Plaintext Attack): The

assailant gets sets of plaintext and cipher text by perusing the meter. CPA (Chosen plaintext Attack): [8] the aggressor can pick the plaintext and the comparing cipher text. CCA (Chosen Cipher text Attack): Since a message authentication key is produced for each scrambled meter perusing, the assailant cannot fashion a substantial cipher text for a subjective esteem; in any case, he/she can dispatch this assault for open key cryptosystems. To accomplish metering knowledge as depicted in the past areas, various specialized issues should be effectively tended to. The capacity to work with vast volumes of information will be a key prerequisite. It is additionally fundamental that advancements have the capacity to work with an assortment of information; for example, climate data and purchaser data, geographic information subsequently requiring systems for proficient information combination and reconciliation. Such a major information incorporation and examination motor are being produced by a *C*3 vitality, where errands, for example, voltage streamlining, resource administration, blackout administration, and blame location to client-centered administrations; for example, demand–response, stack estimating and client dividing, and focusing on are to be coordinated. Continuous observing and diagnostics-centered investigation would be a critical prerequisite in such frameworks [9]. To accomplish genuine advantages of examination results, it is fundamental to pick up purchaser's acknowledgment and support for Smart electricity meters. The main prerequisite for such acknowledgment is straightforwardness of the procedure, which is right now being tended to by government controllers and in addition utilities. The accessibility of straightforward and visual presentations of data is additionally an essential need. Making smart energy meter information and examination results accessible on the web and on cell phones will make such data all the more promptly accessible furthermore overhauls imparted to buyers in close continuous. Smart electricity meter investigation in this manner will keep on evolving, making requests on the present information and innovation accessible.

7 Technology Adopted in Smart Meter

This report proposes the sharp essentialness meter with scrutinizing sign using GSM made to lessen the power use charge by giving the imperativeness meter examining to the customer with a prepared message before growing of unit charge. The looking at from Utility relationship as SMS is being gotten by Smart centrality meter programmable interface and the activity is performed by the meter as per give data Microcontroller can be utilized to screen and record the meter readings. In case there should be an occasion of a client defaulter, no persuading inspiration to send a man to utility ousts the Utility can cut-off and reconnect the client relationship by short message advantage [10]. A PC with a GSM beneficiary at the inverse side, which contains the database, goes about as the charging point. Live meter dissecting from the GSM engaged significance meter is sent back to this charging point discontinuously and these unnoticeable parts are redesigned in a central database.

In addition, the customer can check the status of drive from wherever. It gives ease in taking the meter readings, exactness. In existing structure, either an electronic imperativeness meter or an electromechanical meter is settled in the begin for measuring the usage. The meters in a matter of seconds being utilized are recently fit for recording kWh units. The kWh units used then still should be recorded by meter investigate month-to-month, by strolling. The recorded data ought to be managed by a meter breaking down association. For setting up the meter breaking down, connection needs to firstly interface each recorded power use datum to a record holder and after that pick the total owed by system for the specific assessment being utilized distinctive structures in light of various stages have been proposed by different research bundles wherever all through the world for Automatic Meter Reading. Tele wattmeter were executed to transmit data on month-to-month prologue to a remote central office through a given telephone line and a few modems [6]. A chip or DSP-based meter is used as a touch of this to gage the power usage of various customers in a region locale. These techniques were generally executed in regions that had a settled telephone make. In this estimation, framework that circuits the GSM manage as a mean of transmitting centrality data is huger. The GSM manage offers most expansion in most made and making countries. This strategy is likewise intense in customary accomplishes, which are not thickly populated, and in which, an enormous number individuals don't have acknowledgment to a settled telephone compose. So in a country like India we need to focus more on this system as it can be executed successfully and sensibly. In this system PIC controller is used to control. Yield beats from the metering IC are counted using the default clock of PIC MCU. The flag from meter through Optocoupler is ordinarily high and the high to low move of this voltage wave demonstrates the occasion of a pulse. The numbering of low pulse is an inefficient procedure as rash setting up issues may even be viewed as a pulse by the device. So the passed on pulse is turned before applying to the counter.

7.1 Types of Meter

A. Electricity Single-Phase Meters

Single-stage power is frequently utilized as a part of homes or business where power is for the most part utilized for general purposes [5]. Single-stage electric power alludes to the dispersion of substituting current in which every one of the voltages of the supply shift as one. Regularized frequencies of single-stage power frameworks are either 50 Hz or 60 Hz. Single-stage power accessibility fluctuates in various nations. Typical Features of Single-Phase Meters.

- Light Emitting Diode (LED)
- LCD display
- Rated voltage 120, 220–240 V
- Rate indicator
- Frequency 50, 60 Hz
- Current 5, 10 A or 20 A
- Limit temperature −25 to +70 C
- Threshold current: 60–100 A
- Operating temperature −10 to +65
- Power consumption below 1 W
- Keypad
- IP rating IP52
- Humidity Operating 95% RH

B. Electricity Three-Phase Meters

Tremendous structures, generation lines, office pieces, and various units have three-arrange control. The key fundamental standard of a three sort out load is the electric engine. Such engines are related in industry for fans, pumps, blowers, transport drives, compressors, and so forth. Broad circling air through and cooling gear (units more than 8.8 kW cooling limit) utilize three organize engines for reasons of ability and economy. These sorts of weights do not require the turning engaging field commonplace for three compose engines however abuse the higher voltage and power level when in doubt related with three organize dispersal. The subsequent DC current is less asking for to channel than the yield of a solitary stage rectifier. Such rectifiers might be utilized for cell charging, electrolysis systems, for example, aluminum period or for process of DC engines. It is in this manner, more reliable electrical power that licenses machines to run a great deal more profitably and last different years longer. In a three arrange structure, the stages are scattered correspondingly, giving a division of 120°. The rehash is regularly 60 Hz in the United States of America and 50 Hz in Europe and. The waveforms of the three supply conductors are stable from each other in time by 33% of their period. Three stages have properties that make it extraordinarily engaging in electric power structures. Thus, making it conceivable to wipe out the reasonable transmitter on two or three lines; Power move into a straight adjusted load is solid, which diminishes generator and engine vibrations; three orchestrate frameworks can make a charming field that turns in a predefined heading, which improves the game plan of electric engines. Three-stage frameworks may have an impartial wire. A fair-minded wire permits the three sort out framework to utilize a higher voltage while as of not long ago supporting lower voltage lone stage mechanical gatherings. In high voltage dispersal conditions it is essential not to have, an impartial cable as the heaps may just be linked between stages.

8 Seizing Loopholes

Numerous load profile looks at have utilized information mining techniques, arrange insistence, and quantifiable frameworks to secure picking up from client stack records. Information of utilization practices is basic, as it is incredibly valuable for figuring requests and making showing system, and permitting redo charging [7]. Utilize information amassed from clients' heap profiles could in like way to perceive, recognize, and expect coordinate anomalies or assortments from the standard that finally might be an immediate consequence of blemished metering or human mediation and trickery. Potential theft or particular misfortunes can in like way be perceived by separating Smart meter information and estimations from sensors fastened to transformers or feeders.

9 Conclusion

The paper has introduced an exhaustive review of brilliant metering and power Smart meter information examination. In spite of the fact that there has been much constraint to Smart meters because of protection and wellbeing concerns, clearly Smart meters are digging in for the long haul and that the SG and smart metering will be a lifestyle later on [3]. Various diverse measurements to smart electricity meters have been emphasized including the Smart meter innovation, existing investigation advances and apparatuses, and the current mechanical transformations. Undoubtedly, security and honesty of client meters has been and keeps on being a noteworthy concentration by utilities and sellers. In such manner, various endeavors by government and industry have begun to address potential security dangers [2]. For instance, an extensive arrangement of digital security rules distributed by the National Institute of Standards and Technology (NIST), and clarifies that endpoint and framework sellers have been made a request to conform to new necessities to address remote get to, confirmation, encryption, and protection of metered information and client data. The sending of a smart electricity meter System begins with decision of the advancement and the making arrangements for foundation, operation, and upkeep. Utilities have joined inside the course of action system various segments of organization, control, and consistence to support successful project utilization. Utility Metering Services operations are competent to ensure the correct, correct, tried and true, and solid operations of the pay charging meters and support contraptions. With the important augmentation of new estimation developments and compromise of correspondence systems into fundamental meters, metering operations will be tried both indeed and operationally in the nearby and whole deal. The complement on metering operations in utilities will increase as more refined charging and estimation systems are made, created, and sent. The paper has furthermore displayed the present Smart metering space as the Smart metering scene, and from that point forward, a framework has been

developed to relate splendid meter data to accomplices and applications made by their necessities and the examination mechanical assemblies and strategies required to fulfill the accomplice needs. The outline would help perceive the present hindrances in smart metering. Another dedication of this paper is the ID of Smart electricity meter examination building squares, which permit to interface the broad assortment of devices used for brilliant metering and perceive the standard examination works out. The SG and Smart meters will be a bit of a substantially broader IOT later on consolidating different parts of humankind needs and organizations to satisfy such needs, and the examination necessities discussed.

References

1. X. Yu C. Cecati T. Dillon M. G. Simoes "New frontier of smart grids" IEEE Ind. Electron. Mag. vol. 5 no. 3 pp. 49–63 Sep. 2011.
2. NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 3.0 (Government Report) Dec. 2014.
3. A. H. Nizar Z. Y. Dong Y. Wang "Power utility nontechnical loss analysis with extreme learning machine method" IEEE Trans. Power Syst. vol. 23 no. 3 pp. 946–955 Aug. 2008.
4. H. Liu Z. Yao T. Eclund B. Back "From smart meter data to pricing intelligence: Real time BI for pricing intelligence" 2012.
5. http://www.idealprepaid.co.za/Info/TypeOfMeters.asp.
6. "Smart gas meter penetration to reach 11% by 2016" Apr. 2015.
7. J. Zhang D. W. Gao L. Lin "Smart meters in smart grid: An overview" Proc. IEEE Green Technol. Conf. pp. 57–64 Apr. 2013.
8. L. Sankar S. R. Rajagopalan S. Mohajer H. V. Poor "Smart meter privacy: A theoretical framework" IEEE Trans. Smart Grid vol. 4 no. 2 pp. 837–846 May 2013.
9. S. Prasad S. B. Avinash "Smart meter data analytics using OPENTSDB and HADOOP" Proc. IEEE Conf. Innov. Smart Grid Technol. Asia (ISGT Asia'13) pp. 1–6 2013.
10. X. Hao et al. "Smart meter deployment optimization for efficient electrical appliance state monitoring" Proc. IEEE 3rd Int. Conf. Grid Commun. (SmartGridComm'12) pp. 25–30 2012.

Testing of Web Services Using Manual Testing Approach

Japneet Singh, Sanjib Kumar Sahu and Amit Prakash Singh

Abstract In the modern world of technology, if you want to develop a software application you do not need to build each and everything from scratch in your application. There are lots of ready-made services available which you can implement into your application and you can start providing those services in your application. For example, if you want to display weather forecasting-related information you do not need to collect, process, and analyze the data in your application. You can buy the services from the people who already have built the application analyzing this type of data and maintaining it in a suitable manner. So, the Web services allow us to do these kinds of implementations. Web Services can be defined as the mechanism or the medium of communication through which two applications will exchange the data irrespective of their underline architecture and the technology. So this paper focuses on determining the various testing capabilities involved in the process of testing of web services and also the method of writing the test cases to test the web services using the concept of data variation and modification also called as Data Perturbation. The various capabilities includes the testing of SOAP messages, testing of WSDL files, and using WSDL files to generate test plans and lastly testing the published, find, and bind capabilities of web services.

1 Introduction

Web services can also be defined as a service integrated in an application which uses Simple Object Access Protocol (SOAP) for transfer and communication of data in the form of XML format through the Internet.

J. Singh (✉) · S.K. Sahu · A.P. Singh
USICT, Guru Gobind Singh Indraprastha University, Dwarka, New Delhi, India
e-mail: japneetheyer@yahoo.in

S.K. Sahu
e-mail: sahu_sanjib@rediffmail.com

A.P. Singh
e-mail: amit@ipu.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_47

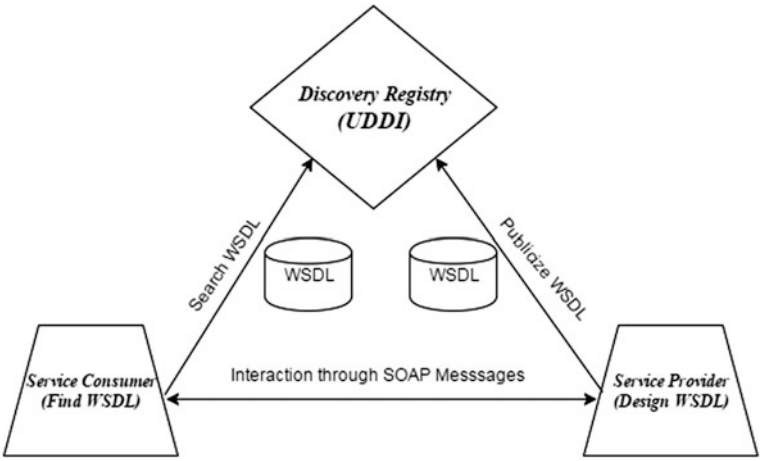


Fig. 1 Components of web services

There are various technologies associated with the web services which include Universal Description Discovery and Integration (UDDI), Extensible Mark-up Language (XML), Web Services Description Language (WSDL), and Simple Object Access Protocol (SOAP).

The Web services uses some standardized protocols like Web Service Description Language (WSDL) used for describing the description of the service, Universal Description Discovery and Integration (UDDI) used for publishing the WSDL document, and Simple Object Access Protocol (SOAP) used for sending and receiving of web service requests and responses [1]. A basic call to a web service includes the interaction and usage of three components which are service Consumer, Service provider, and service registry which is as shown in Fig. 1.

The service provider is responsible for designing the WSDL document and also for publishing it in the service registry (UDDI). The service consumer is responsible for searching the service registry (UDDI) to find the possible match against the business needs, also finds the endpoint of the service (URL address), and finally calls the matching web service by exchanging the request\response SOAP messages. This can be used as a first step toward the WSDL-based testing or more concretely toward manual testing of web services.

Web services also provide us the facility of having common communication infrastructure which is widely supported also based on the internet and also implements standard technical formats.

There are also various advantages associated with this technology like it works independently of hardware/software platform, also helps in the reduction of the complexities as well as the cost of the software integration.

Figure 1 depicts the components of web services.

The roadmap for the rest of the paper is as follows. In Sect. 2, we have discussed about the related work being done in the area of testing of web services. Section 3 talks about the solution of generating the methods to test the web services. Section 4 talks about the information of proposed system of using the method of Data Perturbation to generate the test cases for testing the web services manually [2]. Finally, the paper is concluded and future scope has been defined in Sect. 5 of the paper.

2 Related Work

As we already know that the service-oriented software has a complex nature but there has been a huge increase in the deployment of the Web services in the various software applications. So by testing the web services, we aim in a direction of reducing the errors in it, also increase the confidence of user's in using the web services which ultimately leads to the increase in quality of service oriented software (SOS). Web service description language is mainly responsible for loose coupling among web services. WSDL (Web Services Description Language) is used to describe the services offered by the web services and it is based on XML language [3].

The WSDL file also describes the process to call the services, i.e., what input values. We have to provide the XML request format and what will be the XML format of the response it is going to generate for each kind of service.

The WSDL file also contains the information about the concrete description (Port, binding, service) and also about the abstract description (Operation, Port type, Message) [4]. But this information is not sufficient to test the web services functionality.

So by testing the WSDL description file helps us in implementing the black box testing of web services but in recent times a very minor effort has been spent on testing web services on the basis of WSDL description files.

There are various challenges for the testers to test the web services like will the web services interaction be handled in a suitable manner and will the requests be handled for all types of data. The characteristics associated with the testing of web services are that we do not have any access to the source, Low level of testability, Web services are loosely coupled, and lastly there is no UI associated with the web service through which the testing can be done easily.

As already discussed, the various testing capabilities associated with the web services testing include testing of SOAP messages, Testing of WSDL files, generating the test plans on the basis of WSDL files, and lastly testing the binding, publishing, and searching capabilities of web services [1].

3 Solution for Testing Web Services

For testing the web services manually, we have identified three main steps to be done by making changes in the request messages present in the XML format and also checking the response of the web service also in the XML format only.

The three steps to be followed are:

1. The first step will be the modification of the request messages to be sent in the XML format by changing the various parameters in the request messages.
2. The second step would be of sending the modified messages to actually check the response from the web service.
3. The third step would be related to the analysis of the response messages sent by the Web service under testing and comparing the actual response with the expected response message.

These above three steps can also be represented in the form of a Pictorial representation as illustrated in Fig. 2.

3.1 Characteristics of the Solution

1. There should be a formal model used for the XML schema and XML messages used for sending the request messages and getting the response messages.
2. Data Perturbation should be implemented using some rules [5].

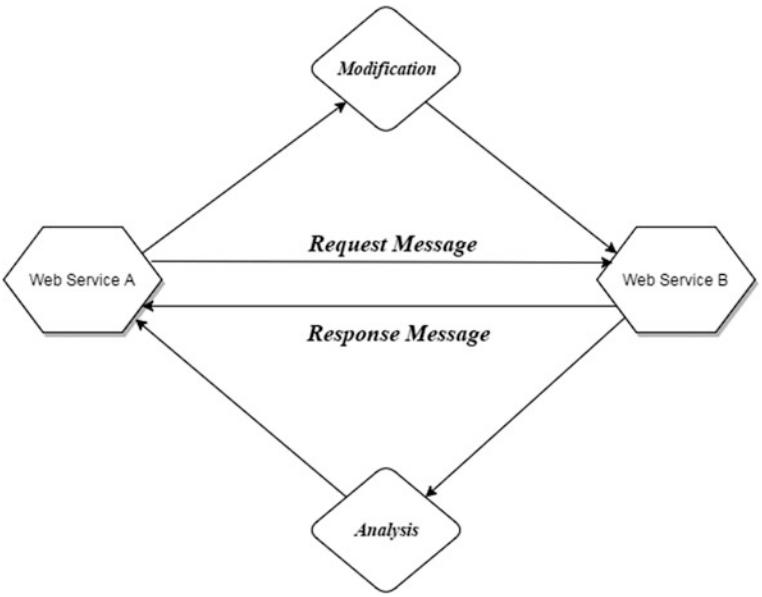


Fig. 2 Representation of basic steps to test the web services

Fig. 3 Interaction between web services by peer to peer communication

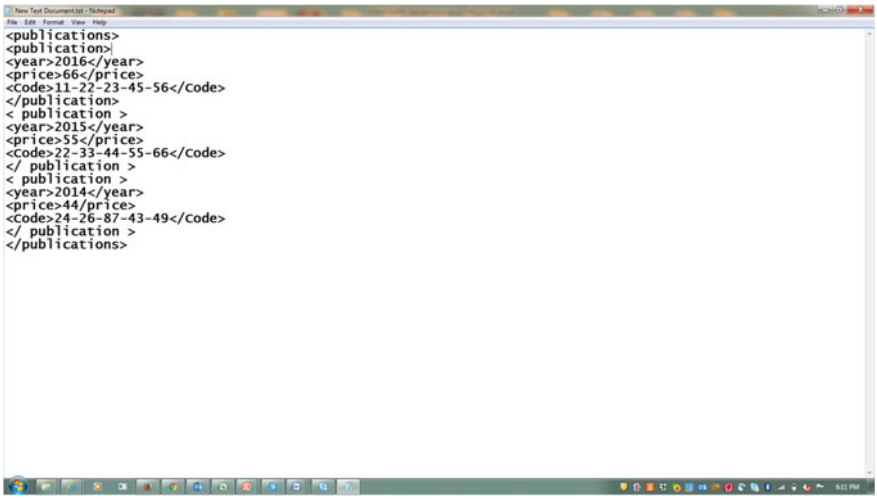


Fig. 4 Representation of the XML message

3. Interaction between the web services should be peer to peer communication instead of multilateral communication as illustrated in Fig. 3.
4. Testing of the SOAP messages is required.
5. Also Manual testing known as Black Box Testing can be carried out for generating the test cases for testing the web services [6].

3.2 Formal Model of Schema Representation

The regular tree Grammar representation is six tuple representations with the help of these below symbols:

$<T, D, N, A, P>$

One example has been explained below for the XML Schema and XML message for the Publications:

XML message:
See Fig. 4.

XML Schema:
See Fig. 5.

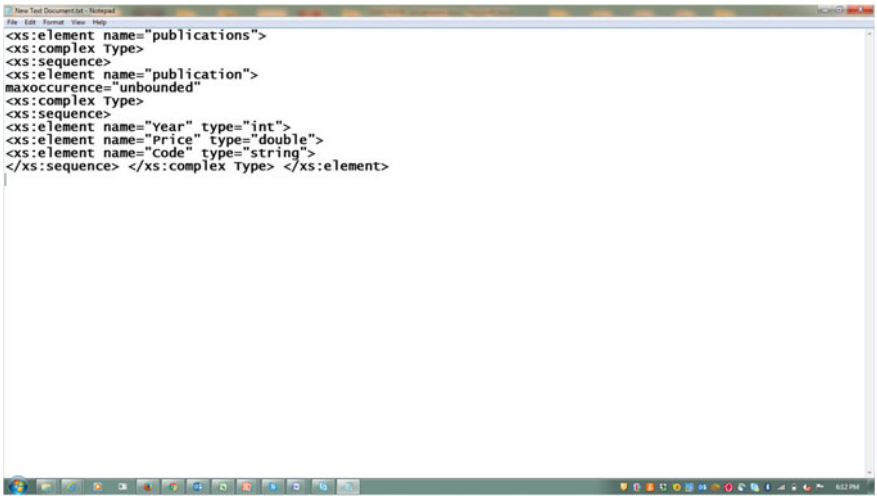


Fig. 5 Representation for the XML schema

Regular tree model example:
Example of the above written schema for Publications:

T = {publications, publication, Year, Price, Code}
D = {int, double, string}
N = {nt, np, nc, nr, ny}
P = {ns → books, nb → book <ny nr nc>, ny → Year, nr → price, nc → code}

Derived tree for publications example is illustrated in Fig. 6.

4 Proposed Approach Using Data Perturbation Techniques

The process of Data Perturbation includes two things under it.

1. Modification of the request messages is done.
2. Analysis of the response messages is done.

Data Perturbation is based on the following two steps:

1. Data value Perturbation: This process includes the modification of values in the messages to be sent as request messages based on their data types.
2. Interaction Perturbation: Interaction Perturbation is classified into types as RPC communication Perturbation and Data communication Perturbation [7].

Our approach is mainly based on the generation of test cases using the above-mentioned two approaches of Data Perturbation. Use of Data Value

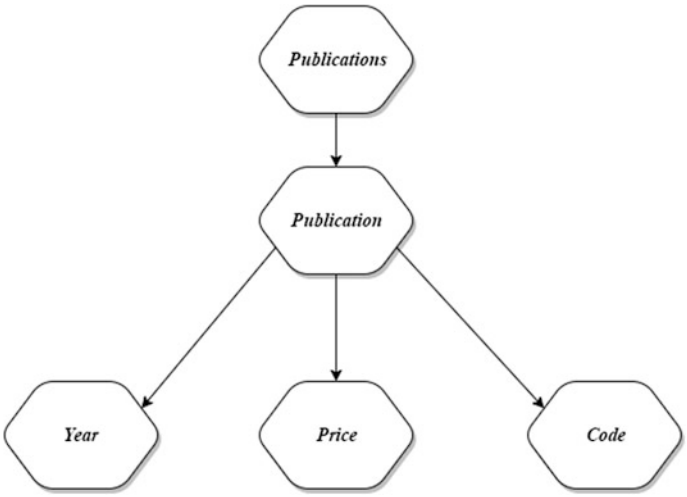


Fig. 6 Representation of the derived tree for publications schema

Table 1 Boundary value test cases for various data types

Data types	Test cases
Numeric	Maximum value, minimum value, zero
String	Maximum length, minimum length, zero length
Enumeration	Boolean value set, finite set of values

Table 2 Example for the numeric data type

Original value	Modified values	Test cases
<price>66</price>	-2^{63}	Minimum value
	0	Zero
	$2^{63} - 1$	Maximum value

Perturbation technique to generate the test cases for testing web services mainly depends upon the modification to be done on the request messages based on the different data types [2]. As an example, we have considered three data types here which are Numeric, String and Enumeration.

So the Boundary value test cases for the data types can be written using these below values [2] (Tables 1 and 2).

RPC Communication Perturbation technique can also be used as a method for generating the test cases in term of the data uses. There are two kinds of data usages which include the SQL-based data and normal used data [8].

Mutation analysis as well as using the mutation operators can also be used for testing the normal data and SQL injections can be used for testing the SQL-based data [9].

We can understand from the below example
Original message:

See Fig. 7.

Modified Message after applying Mutation by changing the order of data in which the elements are expected.

See Fig. 8.

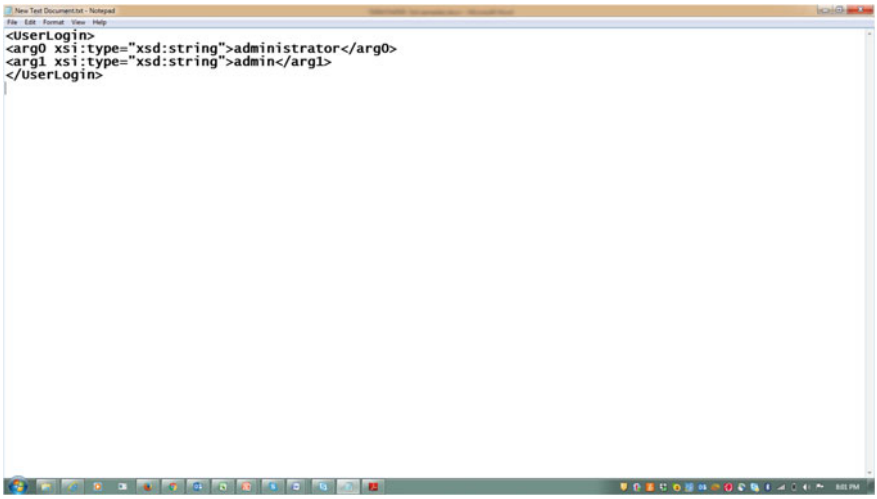


Fig. 7 Representation of the original message

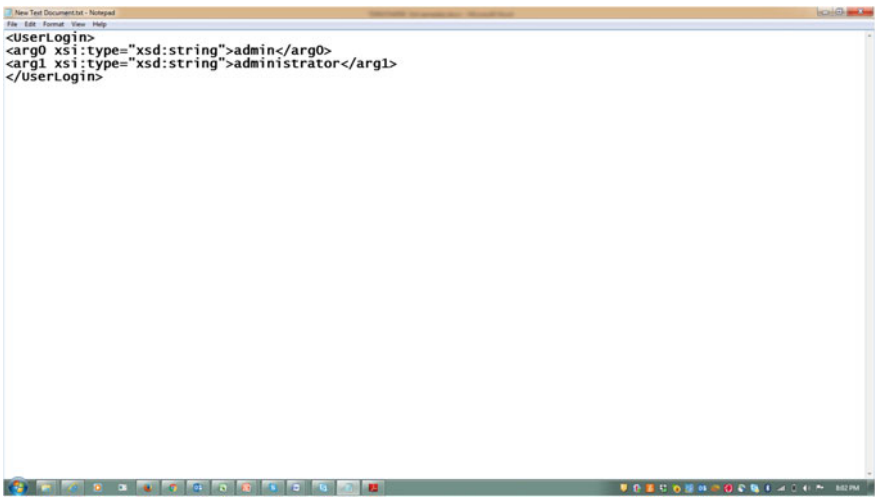


Fig. 8 Representation of the modified message

5 Conclusion and Future Scope

Web services help the users to directly fetch the data with in the developed application by just calling those pre defined web services already written to serve the same purpose. So it becomes very important for the users to generate the effective and practical ways to test the web services. Two techniques have been discussed in this paper which helps in generating the test cases to manually test the web services. These have been listed as Data Value Perturbation and RPC Communication Perturbation.

Data value Perturbation focuses on generating the boundary value test cases for the different data types used in the request format and focuses on semantic based testing, whereas RPC communication Perturbation technique is more of syntax-based modification done for the messages. The future work lies around the area of analyzing the relative importance of data value Perturbation and RPC communication techniques. Also the future work can also involve the work of analyzing the correctness of output which comes as a response for the request message.

References

1. Wikipedia, https://en.wikipedia.org/wiki/Semantic_Web_service.
2. Wuzhi Xu and Dr. Jeff Offutt: Generating Test Cases for Web services using Data Perturbation (2004).
3. Jing Sun and Gillian Dobbie: A framework for testing semantic Web Services. Fourth South-East European Workshop on Formal Methods (2009).
4. S. Madha Mohan and A.M. Abirami: A test Case reduction method for Semantic Web Services. Second International conference on Computing (2010).
5. Ana C V. De Melo and Paulo Silveira: Improving Data Perturbation Testing Techniques for Web Services (2010).
6. A. M. Abirami and A. Askarunisa: Black Box test case prioritization technique for semantic based composite web services. IEEE-International Conference on Recent Trends in Information Technology, ICRTIT MIT, Anna University, Chennai. June 3–5, (2011).
7. Ana C V. De Melo and Paulo Silveira: Exploring XML Perturbation Techniques for Web service testing. 9th International Conference, ICWE 2009 San Sebastian, Spain, June 24–26, 2009 Proceedings (2009).
8. Dr. Jeff Offutt: Applying Mutation Testing to web applications. George Mason University (2010).
9. Mutation Testing, https://en.wikipedia.org/wiki/Mutation_testing.

Analysis and Implementation of Business Intelligence Software for Report Bursting

Sheril Yadav, Aijaz Ul Haq, Seema Rawat and Praveen Kumar

Abstract Business Intelligence is very effective in the implementation of business transform programs within an enterprise framework. In this Business object is the current element tools that makes leader in the Business Intelligence software industry. It provide queries analysis and reporting tools to organization that need to access data stored in the different sources. Business Intelligence is used for analysis of data and represents the useful information to help industries executives, business managers and other user to make additional information business decision. It consist of the various tools, application, or methods that help the organization to collect the data from the external or internal datasource to build the report, dashboard and visualization to create the logical results available for corporate decision makers as well as operational workers. Bursting is one most important features of the Business Intelligence which helps in a process splitting data into simpler unit's wise, generating reports for separate unit, and it delivered the reports to different destinations. The data for the report is created by executing the query and splitting the data based on a Key value. For each unit of data, a separated report is generated and delivered. It helps in splitting single reports based on component in the data model and delivers the report based on the other component in the data model. It helps in reducing the efforts and maintain coast of the projects. It can fetch by the delivery element, it allows to apply to different template, output format, delivery methods, and locate to each split segment of your report. Example implementations include: In the health care domain, we need to send huge claims amount to different insurance vendor for different LOB (line of business) in report which led to get

S. Yadav (✉) · A.U. Haq
Satya College of Engineering & Technology, Palwal, Haryana, India
e-mail: sheril_08@yahoo.co.in

A.U. Haq
e-mail: aijazullaq@satyaedu.org

S. Rawat · P. Kumar
Amity University, Noida, Uttar Pradesh, India
e-mail: srawat1@amity.edu

P. Kumar
e-mail: pkumar3@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_48

more resources and time effort to validate the data of different LOB. For making it more optimization we will burst the reports in LOB wise will send to the vendor via email.

1 Introduction

Business intelligence plays an important role in the decision or strategic planning process within a corporation or industries. It helps company or organization to gain vision in the critical operations in the field of the reporting application or analysis tools. It also contains a variety of components such as dashboard, charts, reports or many more. Bi applications helps in understanding the various information properties and helps in making better decision and how to interact with each other. These properties can include the business database, domain information personal data, product data, as well as any other source of information which is valuable for your operation.

Healthcare domain are also generating huge collection of data in different terms like membership, finance, claims, billing, pharmacy, external audits, etc.

Healthcare-based industries need to show full opportunity of their financial operations. Here BI offers full transparency, analysis and delivery of the financial and operational data. BI allows healthcare provider to drill from the reports into detailed analysis of cost and claims, having data underlying cash flow statements. BI's analytical abilities allow providers to analyze execute cash flow analysis and monitor underwriting requirement [1, 4]. Here second other important feature of healthcare domain is claim management, it is most complex job to handle the flow of claims that received from the different providers. BI provides current, historical, or predictive view in the business operation, mostly in this case data that has been assembled into the data warehouse or data marts.

A BI application, which involves the data integration and data cleansing function, can allow you to integrate these different data sources into a particular logical structure for real-time reporting. An expert filed of BI is known as competitive intelligence that focuses on the external environment. BI provides a path for better decision making across the enterprise.

Today's recent businesses world, different technologies have to manage huge availability of data. So the Data warehouse needs to set up sources to store this data. We can use the ETL process (Extract, Transfer and load) for the Metadata support, for functional capability, or access to directly read the data from different data source. After that with the help of OLAP (Online Analytical Processing), user can analyze different dimensions of multidimensional data.

This paper explores the concept of bursting and the publication which is important application of BI. As the name implies bursting it means splitting of data. In the healthcare domain, we need generate the different claims or finance reports which contain huge data of subscriber or member which results into lot of resources

requirement to validate the data or more efforts and cost also required, by using this technique we optimized the reports in such a way that it contain the data for particular accounts, group, or LOB which easily help the business or customer to validate the data and the each different report will be send to multiple vendors via email.

2 Business Intelligence and Bi Components

According to Hans Peter Luhn et al. (1985), "he defined BI in his article the ability to capture the interrelationship of the presented facts in such a way as to guide action toward desired goal". It is used as a way for companies to make logic of mountain of data that have become available to them doe to rise of low budget storage and the ability to collect large amount of data through multiple input data source As per John Kemp, Benjamin Dietz et al., a strategic business intelligence platform put the right information in the right hands at the right time and gives Managers and executives the ability to test various scenarios for business spending and investments while monitoring important operational drivers of company performance. According to the Gartner definition is used mostly in the organization. According to Gartner, Bi is the umbrella term that is used to include all the application, infrastructures and tools that enables access and analysis of information to improve and optimize performance and decision.

3 Data Warehouse

A data warehouse is a major component of the Business intelligence; it is relational database that is used for query processing or analyzing purpose. It is subject-oriented, volatile, and integrated. It also contains the historical data that is retrieve from the transaction database, but it can also contain the data from different data source [2, 3].

It can also include the operational data which can be defined as data set of integrated data used for decision making for domain wise. It also includes an extraction; transformation and loading solution. It separates the load from different transaction source and enables the organization to combine data from different sources.

Data warehouse are built in way to help you analyze the data in optimize manner. Data warehouse also put the data in the different data sources into a consistent format. They also help in resolve the problem of naming conflicts and inconsistence among the unit of measures [1, 4, 5] (Fig. 1).

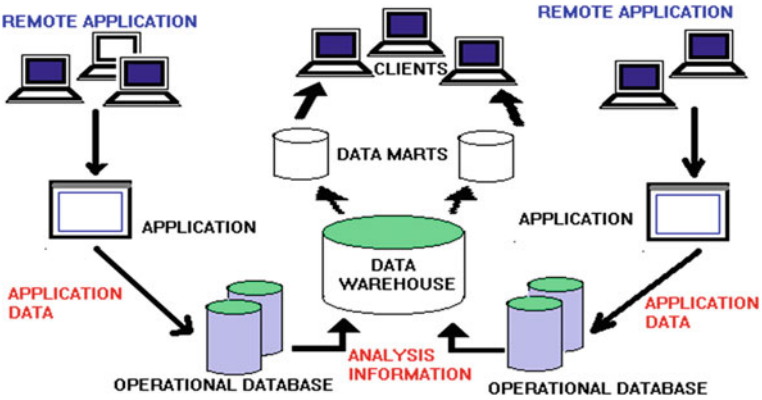


Fig. 1 Architecture of a data warehouse

3.1 OLAP

Data exist in the form of relations database; OLAP offers a better view into the unused potential data. It supports the multidimensional view of data which provides increase in the information content of same amount of data.

OLAP can be defined using the five keywords—Fast Analysis of shared Multidimensional Information.

Fast as most complex queries can be processed in less than 5 s. Analysis indicates to the process of analyzing the complex queries and to form a strong vision for the result of these quires. Fasting of data retrieval and analysis can be used on the procedural side of the database management. Shared sources, such as warehouse, are used to get information which is required for analysis [5].

The information may be interrelated in more than one or two dimensions. For example, a particular set of business data may be related, variously, to accounts, finance and claim data. It can also go in opposite direction and can show the data that includes the combine data this technique known as drill-down [5].

Slicing and dicing it states the ability to check the database from various viewpoints. It performs along with time axis in order to analyses the different styles and pattern [5].

4 Business Objects

Business Objects acts as fronted tool for reporting. It can be used standalone, to report data directly from the source system or more often, it's used as another front-end for BW. It allows users to navigate, analyses, access, formatting, and share information across an industries [2] (Fig. 2).

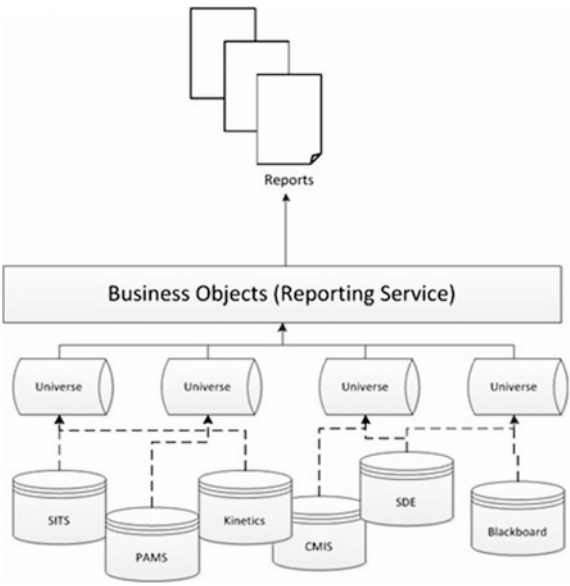


Fig. 2 Architecture of business objects

Here Crystal reports is client report design tool that is fully integrated with SAP.

Crystal Report is a tool which allows us to form flexible, pixel-perfect, feature-rich reports and integrate them easily with software developer kit into web and window application using Java, and .Net application. When we used within the SAP business object enterprise business intelligence platform, Crystal reports can be published to the web, it can be viewed through Info view portal and managed and deployed in a web based environment. The reports can be deployed and published using a Crystal report designer application. Crystal reports server is an enterprise reporting solution that helps us to create, manage, and deliver report over the web.

5 Literature Review

Business Intelligence plays a very crucial role to attain economical edge over competitors in the challenging economy we are. Business using the Business Intelligence approach is able to develop the intelligence-based information system to gain the useful business view and make faster and more trustworthy business decision. Business process intelligence provides the information to improve the organizational performance. Over the past two decades, progress in the technology have raised the importance of BI system and software to an organized corporate policy and overall success. They can be built by a services provided by or by the people working for the organization. In the past research, it has shown that Business Intelligence is one of the fast developed methods of intelligence gathering in the field.

6 Methodology

This paper gives an idea of the bursting and publication of different reports using in the BI application which helps to optimize the efforts in terms of cost or time and recourses. As the name suggests, bursting means splitting of data block in the simpler units for more efficient way to use and deliver to multiple destinations.

In this we need to emphasis on the domains like heath care, finance where the huge data need be taken care by the different database need to share the reports according to their requirement. In this we are creating two different reports using the crystal report and universe, i.e., web-i reports which contain huge data. Crystal reports are used to generate reports from different data sources. It allows users to generate reports that include special conceptions and implement new business requirements into reports to reduce dependency on IT and Report developers. Crystal Reports can connect to any data sources that include Relational databases like Oracle, OLAP data source systems like BW, or also with XML data.

Nowadays, different organization are creating multiple reports for Health care domain which contain the data from the Claim or finance department, these reports further send to the multiple vendor that validate claim or finance data in a consolidated way. This becomes a tedious job for them to retrieve information about a single required account. Therefore, it requires lot of efforts in terms of time, cost, and man power. To overcome this, we are creating the report and burst them in such a manner that we get information selective to particular account (Fig. 3).

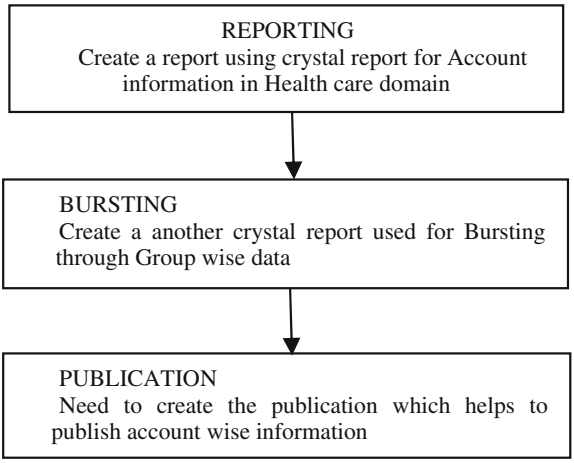


Fig. 3 Flow of requirement

6.1 Generating Crystal Report

For this we need to generate report using Crystal report which contains claim and finance data having the backend as the Facets. Here is PDF file for report, Report generating the information of the Account name with the claims received in the current year (Fig. 4).

6.2 Bursting the Report

The bursting has some properties as mentioned below:

- It can be done by Split By element which is governs how to data is split.
- In this Deliver By option can be governs how the formatting are applied in this.
- Also in the delivery Query is a Sql query that allow the BI publisher to construct the data file.

Step 1: After this, we create another Crystal report which will be used for the Bursting the Groupwise information (Figs. 5 and 6).

For Publication:

Step 3: To publish these we need to create publication on the Tool CMC Info view. Click Manage > New > Publication (Fig. 7).

Year : 2015

Account ID : 000000001 Direct Pay Parent Group

Group ID : 00000001 Direct Pay Group

ACCOUNT NUMBER	ACCOUNT NAME	GROUP NUMBER	GROUP NAME	SUBSCRIBER NAME	CLAIM NUMBER	LOB	CLAIM RECVED DATE	CLAIM AMOUNT	
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Daniel	E00000011000	M	9/2/2009 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Barbara	000108352000	D	10/20/2014 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Michael	000146454900	M	5/15/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Meredith	000144406700	D	7/6/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Debra	E01325643400	M	7/6/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Robert	000144513200	M	7/8/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Karen	000144843000	D	7/9/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Michele	E01331938300	M	7/9/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Marianna	000145075000	D	7/10/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Edward	000144033400	M	7/10/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Charles	000144566500	M	7/10/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Alan	E01333550900	M	7/10/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	David	000145482500	D	7/13/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Angelica	000145532000	D	7/13/2015 12:00:00AM		$0
000000001	Direct Pay Parent Group	00000001	Direct Pay Group	Michele	000145141400	M	7/13/2015 12:00:00AM		$0

Fig. 4 PDF of the report

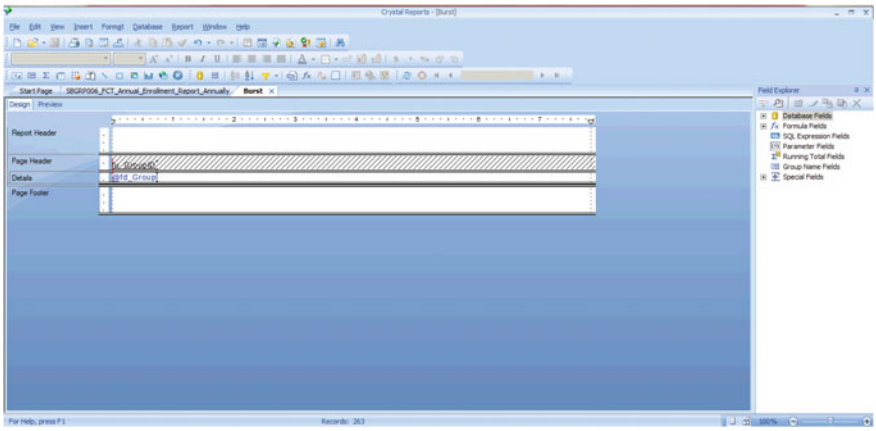


Fig. 5 Crystal report for bursting

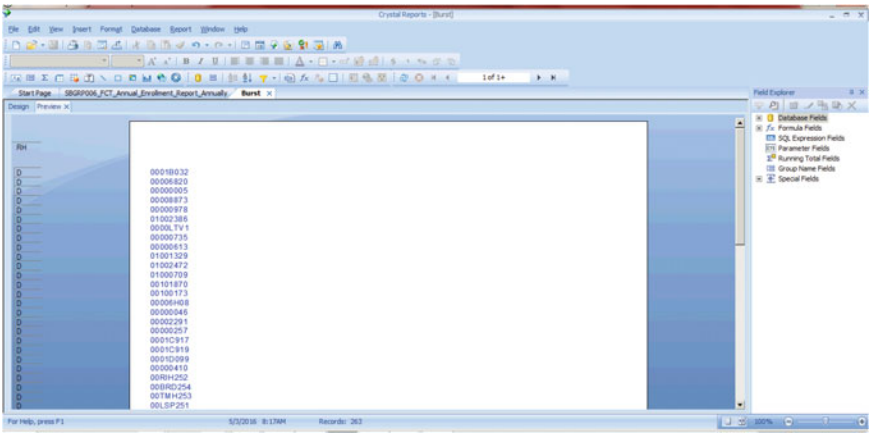


Fig. 6 PDF of the report

Publication Steps:

Step 1: Here It shows the source report as the Account Report (Fig. 8).

Step 2: Here It shows the Bursting report through which we further divide by Groupwise.

- Here Dynamic recipients are publication recipients who exist outside of the Business Objects Enterprise system.
- For the Recipient Identifier, select fields that contain the recipients identify values.

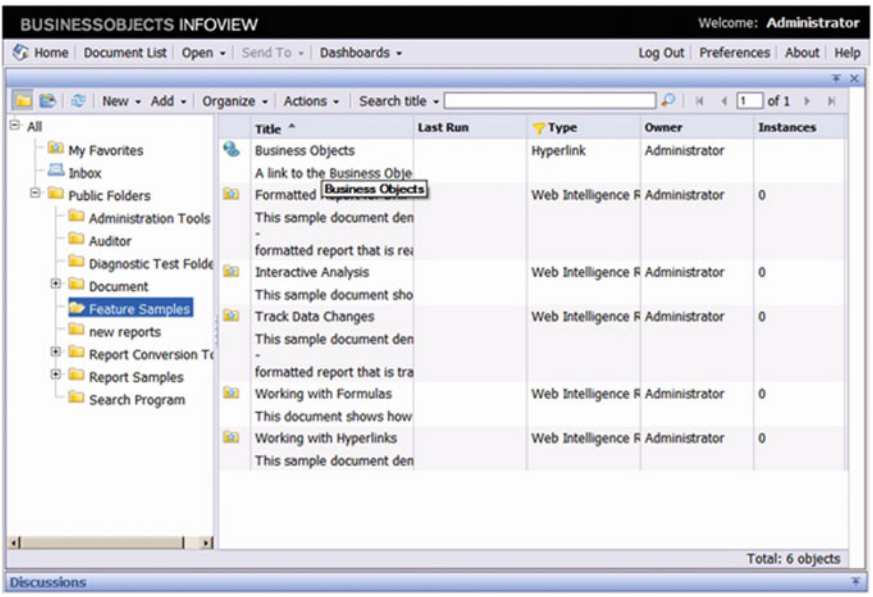


Fig. 7 CMC info view

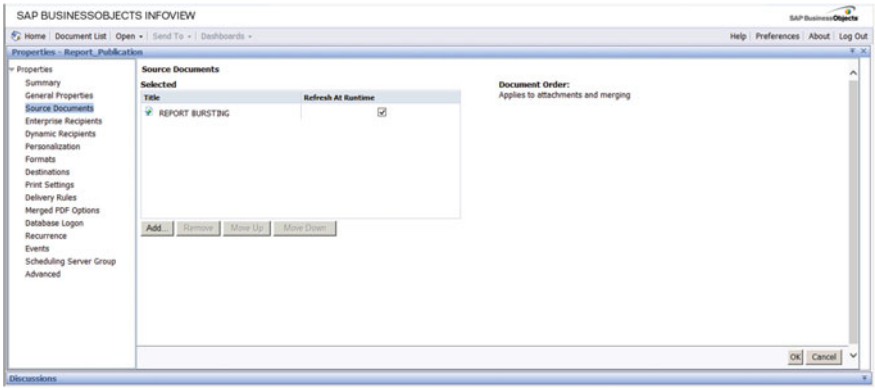


Fig. 8 Taking the source report (i.e., account report) in the source report tabs

- Here the Full Name is optional. Select a field that contains the full names of the recipients.
- To deliver the publication to a particular email address, select a field that contains the recipients email address on the email list. To distribute the publication to all dynamic recipients, ensures that the User list is selected (Fig. 9).

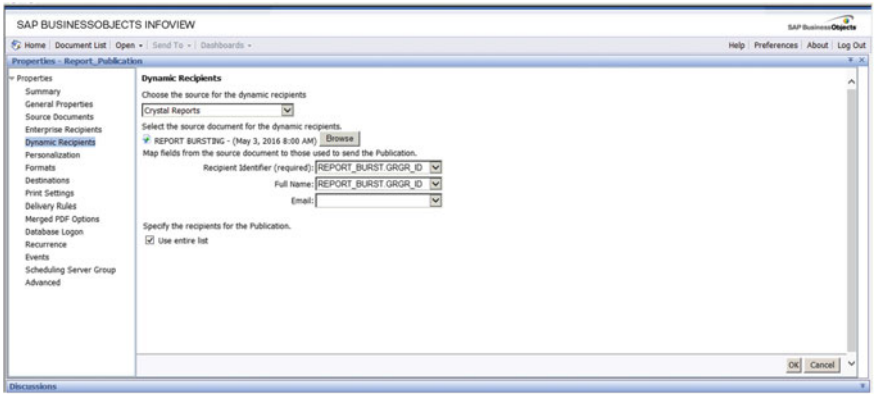


Fig. 9 Taking the dynamic report (i.e., bust report) in the dynamic report tab

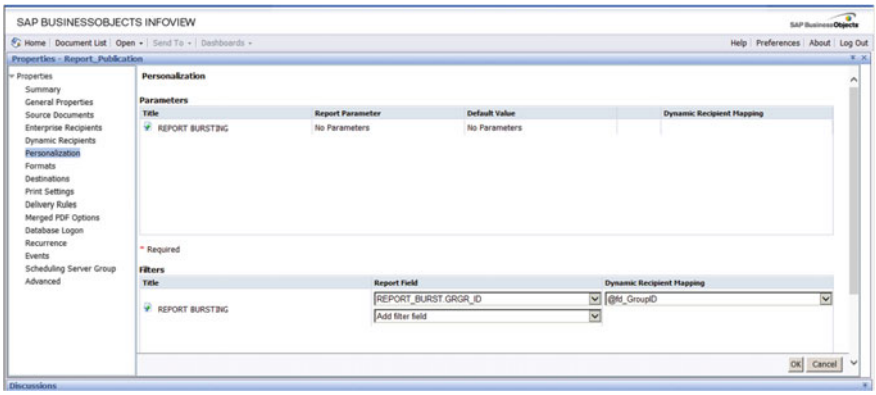


Fig. 10 Personalization, in this original report compare with the dynamic report

Step 3: Here we need to show how to burst the report, now the original report column Group Id will be matched with the dynamic report column Group Id

- Personalization is the process of filtering data in source document so that only relevant data is displayed for publication recipients.
- After that click the Personalization.
- Then click the edit button that is next to the parameter value to change a default value. After that, select the parameter values.
- Select the dynamic recipient's source column from dynamic recipient mapping column to override the default parameters value (Fig. 10).

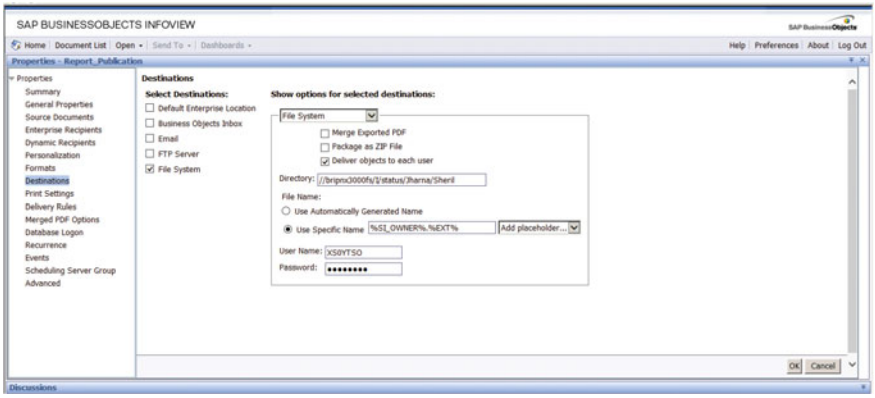


Fig. 11 Destination of the report

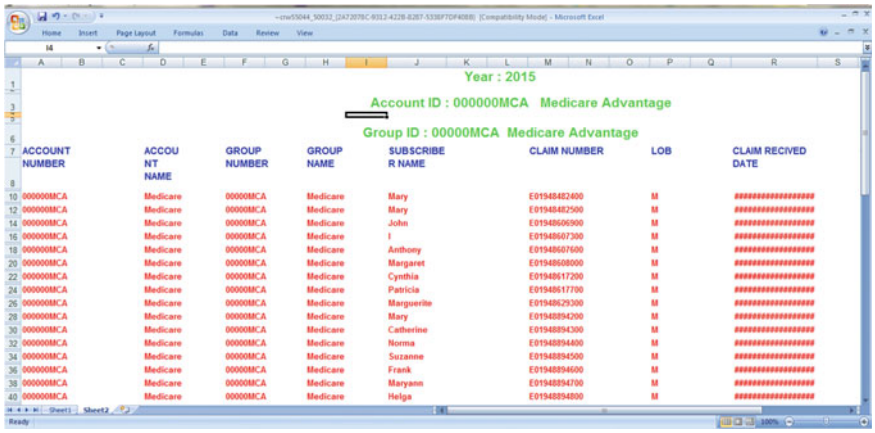


Fig. 12 Final output of data

Step 4: Destination are the locations that you will deliver the publication. A destination can be the Business Object Enterprise location in which a publication is stored, Business Object inbox, an email address, an FTP server, or a directory on the file system (Fig. 11).

Step 5: Final Output of the Report (Fig. 12).

Fig. 13 Time for running the publication

Time for running the Publication (Fig. 13):

7 Conclusion

These components of Business objects have ability to distribute personalized reports to enterprise and external recipients. It also includes the multiple reports per publication, in which it also include the static document. It also provide the huge range of output formats as well. It also have the ability to add customs functionality using the publication extensions. Publication will be more efficient component over the scheduling the different report It has flexibility to invoke the custom code in Java also for publication workflow. In this we did not require unnecessary data refreshes. It can send the personalized information in the mandatory format to planned recipients at specific intervals of time. It also minimize the database access. It will easily deliver the targeted business information to group or individuals through an email. As BI help you to understand the implications of various company processes for better and enhance your skill to recognize suitable opportunities for your organization. Moreover, it helps in save time on the reporting process. It also reduces duplication of roles or duties in the company and also improves the correctness and usefulness of the data generated by the publication for different accounts.

References

1. Singh, H.S. Data warehouse: Makron Books, 2001.
2. Surajit Chaudhuri and Umeshwar Dayal, An overview of the Data warehousing and OLAP.
3. Olsen, David H., Bryant, Pam-Dupin, Business Intelligence and information system: exchanging student knowledge in the database course (2012).

4. Rayman, J. and Greenwald, R "Oracle Data Warehousing and Business intelligence solution", Wiley Publishing, Inc, (2007).
5. W.H (1999) 'Building the Operational Data store', Wiley Publishers-New York, 2nd edition.
6. TURBAN, E. et al., Business intelligence: Bookman, 2009.
7. Kaula, Rajeev Business Intelligence Rationalization: A business rule approach, International Journal of information, Business management (Feb 2015).
8. Suefert Andhreas and Schiefer Josef. (2005) "Enhanced Business Intelligence–Supporting Business Process with Real–Time Business Analytics.
9. Tvrdikkova, M. (2007) "Support of Decision Making by Business Intelligence Tools", Computers information System and Industrial Management Application, 2007.
10. Zeng, L., Xu, L., Shi, Z., Wang, M. and Wu, W. (2007), "Techniques, process, and enterprise solutions of business intelligence', 2006 IEEE conference on system, Man and Cybernetics October 8–11, 2006, Taipei, Taiwan, Vol 6.
11. Y, Malhotra" Information Management to Knowledge Management: Beyond "Hi-Tech Hidebound" system', in Srikantaiah, Koening, M.E.D. (Eds.), Knowledge Management 2000.
12. Rizzi Stefano and Cella Luris 'Beyond Data Warehousing: What's next in the Business Intelligence? (2004).

Practical Concepts and Future Implication of IoT: In Perspective of India

Ankita Gupta, Nabeel Zaidi, Himanshu Kaushik and Praveen Kumar

Abstract Internet of things (IoT) presents "smart objects" as the core tool to focus on ubiquitous computing and cyber physical systems. Strong connectivity and an evolved generation of embedded systems facilitate the common grounds for intelligent object-based computing eliminating human-to-human or human-to-machine interactions. Basic objective of IoT is enabling seamless self generation of data and information transfer between Objects; knitting the physical objects into the virtual world. This paper focuses mainly on formulating idea of IoT into practical concepts, architectural modelling techniques of IoT, understanding the enabling elements and method for practical setup of embedded object communication. We have also evaluated the popularity of IoT applications as compared to other. Furthermore, future implication of IoT in perspective of India is given.

1 Introduction

Technology sees no limit to simplicity. From the era of vacuum tubes in the last century later replacing transistors followed by integrated circuits (IC), till now taking "computing" outside the realms of machine mounted on a desk [1].

A. Gupta (✉) · N. Zaidi · P. Kumar
Amity University, Noida, Uttar Pradesh, India
e-mail: ankita.gupta9@student.amity.edu

N. Zaidi
e-mail: nabeelzaidi@ymail.com

P. Kumar
e-mail: pkumar3@amity.edu

H. Kaushik
Shri Mata Vaishno Devi University, Katra, Jammu, India
e-mail: himanshu.kaushik@smvdu.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_49

The term internet of things was coined by Kevin Ashton of the MIT Auto-ID centre which describes the possibility of identifying products from supply chains using RFID (Radio frequency identification) tags as pointers over internet databases that hold the information about products which were tagged. Coordination and support Action for Global RFID-related Activities and Standardization (CASAGRAS) project 2009 [2] gave definition of IoT as A global network infrastructure, connecting physical and virtual objects through data capturing and communication capabilities. This paradigm involves existing and evolving network and internet developments providing Object identification, sensor and connection capabilities. Figure 1 explains the prevailing situation where physical and digital environment are completely aloof and work independent of each other.

Figure 2 explains how the physical and digital world interacts with each other wherein inputs can be taken up from either environments and processed to give outputs in either environment.

Figure 3 elaborates how the digital and physical worlds are completely merged as one and interrelated for inputs and outputs [2, 3].

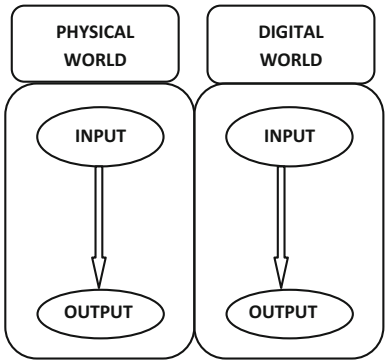


Fig. 1 Physical and digital world [2]

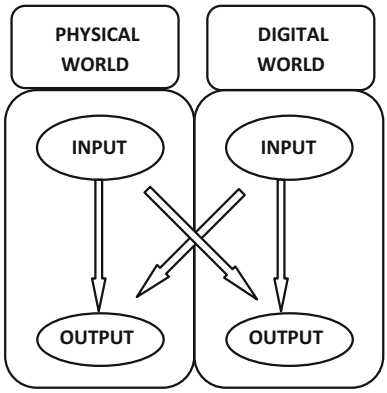


Fig. 2 Interaction of physical and digital world [2]

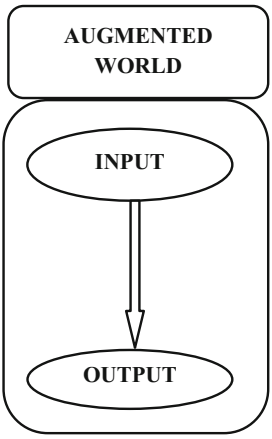


Fig. 3 Augmented world [2]

The IoT paradigm can be seen as connecting the physical and digital world in a worldwide augmented continuum where humans and physical objects cooperate in order to fulfil their goals.

In this environment, information and communication systems are embedded into the environment around us. It leads to generation of large amount of data which is needed to be stored, processed and presented seamlessly, in an effective and easily interpretable manner. IoT can be explained and differentiated from the internet with the help of S-E-N-S-E framework which may tilt the direction of technology and development and adaptation with important implications for Technological companies. This framework consists of Sensing, Efficient, Networked, Specialized and Everywhere [1] (Table 1).

Table 1 SENSE framework [13]

Authors	Working of internet of things	Differentiating from regular Internet
Serbanati et al. [2], Gubbi et al. [6], Puranik et al. [3]	**S**ensing: concerned with sensors attached to things for measuring temperature, pressure, acceleration etc.	On average more data is generated by machines with lesser human–machine interaction
Royer et al. [14]	**E**fficient: adding intelligence to the manual processes and activities (e.g. Temperature controls as per weather conditions)	Extending internet productivity gains to objects and not just people
López et al. [7], Zhang et al. [8, 11]	**N**etworked: connects more physical objects like cars watches and electronics to the network	Shifting intelligence from the cloud to more developed networks (fog computing)

(continued)

Table 1 (continued)

Authors	Working of internet of things	Differentiating from regular Internet
Lee et al. [15], Bassi et al. [16]	**S**pecialized: customizes the existing technology and processes as per the requirements (healthcare, production, transportation)	Fragmentation of internet services instead of broad horizontal connectivity of Pc's and smart devices
Nansen et al. [5], Sadeghi et al. [4]	**E**verywhere: developed pervasively for implementation (e.g. Used in wearable technology, homes, offices etc.)	Ubiquitous presence, resulting in extensively networked devices and more in magnitude

2 Ubiquitous Computing Pertaining to IoT

The 1990s, internet wave connected 1 million people while the 2000s mobile wave led to another two billion users and now successfully heading towards a fully integrated environment in sync with technology and communicating constantly through the internet. The internet of things (IoT), seen as the third wave in the development of internet has the strength to connect about 28 billion "things" to the internet by 2020, from bracelets to cars to entire cities and beyond [1]. IoT enables computers that know everything related with the objects around us called as things, gathering data, tracking and keeping count of dynamic quantities in the environment like temperature etc., without any human interference; in other words, turning physical world into one big information system [3].

Over the last decades, production engineering and automation along with intelligent computation systems incorporated internet of things (IoT). The industrial control systems merged with a number of computing components involved in control and production systems and increased manifolds. The programmable logic controllers replaced with easy programmable embedded devices to control physical processes i.e. advanced cyber physical systems (CPS), CPS basically communicated over closed industrial communication networks which are often linked to the Internet [4].

3 Architectural Modelling of IoT

The model for internet of things defines the basic components of internet of things and how they work in sync to obtain the desired output. The IoT scenario is seen as a generic user that interacts with a remote physical entity from the physical world. Two terms essential to understand the model of IoT is "*User*" and "*Physical Entity*".

User can be defined as a human being or a software agent that needs to perform a goal and needs to interact with the physical world through the medium of IoT.

Physical entity is a discrete identifiable and unique part of physical environment that corresponds to a specific object in the physical environment [2] (Fig. 4).

Similarly, in the digital world *digital entitles* can be defined as software identities having autonomous goals digital entities can be seen as Users in the context of IoT. Hence, physical entities can be seen as digital entities in the digital world also called as the *digital proxy* of the physical objects. These digital proxies are the digital replication of physical objects and can be seen as 3-D models, clones and avatars. These proxies have few basic properties:

1. Proxies are digital entities and are bi-univocally associated with physical entities/objects that they represent having a single unique ID for identification with the represented object.
2. Proxies are synchronized about certain aspects of the physical entities that they are associated with. Any changes in the physical entities lead to the change in the digital entities of the corresponding proxy and vice versa.

Now for the connecting of physical objects to the internet one or more Information and communication technology (ICT) are placed in vicinity or attached to the physical entity which leads to technical interface and allowing it to a part of digital world. This is done thorough devices which are later explained in detail.

Resources are digital, identifiable parts that allows varies capabilities and are associated with the Digital Proxies. One digital proxy may have more than one resource and hence the smart object. The basic capabilities of resources in IoT are:

- Retrieving physical properties of the physical entities collected through sensors.
- Modifying the physical properties of the physical entities with the help of actuators.
- Retrieving and modifying digital properties from the digital proxies.

The associations between the resources and smart objects are recorded within the smart objects or stored with Resolution service which acts like registry-based provider for the resolution services much like the DNS or ONS service. It accepts the object ID as input and provides network address of the services associated with it. Or another way ID's of virtual digital proxies are stored and accessed through lookup services.

Thus, these Services provide interoperability and provide actual access to resources [2]. Figure 5 shows the block diagram for the model.

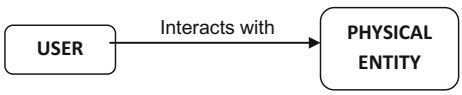


Fig. 4 User entity relationship

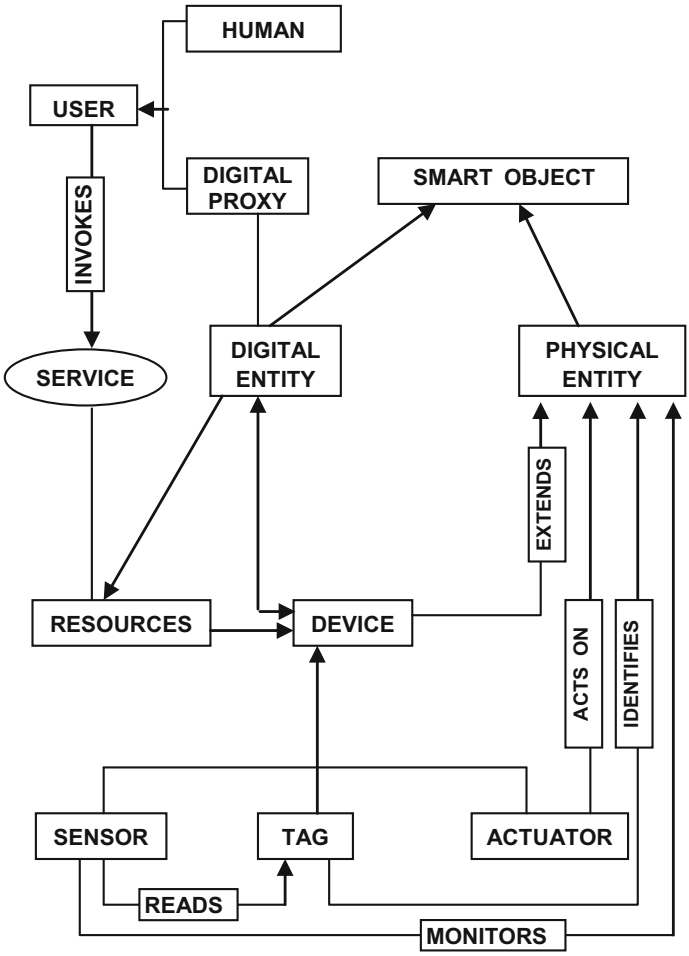


Fig. 5 Model for internet of things

4 Enabling Elements of IoT

According to Nansen et al. [5] from a commercial perspective, the IoT is primarily a set of methods and standards for tagging physical products in digital networks, so that they can be tracked through their manufacture, distribution, storage and purchase. The components of IoT can be categorized under three main divisions as follows.

Hardware—consisting of sensors, actuators, tags and other embedded hardware.

Middleware—on demand computing and data storage tools for data analytics.

Presentation—visualization and interpretation tolls that are easy to understand, platform-independent and used on different applications [6].

Few of the enabling technologies which are comprised in the three main categories are as follows.

4.1 The Things

In the perspective of internet of things, a thing is defined as any physical object that can be uniquely identified over a network of heterogeneous or homogenous similar objects and are capable of sensing their physics environment and capturing them as raw data, being able to transmit and receive the data over the network and implement actions and events physically or digitally. From the above discussion, it can be seen that these Smart objects are the extensions of physical identity with its associated digital proxy. Devices mediate the interaction between the physical entities and their respective digital proxies extending both [7].

Such objects also termed as device and are of following subtypes:

Sensors—are used to provide with information about the physical entity that they monitor. They measure the physical state of the entity sensors can also be embedded into the physical structure of the objects which provided direct connection to the network or similar smart objects [7].

Tags—help in supporting the identification process and are used by specialized sensor devices also called as readers. Barcodes and QR codes are read using optical technology while RF-based chips used and recognized by RFID [3].

Actuators—Actuators are machines that are used to modify the physical state of the physical entity; for example, motors causing translational, rotational motion or activation/deactivation functionalities of physical objects [2, 3].

4.2 Radio Frequency Identification (RFID)

RFID enables embedded microchips for wireless data communication. The passive RFID tags are used which are not battery powered and store the unique ID. They use the power of the reader's interrogation Electromagnetic radio signals to send the ID to the RDIF reader. Active RFID readers come with their own power supply and are capable of instantiating communication. RFID tags have found application in supply chains, bank cards and in other security applications [6, 7].

4.3 Wireless Sensor Networks (WSN)

The wireless sensor network is composed of sensor nodes and all the sensor data is shared among these sensor nodes. This shared data is further transmitted to distributed or centralized system for processing. Low power-integrated circuits and wireless communication have enabled efficient and low cost devices which can be used in remote sensing applications [3]. WSN monitoring network consists:

WSN Hardware—the core WSN hardware consists of a node which has sensor interface, processing units' power supply and transceiver components.

WSN Communication Stack—communication stack includes a systematic topology, routing for randomly deployed nodes.

Middleware—a platform-independent middleware is required or developing sensory applications, like Open Sensor Web Architecture (OSWA).

Secure Data Aggregation—a secure data assembling method is required to ensure reliable data collection from the sensors. Security is of utmost importance as systems are directly linked with actuators; hence protection from intruders is critical [6].

4.4 Addressing Schemes

The unique identification of things is crucial for the working of IoT. Every element which is connected must be addressed with a unique identification. Uniform Resource name (URN) system creates replicas of the resources which are further accessed with the help of URL. A subnet with a gateway having URN is required since the WSN runs on a different stack than the internet. Hence, a layer for corresponding sensor devices with suitable gateway is required. At the subnet level, unique IDs are used as URN's of sensory device. At node level, each sensor has URN which is addressed by gateway. Thus, entire network forms a web of connection from high-level users to low-level sensors, addressable through URN and accessible through URL [6].

4.5 Data Storage and Analytics

In the age of IoT where enormous volumes of data is being generated continuously by innumerable smart objects, large data centres with servers are required for data storage. "Cloud" computing may seem ineffective hence "Fog" the new network edge is under consideration where data networks reside closer to the source and can be easily accessed without latency and the expense of carrying it to all the way to the Cloud servers [6].

4.6 Visualization

Visualization is the next big benchmark in IoT which requires even a layman to be able to connect with the technology where information can be provided to the user in the simplest manner using touch screen technology, smart tablets, phones, etc. [6].

5 Challenged to IoT and Its Popularity

Apart from the vast opportunities that IoT brings, there are deadly risks and threats that are of prime and are as follows:

Population and Scalability Issues: Major problem is the increase in the number of entities that are connected over the network, resulting in more sensors and objects embedded with data and systems. The channels, methods and data items related with each object are subjected to potential abuse. As a result, the number of potential targets for threats increase manifold which can bring down the entire system at large [8].

Cost and Complexity: The interconnecting to objects rise huge cost for the technical enablement of physical objects to communicate with each other, such as desktops, laptops and other devices, RDIF tags, sensors, etc. This vast need for resources combined with the complexity of assembly pose a major challenge to IoT [8, 9].

Cyber Attack Implications: *Capture attacks* may take place to access unauthorized control over the networks, gaining physical and logical proximity to objects and causing unwanted operations and enabling devices with destructive capabilities. Capture of systems may lead to information leakage which is widely spread throughout the systems. *Disrupt*, *destroy*, *deny*, *degrade* attacks can be easily implemented by attackers once the systems are hacked or captured [9]. This calls for the need of high level of cyber security to be applied in IoT. *Data manipulation* attacks including manipulation of embedded data by replacing or modification of tagged information may increase infecting portable data stores.

Privacy Concerns: Privacy of information may be hampered. For example, location-based information generating devices if hacked or leak data, can cause threat to privacy to location of individuals and confidential resources. Cellular networks also generate highly sensitive data demanding high security concerns [9].

The hype of IoT is very huge currently. It is assumed that everyday one or other company announces new product daily. In spite of making any one-sided prediction, we have evaluated the most popular IoT application using three things: What most of the people searched on Google, twitter and LinkedIn [10]. The highest score gets a 100% rating and others are given scores relatively. Then we have formulated the result in a pie chart as shown in Fig. 6.

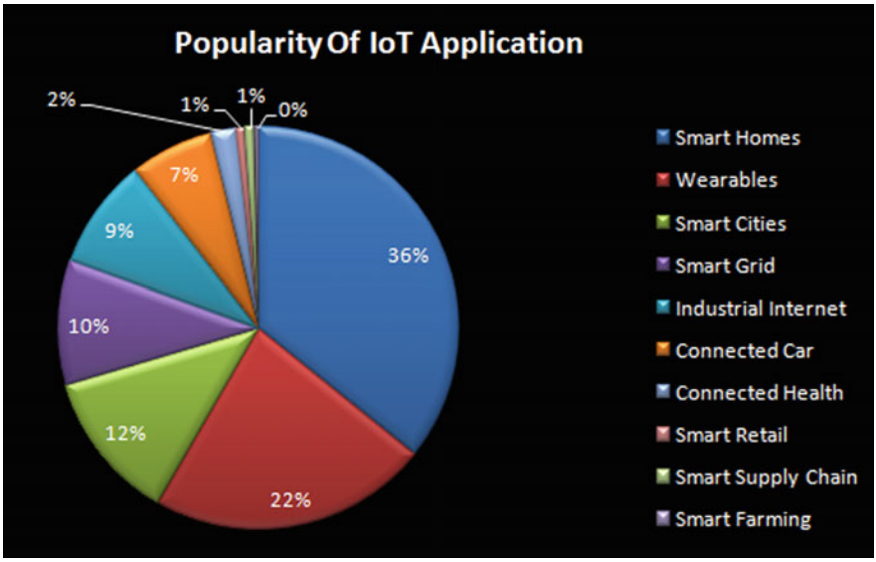


Fig. 6 Popularity of IoT applications

6 Applicability of IoT Towards Digitalizing Future Mega Trend in the Perspective of India

With India heading towards the ambitious goal of achieving over 100 smart cities along with digital transformation about Rs. 7,060 Crore have been allocated for massive expansion of IoT in the country under the nationwide initiative Digital India. Several project initiatives have been taken up by National Informatics Centres working with other agencies to implement Smart Card Operating Systems Standards, used in transport applications as smart card operating system for transport applications (SCOSTA). Another successful application of object identification under the realms of IoT has been seen presently by C-DAC, Noida which is in developing and testing pilot project of Parcel Tracking System for Department of Posts. Speedpost centres across different cities are enabled with pilot project. With a clear success of the project it will further be integrated with existing Speed-Net software of Department of Posts [11].

AADHAAR, another concrete example of a massive, real-world deployment of a system to provide individual authentication is the world's largest biometric database platform serving LPG consumers, NREGA workers, students and scholarship beneficiaries and other numerous individuals. Introduction of smart sensors can bring about verification or identification of individuals through Aadhaar authentication in easier and efficient manner. Nationwide initiate SWACH BHARAT is digitalized with projects that create solar powered trash mechanisms and other trash compactors that inform municipal sanitation authorities when the trash is full.

Table 2 IoT Start-ups in India

S. No.	Name	Brief Introduction
1.	Smart Driving-"CARIQ"	This start-up is based in Pune and it makes car smarter. Thanks to this device as it records the data of our car like speed, mileage and our driving pattern. We can easily connect to our peers and can even compare our stats with our friends, colleagues etc. It was launched in 2012 and in fact is available for just Rs. 6000
2.	Sensegiz	This device can be used to find the stolen things, or the things on which we used to waste time. On an average we spend about 55 min a day looking for things i.e. 5 days a year. But with the help of this it becomes easier. With very small sensors it can be applied to any object
3.	Entrib ShopWorx	It aims on making the floor of a shop smart for manufacturers It is also a start-up of Pune. We generally rely on a single person for all the repair and maintenance of the floor. But with the help of this, it connects all the floors of the shop and gives a unified view and knows when to act
4.	TeeWe	This is coming to India pretty soon. Its aim is to connect all our content from pictures to movies to Television through a single device

National centres of excellence for internet of things (CoE-IoT) are proposed to be set up, involving incubation centres and infrastructure supporting innovation in field of IoT with industry partners NASSCOM and academic s partners ERNET [12].

Efforts are made for development of common open framework for IoT and standards to maximize national investment of industries and participation by research bodies in innovation and development of IoT in various aspects of Digital India Initiative [12]. Here are the lists of promising start-ups that are going to become a boom in the near future according to us in India (Table 2).

7 Conclusion

Internet and web of things is the great leap towards bridging the distance between physical world and virtual world. IoT has emerged as a paradigm that turns every other ordinary object to a digitally and virtually sound smart object and linking it to the internet and by applying the existing protocols and standards for intercommunication of smart objects.

In this paper, we have given an idea of practical concepts of IoT and have given a model of IoT. We have given a theoretical idea of IoT from India's point of view and also have made familiar with the recent development of IoT start-ups in India. IoT is set to change the world with global applications ranging from personalization —home health, telemedicine and interactive marketing. IoT is set to cater individual

and personalized real time desires, monitoring of resources and environmental parameters and other automatic optimizing functions independent of human controls.

References

1. Goldman Sachs Global Investment Research "The internet of Things: Making sense of the next mega-trend", (September 3, 2014).
2. Alexandru Serbanati, Carlo Maria Medaglia and Ugo Biader Ceipidor CATTID –"*Sapienza*" University of Rome Italy, "Building blocks of the Internet of things: State of the art and Beyond".
3. Shruthi Puranik, Jayashree Mohan, K Chandrasekaran, Department of Computer Science and Engineering, National Institute of Technology, Karnataka, Surathkal, India, "Smart and Secure Monitoring of Industrial Environments using IoT", WCI'15 Proceedings of the Third International Symposium on Women in Computing and Informatics, 644–649, 2015-08-10.
4. Ahmad-Reza Sadeghi, Christian Wachsmann; Michael Waidner, "Security and Privacy Challenges in Industrial Internet of Things.", DAC 15' Proceedings of the 52nd Annual Design Automation Conference.
5. Bjorn Nansen, Luke van Ryn, Frank Vetere1, Toni Robertson, Margot Brereton, Paul Douish, " An Internet of Social Things".
6. Jayavardhana Gubbi, Rajkumar Buyya, Slaven Marusic, Marimuthu Palaniswami. The University of Melbourne, Australia, "Internet of things (IoT): A vision, architectural Elements, and Future Directions", Future generations computer systems 29 (2013).
7. Tomás Sánchez López, Damith C. Ranasinghe, Mark Harrison, Duncan McFarlane, " Adding sense to the Internet of Things: An architecture framework for Smart Object systems".
8. Zhi-Kai Zhang, Michael Cheng Yi Cho, Shiuhpyng Shieh, "Emerging Security Threats and Countermeasures in IoT".
9. Michael J. Covington, Security Intelligence Operations Cisco Systems, Inc. San Francisco, California, USA and Rush Carskadden Click Security Austin, Texas, USA, "Threat Implications of the Internet of Things".
10. Knud Lasse Lueth, "The 10 most popular Internet of Things applications right now".
11. R&D, Department of Electronics and Information Technology (DeitY), Ministry of communications & IT, Government of India, "Radio Frequency identification (RFID)".
12. Department of Electronics and Information Technology (DeitY), Ministry of communications & IT, Government of India, "IoT Policy document".
13. Dominique Guinard. University of Fribourg (2011), "A Web of Things Application Architecture - Integrating the Real-World into the Web".
14. Michèle Royer, PhD. Bellevue College Economic & Workforce Development, "The Internet of Things (IoT)", (August, 2013).
15. Byung Mun Lee and Jinsong Ouyang, "Intelligent Healthcare Service by using Collaborations between IoT Personal Health Devices", International Journal of Bio-Science and Bio-Technology Vol. 6, No. 1 (2014), pp. 155–164.
16. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, and Stefan Meissner, "Enabling Things to Talk: Designing IoT solutions with the IoT Architectural Reference Model".

Analysis of Distributed Mutual Exclusion Algorithms

Krishna Rawat, Nabeel Zaidi, Praveen Kumar and Tanupriya Choudhury

Abstract In computer technology, mutual exclusion is basically an attribute of control of concurrency, which is generally used to prevent the condition of race. There is a requirement that not more than one thread can enter a critical section at the same time. This requirement of mutual exclusion was introduced by Edsger W. Dijkstra in 1965 in his paper entitled, "Analysis of Distributed Mutual Exclusion Algorithm". Message Complexity, Critical section, throughput, and synchronization delay are the major part of these algorithms. Here we are analyzing Lamport Algorithm and Ricart–Agrawala algorithm for the message Complexity, synchronization delay, and system throughput.

1 Introduction

The basic problem in the distributed systems of computer is the Mutual Exclusion. It makes sure that simultaneous access of processes to a resource that is shared or serialized data is executed in a manner that is mutually executed. Mutual exclusion present in distributed system states that only at a single time only one process is allowed to execute its critical section. We cannot use the variables that are shared or a kernel that is local to implement mutual exclusion. The sole decision as to which process should be allowed to execute its critical section is based on the efficiency by which message is passed between the process as to know which process is currently

K. Rawat (✉) · N. Zaidi · P. Kumar · T. Choudhury
Department of Computer Science and Engineering, Amity School of Engineering and Technology, Amity University, Noida, Uttar Pradesh, India
e-mail: krishnarawat269@gmail.com

N. Zaidi
e-mail: nabeelzaidi@ymail.com

P. Kumar
e-mail: pkumar3@amity.edu

T. Choudhury
e-mail: tchoudhury@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_50

executing its critical section or to know the current state of other process. The mutual exclusion algorithm that is used in distributed system is very complex as algorithms had to deal with the messages that is unpredictably delayed and having incomplete knowledge of the system delays. Basically, we can have three different approaches on implementing these distributed mutual exclusion given below:

1. Approach based on Token
2. Approach based on Non-token
3. Approach based on Quorum

In approach based on token, a token which is unique (let us name it as Privilege message) is shared between various processes. A process is only allowed to enter in its Critical Section only if it has a token and it keeps holding the token until and unless its Critical section is executed. Mutual exclusion is made sure because of the uniqueness of the token. Those entire algorithms that use this approach differ among themselves in a way the process searches for a token.

In approach based on non-token, more than two messages are exchanged between the processes to decide which process will have its critical section executed next. A process will only get its critical section executed, when the local variable on which it is defined hold true value. We can see that the mutual exclusion is made sure because at a single time only one local variable will hold the true value.

In the approach based on quorum, each process needs permission to execute its critical section from its subset which we call as quorum. These quorum are made in a way that when two processes concurrently needs access to its critical section, one process is given more power as it receives both the request which further decides that only one request executes its CS at a particular time.

In this section we will deal with some more basic that one should know about the mutual exclusion algorithms.

2 Preliminaries

In this part, we will go through the underlying system model, and further discusses the requirements of mutual exclusion algorithms.

2.1 System Model

Let us assume that the system has N processes as S_1, S_2,… S_N. Let us assume that there is no loss of generality and only a single process is running once at a time on each process. Let the process at process S_i be p_i. Let us also assumes that these processes communicate with each other asynchronously over a communication network [1]. A process, who wishes to enter the Critical Section, must request all other process by

sending a message of REQUEST and then should wait for the response from these processes. When a process is in waiting state, it is not allowed to send further REQUEST message and thus a process can only be in any of the following state:

1. CS is being requested.
2. CS is being executed.
3. Process is in idle state.

When the critical section is being requested, the process is not allowed to make further REQUEST, while in the idle state the process is executing outside the CS. We can come to a conclusion that in token based approach, a process can also be in a state in which a process that have the token is executing outside the critical section. We call such type of states as idle token state. There may come a time when the process has many critical section request pending. A process can even queues these request so that it can serve the process only one at a time.

In this paper we won't make any assumption whether the communication channel is FIFO or not because this paper is more algorithms-specific. Hence, we also assume that message is delivered reliably though all the channels, processes are not crash and there is no partitioning of network.

Throughout the paper, we will use N as to denoted the total number of processes or the processes, T will denoted the average of the message delay, and E will denote the average of the execution time of the critical section.

2.2 Mutual Exclusion Algorithms Requirements

Every Mutual exclusion algorithm should fulfill the following preprocess.

1. Safety Property: The safety property ensures that at a time only one process is allowed to access the Critical Section. It is very important property of mutual exclusion algorithm.
2. Liveness Property: In this property, deadlock and starvation are absent. It also ensures that two or more process should not wait for REPLY message which will never come. While the other processes are repeatedly executing the CS, then a particular process must not wait for them. That is to execute the CS in finite time every requesting process should get an opportunity.
3. Fairness: In the context of mutual exclusion fairness means, that to execute the CS each process must get a fair chance. It basically means that the REQUEST generated by the processes must execute the CS in order of their timestamp.

2.3 Performance Metrics

Message Complexity: Message complexity is the total number of messages that are send and received by the processes during the execution of Critical Section.

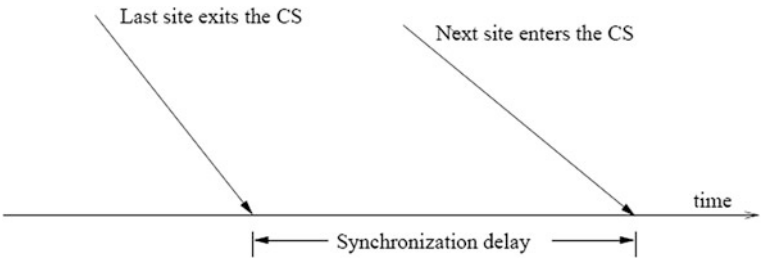


Fig. 1 Synchronization delay

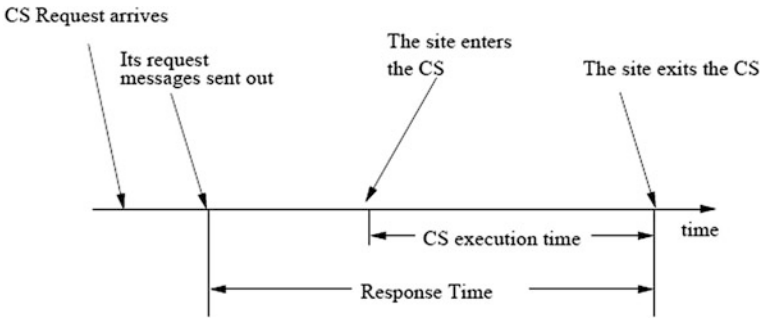


Fig. 2 Response time [5]

Synchronization Delay: Synchronization delay is the delay in the time period between a process exit the CS and the next process enter the CS. It is also represented by '*T*' (Fig. 1).

Response Time: It is the time interval when a REQUEST message has been send by the process and waits for accessing the CS to the time the CS execution is over (Fig. 2).

System throughput: System Throughput is a rate at which the system executes requests for CS. If synchronization delay is represented by '*T*' and average critical selection execution time is represented by '*E*' then the throughput is represented by $1/(T + E)$.

3 Lamport's Algorithm

A distributed mutual exclusion algorithm was developed by Lamport as an example of his clock synchronization scheme [2]. Since a request for CS are executed in the order of their timestamps and logical clocks determines time, this shows that the algorithm is fair. When a request for the CS is being processed by a process, its local clock is updated and a timestamp is assigned to the request. A queue is

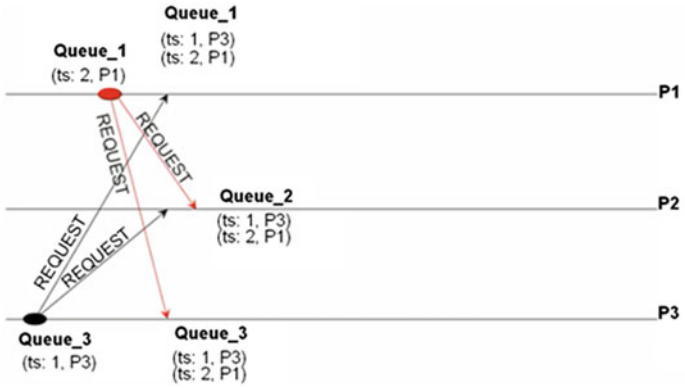


Fig. 3 Process sends REQUEST [4] message

maintained by every process that holds mutual exclusion requests which are arranged by their timestamp. A communication channels is required by this algorithm to deliver messages in the FIFO order.

Explanation

From Fig. 3, we have three processes *P*1, *P*2, *P*3 and *P*1, *P*3 want to access the critical section. *P*3 generates the REQUEST first and the way Lamport's algorithm works is to broadcast the request to other processes, so *P*3 broadcast the REQUEST message to *P*1, *P*2 and queued the request along with timestamp in its queue. All the processes receiving the REQUEST message queued them in their queue. Since *P*1 also want to access the critical section (CS) so it broadcast the REQUEST message to the processes. Since *P*3 request was generated with an earlier timestamp than *P*1 so it puts *P*3 REQUEST ahead of its own REQUEST in the queue. Therefore, *P*3's REQUEST is in front of the queue for all the processes.

So now each process REPLY back to the center of the REQUEST message (see Fig. 4). As *P*1 and *P*3 made the REQUEST message so they got the REPLY message. The process that has its request in the front of the queue and has received the REPLY from all the other processes is the only one that can access the critical section (CS).

Once *P*3 finishes executing the critical section then it sends the RELEASE messages to other processes as in Fig. 5, informing them to remove the REQUEST of *P*3 from the queue. So now *P*1's REQUEST is in front of the queue therefore it can now enter the critical section. Once it is done then it can send the RELEASE message.

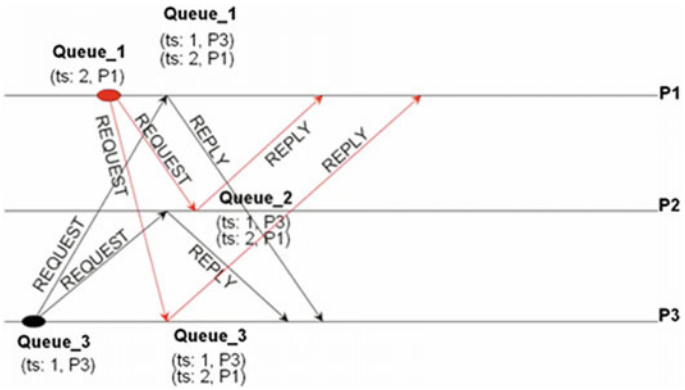


Fig. 4 Process sends REPLY message [3]

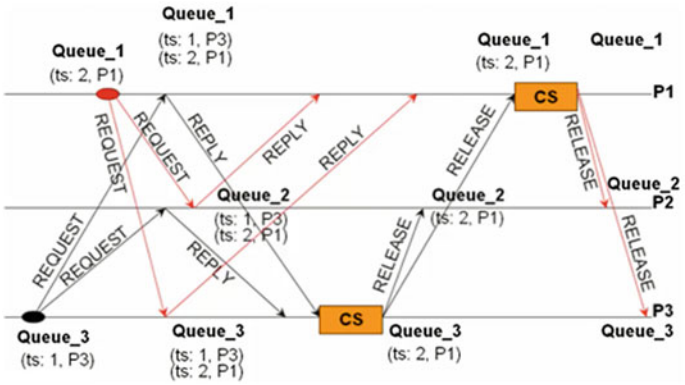


Fig. 5 Process sends RELEASE message [1]

4 Ricart–Agrwala Algorithm

There is an assumption in Ricart algorithm that the channels of communication are FIFO. This algorithm basically uses two types of messages, i.e., REPLY and REQUEST. The task of a process is to send the REQUEST messages to all the processes in order to take their permission to enter the critical section. After that, that particular process send a REPLY message for giving the permission to process to enter the critical section. Lamport style logical clocks are used by the processes for the critical section request to assign a time. When a conflict arises Timestamps are used in order to decide the conflict. Let us assume a process $P3$ is waiting for its critical section to be executed, it receives a message from the process $P1$, therefore if the priority of the request of $P3$ is lower than that of $P1$ then $P3$ won't send REPLY message to $P1$ until and unless it has executed its pending request.

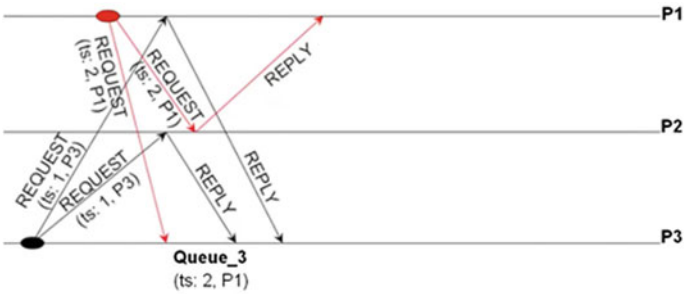


Fig. 6 Process with lower timestamp receive [5] REPLY

Otherwise *P*3 will send REPLY message to *P*1 immediately, making sure that a CS is not currently being executed. Hence if there are many processes asking for the execution of its CS then the priority with highest value gets succeeded and it CS is executed.

Explanation

The basic idea behind Ricart–Agrawala algorithm is it combines REPLY and RELEASE messages. The way Ricart–Agrawala works is that the process wishes to access the CS sends out the REQUEST message. If other process's REQUEST has larger tame stamp then their own CS REQUEST so they don't send the REPLY message until they finish CS execution.

From Fig. 6, if a process like *P*2 does not have any REQUEST messages so it can send the REPLY message to whosoever is requesting. So *P*2 sends the REPLY message to *P*3 and *P*1 and the REPLY message is consider as an authorization by this process to other process to go ahead and access the CS. Since *P*2 does not have REQUEST message so it does not concern about *P*3 or *P*1 entering the CS so it sends the REPLY message. Both *P*1 and *P*3 wants to access the CS but *P*3's REQUEST is having the lower timestamp then *P*1 REQUEST so *P*1 has to let *P*3 to go and enter the CS first so it sends the REPLY message to *P*3. Now *P*3 is the only process that has got all the REPLY messages from other processes. *P*3 is now going to buffer the REQUEST of *P*1 in its queue because *P*3 REQUEST has lower timestamp than *P*1.

After the process, *P*3 has successfully executed the CS then it can send the REPLY message to the entire deferred request. As shown in Fig. 7, it is only *P*1 REQUEST has been deferred but it can deferred the CS access to more than one processes because at a time CS cannot be accessed more than once. So *P*3 sends the REPLY message to *P*1. *P*3 by itself does not have any more further REQUEST message to access the CS. *P*1 has got REPLY messages from *P*3 to *P*2 so now it has authorization to access the CS.

Another level of optimization is after *P*1 is done with its execution of the CS for the first time and comes out of it and there is no more REQUEST messages from other processes (see Fig. 8). Now if *P*1 wishes to execute the CS again it can go,

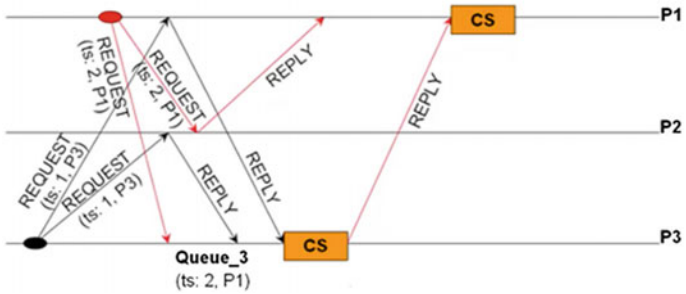


Fig. 7 *P*3 sends REPLY message to deferred [5] REQUEST

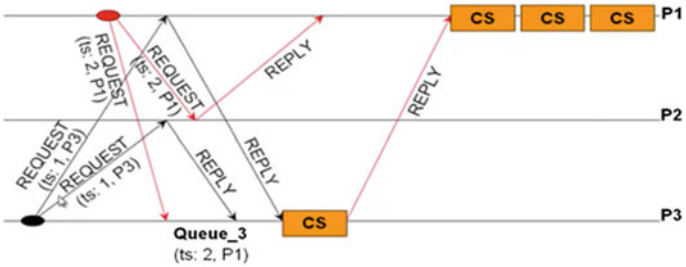


Fig. 8 *P*1 repeatedly executing [4] CS

it need not go through the REQUEST REPLY process because there is no other REQUEST message from other processes [3]. So *P*1 can consider the REPLY itself as an implicit approval to access the CS again until some other process sends the REQUEST message.

5 Analyses and Results

The distributed mutual exclusion algorithm can be examined by some performance criteria which are message complexity, system throughput, and synchronization delay.

Message complexity is the total number of messages that are sent and received by the processes during the execution of critical section. Message complexity in case of Lamport Algorithm is $3(N-1)$. A process will send the REQUEST message to all other processes so there are $N-1$ REQUEST and similarly $N-1$ REPLY, $N-1$ RELEASE. By Optimization a process *P*3 need not required to send the REPLY message to *P*1 because the REQUEST timestamp of *P*1 is higher than that of *P*3. Process *P*3 can simply send the RELEASE message after it has finished

executing the CS. With this optimization, message complexity of Lamport can be reduced in between $2(N-1)$ and $3(N-1)$ per CS execution.

In case of Ricart–Agrawala Algorithm there are $N-1$ REQUEST and $N-1$ REPLY, so message complexity is $2(N-1)$. Once $P1$ has executed the CS and wants to access the CS again then it need not required to send any REQUEST or to wait for an REPLY so message complexity is 0 but in reverse case if any other process has send the REQUEST message then $P1$ has to send the REPLY message, so here message complexity is $2(N-1)$. So according to Roucairol–Carvalho optimization message complexity for CS execution in Ricart–Agrawala algorithm lies in between 0 and $2(N-1)$ per CS execution (Fig. 9; Table 1).

Synchronization delay and system throughput are two more criteria on which these algorithms are analyzed. Synchronization delay is the delay in the time period between a process exit the CS and the next process enter the CS. It is also represented by 'T' [4]. System throughput is a rate at which the system executes requests for CS. If synchronization delay is represented by 'T' and average critical selection execution time is represented by 'E' then the throughput is represented by $1/(T+E)$ (Table 2).

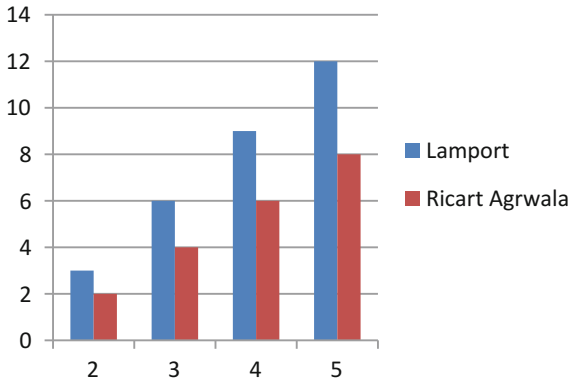


Fig. 9 Message complexity versus number of process

Table 1 Message complexity of Lamport and Ricart Agrawala

No. of process (N)	Lamport	Ricart Agrawala
2	3	2
3	6	4
4	9	6
5	12	8

Table 2 Sync delay and throughput of algorithms

Algorithm	Lamport	Ricart Agrawala
Synchronization delay	T	T
System throughput	$1/(T+E)$	$1/(T+E)$

6 Conclusions and Future Work

In this paper, after going through Lamport and Ricart–Agrawala algorithm, we concluded that these algorithm can be analyzed by message complexity and synchronization delay. Message complexity of Lamport is $3(N - 1)$ [6, 7] messages per CS execution which can be further optimized in between $2(N - 1)$ to $3(N - 1)$ messages per CS execution and gets better in Ricart–Agrawala algorithm, which is best-known algorithm, where message complexity is $2(N - 1)$ message per CS execution and that can be optimized in between 0 and $2(N - 1)$ message per CS execution [5]. We have given a table where for N (no of process), message complexity is calculated and we have also represented the result in the Bar Graph. Synchronization delay and system throughput can also be considered but these two criteria are very close in these two algorithms. We are further trying to enhance the synchronization delay and response time.

References

1. Hyo Jong Lee, Shwetha Niddodi, David Bakken, "Decentralized voltage stability monitoring and control in the smart grid using distributed computing architecture" published in Industry Applications Society Annual Meeting, 2016 IEEE.
2. Michael K. Reiter and Avishai Wool, "Probabilistic Quorum Systems", Information and Computation 170, 184–206 (2001).
3. Michael Wei, Amy Tai, Chris Rossbach Ittai Abraham, "Silver: Ascalable, distributed, multi-versioning, Alwaysgrowing(Ag) FileSystem".
4. JongBeom Lim, Young Sik Jeong, Doo-Soon Park, Hwa Min Lee, "An efficient distributed mutual exclusion algorithm for intersection traffic control".
5. John D. Slingwine, Paul E. McKenney, "Apparatus and method for achieving reduced overhead mutual exclusion and maintaining coherency in a multiprocessor system utilizing execution history and thread monitoring".
6. Hagit Attiya[2], Alla Gorbach[3], Shlomo Moran[4], "Computing in Totally Anonymous Asynchronous Shared Memory Systems" Information and Computation Volume 173, Issue 2.
7. Apolinar González-Potes, Walter A. Mata-López, Vrani Ibarra-Junquera, Alberto M. Ochoa-Brust, Diego Martínez-Castro, Alfons Crespo, "Distributed multi-agent architecture for real-time wireless control networks of multiple plants".

Systematic Evaluation of Iaas Including Case Study

Nabeel Zaidi, Himanshu Kaushik, Raghav Bansal and Praveen Kumar

Abstract Cloud computing is one of the modern techniques used in providing the resources which are used in computing as a service. It is basically a shift from computing similar to a product which is purchased, to computing as a service which usually gets delivered to customers over the World Wide Web from a centralized data-centers or clouds. It is assumed by the time one is able to explore all features of distributed computing, the intense utilization of cloud will be developed by the time. Since the time cloud computing started gaining popularity in Information Technology (IT) industry, it seems academia is way behind in this field. This research paper deals with the basic of cloud along with an analytical review of Infrastructure as a service (Iaas) and a case study is also provided. Furthermore a brief comparison of the vendors of Infrastructure as a Service (Iaas) is given.

1 Introduction

Cloud Computing is a general term which usually covers a variety of services. Since there are other significant developments in nowadays technology, many vendors have stopped using the term cloud because they even use it for the products which have no relation with the actual definition of the cloud. For us to truly know how cloud is an important to various organizations, it is most important to understand what actually a cloud is and its various parts. Since a cloud is a general

N. Zaidi (✉) · R. Bansal · P. Kumar
Amity University, Noida, Uttar Pradesh, India
e-mail: nabeelzaidi@ymail.com

R. Bansal
e-mail: raghavbansal95@gmail.com

P. Kumar
e-mail: pkumar3@amity.edu

H. Kaushik
Shri Mata Vaishno Devi University, Katra, Jammu, India
e-mail: himanshu.kaushik@smvdu.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_51

term used for different utilities, companies can decide when, where, and how they can use services of cloud computing. In this section, we are going deal with different types of services in cloud computing which are generally referred as platform as a service (PaaS), Software as a service (SaaS) and Infrastructure as a service (Iaas). We are also going to give examples and case study to show how Iaas is going to work. The Stack of Cloud Computing can be described as a stack or as a colloq which has variety of services that is built on top of one another under the tag cloud. The definition which is mostly used and is accepted is that of National Institute of Standard and technology (NIST) [1]. This definition is very lengthy hence a summarized version of it is as under.

Cloud Computing is a paradigm for convenient, network on demand access to resourceful shared resources of computer (example applications, services, servers, networks and storage) which can be continuously provisioned and used with minimum effort or service.

The above definition in simpler language means the ability of users to use resources in bulk and these resources can be processed and acquired efficiently and quickly. NIST provides several other characteristics that's seems to it essential for the service to be regarded as cloud. These characteristic are given as under.

Broad Range of Network Access: It simply means ability to access different services which are provided to us using platforms which are standards (mobile, desktop, laptop etc.).
Self Service on Demand: It means the ability at user end to sign up and receives services which are not delayed and that have traditional characteristics of Information Technology (IT).
Elasticity Rapidness: It is an ability to deal with the current demand of the market.
Pooling of Resources: It means various resources are pooled to different customers. [2].
Measured Service: Billing is measured and is send as a service of utility.

There is still a doubt regarding categorization of cloud computing. We believe that the best possible way to increase the advantages of cloud computing is to illustrate particular characteristic of each category. This is essentially required since in recent years the vendors are generally using cloud computing term for those product which are not described by the definition this practice is given a term called cloud washing.

The diagram which is given below shows the stack of cloud computing. As we can see there are three different category of cloud computing: platform as a service (PaaS), Software as a service (SaaS), and Infrastructure as a service (Iaas) (Fig. 1).

An easy way of differentiating these categories is given as under:

Iaas: It is generally the combination of software and hardware that gives powers to all: servers, networks, storage, and operating systems.
PaaS: It is usually a set of services and tools that is design to deploy and code those applications efficiently and quickly.

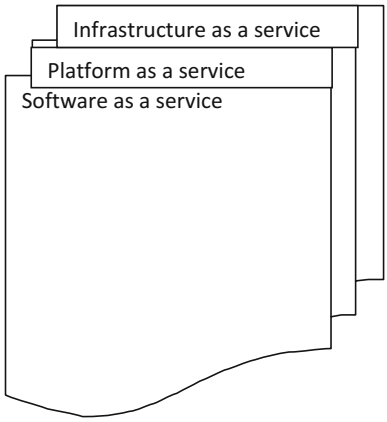


Fig. 1 Stack of cloud computing

SaaS: It is used in applications which are generally designed at users-end sent over the internet.

To fully understand how the above category of cloud computing are related to each other, we may use a transportation analogy [3], by itself one category, i.e., Infrastructure is not useful, it basically waits for someone to make it more productive in solving a problem. Suppose the interstate system of transportation which is used in India.In it even though there are various road built but they are not useful unless and until there are cars and trucks to transport goods and people. In this example roads are the infrastructure and the trucks and car are a kind of platform, i.e., the infrastructure that helps in transporting people and goods. We can consider these goods and people as software. Cloud Computing can also be defined as a main of accessing our data from web instead of using hardware of a computer, With the help of this technology, we can easily store our data which is personal in the cloud and even can access it from anywhere over the world. We can in fact share our work without the help of any hardware component, i.e., by connecting one computer to another through a network and anyone can use this information using cloud.

2 Cloud Computing

Cloud may also provide administration on private as well as open system such as LAN, WAN and similar application for, e.g., video call, email, and so on can be easily executed on the cloud whenever these application and there administration are moved to web cloud this procedure is known as distributed computing. Distributed Computing allows us to design, manipulate, getting the equipment and provide programming functionality. Information which are online and its foundation plus its application are given. The main advantage of distributing computing is that it is stage independent,i.e., it does not need any uncommon application to run

it. There are many [2] organizations which are using its application some of them are given as below:

Microsoft: It has offer point organization that thinks that the substance and the business gadgets that are used in learning to be moved to the cloud and even has started to make its office application to be available in a cloud.
Google: It has generally a private cloud which is used for providing a wide variety of services to its customers, e.g., Google Maps, Document application, access to email etc.
Salesforce.com: In it application are run for its customers to in fact provide changes to cloud organization.

2.1 Attributes

Qualities of distributed computing are given as below:

Dynamic Provisioning [4]: It usually allows the management of administration to view it in necessity of current interest. It is done rapidly and reaching the developmental process and zipping of administration as needed.
Managed Metering: It is generally used for seeing and upgrading the privileges of administration and reporting the data to administration.
Shared Infrastructure: It includes sharings of stock piles administration abilities and administration physically. The base of cloud usually guarantees the maximum number of clients.
Access of Network: We can generally access over the internet using a variety of gadgets cell phones, pc's and portable workstation.

2.2 Administrations Model

Computation of distributed system is conveyed regarding action of plans that can contrast upon prerequisite.

Platform as a Service (PaaS): These are application in which administration can be easily conveyed and in fact can be constructed and elaborated more modestly despite if the fact that administration is upheld.
Software as a Service (SaaS): In it application can be seen as an administration base and stage can be disconnected and may also be sending with less exertion.
Infrastructure as a Service (Iaas): In it the physical base is usually not connected to provide stock piling, figuring and administration of a system by keeping away most of the cost.

2.3 Improvement Models [5]

Public Cloud: It is used on a business platform which is provided by an administration.
Private Cloud: It is usually use d and maintained by a particular organization.
Hybrid Cloud: It includes various numbers of billows and thus the cloud is able to move information or application from one part to another.
Community Cloud: It is used within various associations to share that have some common interest.

Figure 2 illustrate that cloud can also be made in desktop, phone, laptop, Network etc. and can be accessed from anywhere around the world. It basically is an infrastructure and a platform whose aim is to reduce the services of software. PaaS architecture is also currently used in online interaction of multimedia.

2.4 Cloud Computing Advantages

1. It is very flexible as it provide organization to use other assets.
2. Saving of cost since it is very effective and requires very less association as compare to traditional means.
3. Reliability as it increases the capacity of vendors on agreeing over a statement which make it more reliable.
4. It is mobile accessible.
5. There is no need of new programming language to control cloud [6].
6. It offers self administration, i.e., we can use it without the association of server cloud.
7. Cloud computing provides improvement of online programming run time environment with the help of PaaS model.

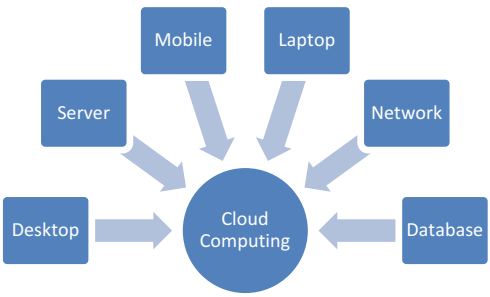


Fig. 2 Applications of cloud computing

2.5 Cloud Computing Challenges

Security of information and checking the utility of a cloud by the supplier of an administration is generally describe as an asset to the cloud administration advancements. It is also reported that there will always be a loophole in the structure of cloud and can be easily exploited by the anonymous and thus will have the power to trade and use the data for their own benefit. But being updated with the latest trend will help us not only to prevent but also to take precautions. Necessities of the client are slowly advancing for the stockpiles, administration of the system and the interfaces. All of these things may lead us to jam in the cloud administration but these things if considered beforehand may also be prevented, despite the fact that the distributed computing is a way of guarantying the security of your account.

3 Infrastructures as a Service (Iaas)

Infrastructure as a Service (IaaS) is simply a way in which delivering of infrastructure of cloud such as storage, network, servers, and operating systems on the demand of service take place [7]. Instead of buying those servers, data-centers space, software, and equipment of network to only buy those things that are required or are on demand.

As there are many research paper published on Iaas which shows that there are various subcategories worth noticing. Basically an Iaas can be obtained as a private or public Infrastructure or even as a combination of both. Public Cloud is an infrastructure in which there are resources which are shared, and are usually deployed when need on the basis of self service. Similarly private cloud is an infrastructure in which there is some of the feature of cloud like virtualization but these feature are only used in private network. Furthermore, some providers of hosting have started to offer a mixture of combination of traditional services with the private and public network cloud. This combinational approach including public and private cloud is known as hybrid cloud.

3.1 Characteristics of IaaS

There many other research papers that have gone through SaaS, PaaS and Iaas. But it is assumed that Iaas is the most developing field among the three [8]. There are some characteristic of Iaas that shows what actually Iaas is. Iaas has basically the following characteristics:

1. Resources are usually distributed as a service.
2. Dynamic Scaling is allowed generally has a changing cost according to the demand, hence a useful pricing model
3. Has many users connected to a single hardware

There are abundant Iaas provider including the largest provider of cloud such as Amazon web services and the Rack space. As we have already mentioned that the line which distinguishes PaaS and Iaas is more becoming blurred as vendors are introducing tools which are a part of Iaas and that also provide their ability for multiple clouds to get deployed.

3.2 Where Iaas Is Making More Sense

Use of IaaS makes sense in a large number of circumstances that are very closely related to all those benefits that are brought by cloud computing. The various situations in which cloud infrastructure is suitable include:

1. Situation in which demand is volatile,i.e., there is signification variable changes in the demand of infrastructure.
2. Best for those new organizations that have not enough funds to invest in the hardware.
3. In situation where the organization is growing rapidly and is not able to scale with its hardware.
4. Situation which needs to limit expenditure of an organization and requires moving to operating expenditure.
5. For businesses which are on trial bases or are temporary.

3.3 Where IaaS Is not a Good Option

Though there are situations in which it is advantageous for Iaas to be used such as scalability and provisioning quick but there exist situation where it may be problematic to be used such as:

1. Situation in which its regular compliance makes the outsourcing or off shoring of data and processing really difficult.
2. Situation in which we need very high level of performances and the infrastructure does not have the capacity to meet the requirement of organization.

In Table 1, we can see the best Cloud Infrastructure as a Service Provider of the year 2016. Various Vendors are compared on different aspects and one can choose the one which best suits to the requirement.

Table 1 Best infrastructure as a service of 2016

S. No.	Different attributes	Amazon web services	Google cloud platform	Microsoft Azure	Rackspace managed cloud	IBM/soft layer
1.	More than 10 global data-centers	Yes		Yes		Yes
2.	Data-centers present in Asia Pacific	Yes	Yes	Yes	Yes	Yes
3.	Data-centers present in Europe	Yes	Yes	Yes	Yes	Yes
4.	Data-centers present in North America	Yes	Yes	Yes	Yes	Yes
5.	Data-centers present in South America	Yes		Yes		Yes
6.	Ethernet of 10 Gigabytes	Yes	Yes		Yes	
7.	40 Gigabytes InfiniBand			Yes		Yes
8.	Hyper-V hypervisor		Yes	Yes		
9.	KVM hypervisor					
10.	Linux variant	Yes	Yes			Yes
11.	Open Stack	No			Yes	
12.	Windows compatible			Yes		
13.	Xen hypervisor	Yes			Yes	Yes
14.	CoreOS container support		Yes	Yes	Yes	
15.	Docker container support	Yes	Yes	Yes	Yes	
16.	FreeBSD					Yes
17.	Linux	Yes	Yes	Yes	Yes	Yes
18.	Windows server 2003	Yes				

D. Case Study

Diet solution program [6] is a very interactive website that focuses on the diet program of an individual. The parent company behind the diet solution program is the live smart solution. It (live Smart) helps dieters by consuming an infrastructure diet (http://www.thedietsolutionprogram.com). The company was established in the year 2008 and has rapidly grown by a total jump of 50× revenue in the year 2010.

This is estimated to be having around more than three million site visit daily with about 1 million unique viewers. During its initial period when they were deciding the infrastructure, they need something that was of low cost, touch and must be highly scalable. They need an infrastructure that is flexible enough to scale down and up as there is wide variation in the traffic in their website on a regular basis. Rob Volk is the CTO of Live Smart has reported that shifting to the infrastructure of cloud has provided him with much more peace of mind. Before shifting they had to manage part time administrators of the systems to work on their sites and Volk even said that it is not the best available option for them. Now with the managed cloud (basically an Iaas service provided Rackspace), Rackspace is generally acting as an administrator of windows and Linux for them. Rackspace can easily make their changes, and respond quickly with accessibility of 24 h in a day.

One of the main reasons for Volk to shift to cloud is to focus on its main business and let the expert handle or manages the infrastructure [9]. The shift was due to the ability of the providers of the cloud to quickly configuring, multiple levels of redundancy and its flexibility. What is surprising is the fact that Volk never considered having its own physical server. He decided to go with the cloud because of its very low cost as compared to owning server and its flexibility. Volk has multiple providers of cloud: multiple servers of database, three servers of web and a balance of load with Rack space consequently using Amazon service of S3. The biggest advantage of Iaas as seen by Volk is the scalability. He explains that during the time of New Year or due to New Year's resolution everyone follows a diet and from that time onwards their peak time starts. In fact they receive traffic three times more than usual till the month of March. With the help of servers of cloud they end up with new web front within few minutes and once the traffic goes down they also take that down.

4 Conclusion

Cloud Computing is not merely a term that simply describes a single thing but a term which is more general in describing services from infrastructure which is at the base to services as platform which is used as a developmental tool and to services as software which replaces on-premise application. Those organizations which are looking to shift to Cloud computing must understand the different aspects of cloud and must know very well their own requirements, then only they will be able to know which category of cloud they really need.

In this research paper, we have given what cloud actually is and also focussed mainly on Infrastructure as a service by giving a case study. Through this small case study, we have successfully given a practical example of where an infrastructure as a service (Iaas) can really help. Cloud computing is a very increasing change within the IT and very sooner it will become the default method used in IT. So organizations are advised to take into consideration, the moving to cloud sooner rather than later. There are various vendors that provide cloud services and hence one

should keep in mind the aspects discussed in this research paper before choosing a vendor. Cloud Computing is a rapidly accelerating revolution within IT and will become the default method of IT delivery moving into the future-organizations would be advised to consider their approach toward beginning a move to the clouds sooner, rather than later.

References

1. Dimpy Rani, Rajiv Kumar Ranjan, "A Comparative Study of SaaS, PaaS and IaaS in Cloud Computing", Volume 4, Issue 6, June 2014 in International Journal of Advanced Research in Computer Science and Software Engineering.
2. Steven J. Vaughan-Nichols, "The Best Infrastructure-as-a-Service Solutions of 2016", February 1, 2016.
3. Ben Kepes," Understanding the Cloud Computing Stack: SaaS, PaaS, IaaS" from support. rackspace.com.
4. Illango Sriram, Ali Khajeh-Hosseini, "Research Agenda in Cloud Technologies".
5. Santosh Kumar, R. H. Goudar "Cloud Computing – Research Issues, Challenges, Architecture, Platforms and Applications: A Survey", International Journal of Future Computer and Communication, Vol. 1, No. 4, December 2012.
6. Case Study of Rackspace, "http://broadcast.rackspace.com/hosting_knowledge/whitepapers/CaseStudy_LiveSmartSolutions.pdf".
7. Raj Kumar Buyya, Chin Shin Yio, Sri Kumar Venugopal, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility", Article in press Future Generation Computer Systems.
8. Shuai Zhang, Xuebin Chen, "Cloud Computing Research and Development Trend" in 2010 Second International Conference on Future Networks.
9. Thomas B Winans, John Seely Brown, "Cloud computing A collection of working papers" in Deloitte.
10. Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, "Cloud Sim: a tool kit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms", Softw. Pract. Exper. 2011; 41:23–50 published online 24 August 2010 in Wiley Online Library.

An Observation on Social Media Content to Analyze Cyberpsycho Attack

Prashant Gupta and Manisha J. Nene

Abstract Facebook, Twitter, WhatsApp, Blogs, etc., are some of the most popular social media platforms. They have grown rapidly because of their persuasive features. Availability of low cost of smartphones make it reachable from desk or cafe/lab to pockets or wearable devices. They make information exchange rapidly faster then traditional method of information exchange. One can disseminate information in any digital form like text messages, images, pdf files, video files, and also exchange locations to near and dear ones. Security experts of social media providers continuously work on improving security and privacy matters. There is a domain which make a huge impact on user generated contents which are used for commercial as well as personal purposes. The study in this paper observes the user generated persuasive textual content in most popular social media platforms which leads to cyberpsycho effect.

1 Introduction

Present era is social media era, almost started 15 years ago. As we connect and use social media with others, an individual generated, shared contents to others; and also read contents from different people belong to close relative, college friends, neighbors, working colleagues, etc. Lot of useful digital information is generated and exchanged using this trail of human interaction. It becomes an ocean of information which is used as an input data for social analytic work. Further useful to make predictions, views about certain topics or news, consumer trends, opinions about government or political decisions, increasing awareness and changing or improving lifestyles. Hence, it becomes a primary source and destination for

P. Gupta (✉) · M.J. Nene
Department of Computer Science & Engineering, Defence Institute of Advanced Technology (DIAT), Pune 411025, Maharashtra, India
e-mail: prashant_mce15@diat.ac.in

M.J. Nene
e-mail: mjnene@diat.ac.in

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_52

business analyst or trend analyst to find out consumer behavior about their services or products and also help to amplify brand value of a political person or party. These social media platforms are also used for promotions and advertisements, at a very low cost, compared to other advertisements media.

Social media provide services to its legitimate users to create and share contents at particular time and day in which it will reach to maximum number of active users and influence most to make your content more shareable, exponentially. It looks to be fair to some extend when it is used for marketing or promoting a product. But it becomes harmful when this influencing feature becomes a field of spreading rumors or false news which may change attitude or behavior of an individual or society. It would reflect as a social or communal riots. It may be used as a weapon to deploy such events in many places intentionally by the adversaries who want to achieve some gains or objectives. This effect is termed as *cyberpsycho attack* defined as "*an attack in which cyberspace is used to change attitude or behavior or perception of an individual or society to achieve some goals or simply motivates towards a certain objective*" [1]. The study in this paper is to analysis the textual contents forwarded using Facebook, Twitter, and WhatsApp and presents an observation on cyberpsycho effect which leads to cyberpsycho attack, as a preliminary step towards identifying it.

Outline of this paper: Sect. 2 describes related work with respect to social media analysis in which methods are described to analyze contents. Section 3 describes the motivation towards the observation on cyberpsycho attack and includes the cyberpsycho attack enabling scenario, and proposed useful steps to analyze it. Section 4 the observation on social media which describe limitation and complexity found during analysis and Sect. 5 concludes the present work and present views for future work.

2 Related Work

In [2], authors estimating citizen alertness in crisis using social media monitoring and to monitor social media in order to find out how people perceive the crisis and how they react to communicated alert messages. In [3–5], authors analyzes social media to evaluate its effect during elections for political campaign. In [6], authors proposes to find out spam campaign which having malicious links. In [7], authors analysis contents to find out spam with respect to cyber crimes. In [8–11] authors analysis the sentiments on Facebook and Twitter messages.

3 Proposed Work

This section describes motivation related to analysis and observation on popular social network contents which leads to cyberpsycho attack.

3.1 Motivation

In our work [12, 13], demonstrate sentiment analysis on Twitter and WhatsApp text messages to analyze cyberpsycho attack. It is observed that cyberpsycho attacks have more complexity because of different languages and different social media services, and hence this motivates for the proposed work in this paper.

3.2 Observation on Cyberpsycho Attack

Figure 1 represents the domain of *cyberpsycho attacks* which is closely related to other cyber attacks like spamming, password sniffing and spoofing, phishing, social engineering, backtracking, etc. Cyber attacks are mostly used to steal information or to view the information of others. Further, adversaries can use this effect by including any kind of traditional cyber attacks. An adversary may use cyberpsycho effect not only for changing user's mindset to perform an action to fulfill certain objectives but also may use it to perform any kind of cyber attacks or warfare.

The observation of the cyberspace which leads to *cyberpsycho attack* are state in Fig. 2a describes the phases which represents the steps which is performed by the adversaries when enabling or deploying cyberpsycho effect which leads to cyberpsycho attack. Figure 2b describes the steps which shows what to be observed when analyzing this attack.

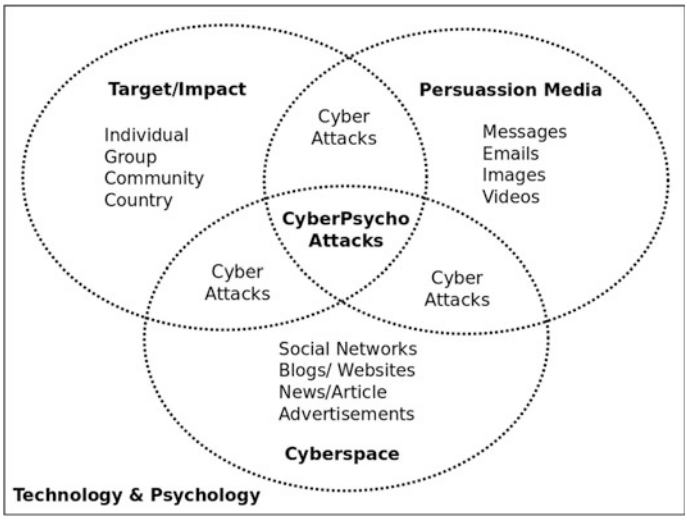


Fig. 1 Domain of cyberpsycho attack

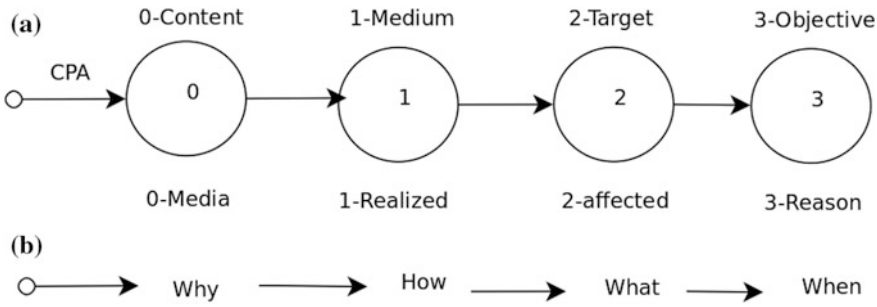


Fig. 2 Steps leading to cyberpsycho attack: an observation

4 Observation on Social Media Content

The process/steps to analyze the cyberpsycho attack are as follows:

```
T           <-    A(CPE)
File        <-    P(T)
EM          <-    P(File)
CPA         <-    A(CPE, EM)
```

where `P()` is process and `A()` is analysis with `T`—topic, `File`—file related to trending `T`, `EM`—Emotions and Metadata, `CPE` stands for *cyberpsycho effect* and `CPA` stands for *cyberpsycho attack*.

These steps leads to analyze cyberpsycho attack. First, have to find out from news and events that going on in the community then observed that it may spreading its effect then contents related to that topic collected in a file through R scripts and platform API authentication process. Second, apply sentiment analysis to the saved file. It will give output related to metadata of the contents and emotions. These all helps to identify the trends which used to spread the news or events and it is also possible to find out the major sources which generate these persuasive contents. Figure 3 shows frequent word as an output of above steps and emotions chart in Fig. 4 represents which emotion are most observed during the sentiment analysis of tweets the similar output obtained when analyzing other platform contents. Table 1 shows information about data which is collected to do this observation study that obtained from some popular social network platforms.

Most of the posts, authors observed are in the form of *sms* language which is not an official or formal language but used mostly in creating content on all social media. Regional language also make impacts when people share or forward messages to those who knows that. So if a message, for example, is in *telegu* or *arabic* then it is forwarded to that region people or those who know that language. Therefore, it is also observed that a single message found to be in multiple language words. For example, a message which having *english* words may also contain *hindi*

Fig. 3 Word cloud based on most frequent words on emotions

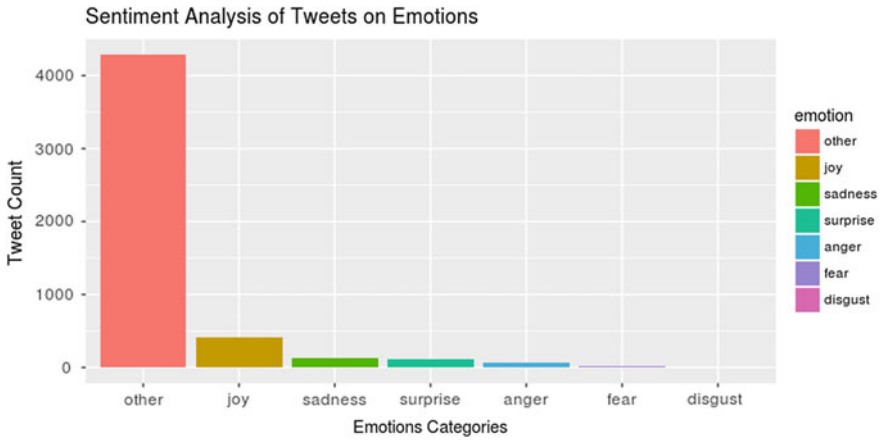


Fig. 4 Sentiment analysis of text messages on emotions

Table 1 Data collected for observation

Social networks	Twitter	Facebook	WhatsApp	Others
Messages count	5000	1500	2500	1000
Content type	Text tweets	Pages, posts	Texts messages	Articles, post, news
Medium	Website	Website	Mobile App	Website
API package	TwitterR	Rfacebook	–	–
Topic taken	Trending	Trending	All	Trending

words and same for other languages. Cross platform contents sharing features of social network platforms makes this effect more effective.

Here, an observation and limitation which observed when analyzing social media contents and when analyzing the cyberpsycho attack related to some of popular social media are described here, with reference to popularity and limitation or complexity related to analysis.

A. Facebook

With 1.9 billion users included 1.2 billion active users and 65 million business, it becomes most popular community on cyber space, as declared in Facebook community page. Users post content on Facebook with a post limit of approximate 450 characters for a *status* update and it may extended up to 16 k for a *note*. The developers API provided in this platforms, have many features like region specifications, language specifications, etc., which makes difficult to observe the different aspects of trending topics. Facebook restricts to download status of the users therefor for analysis work one has to manually collect trending topic related content from the Facebook wall. But search to pages with some strings and users, likes etc., open to explore for a developer. Here author collected pages with reference to popular events, political persons, news, etc., and observe the text posts to identify how much it will contribute to promote themselves and creating cyberpsycho effect.

B. Twitter

It becomes popular as it is used by many government officials and popular personalities. Users post content on Twitter with a word limit of 140 characters. The developers API provided in this platforms, have many features to download the text data and also have features like region specifications, language specifications, etc., which makes easy to some extend, to observe the different aspects of trending topics. The difficulties is that, the language used in this platform are more ambiguous than any other platform as users uses aliases to make content shorter to fit in the limit and to analyze sentiments as those word doesn't belong to any formal language.

C. WhatsApp

This service almost replace the traditional message sending services provide by the telecommute service providers. It is used among the millions of users. It have options to share locations, images, document files, videos etc. These information can be exchanged easily and immediately between one to one or one to many. The use of end to end encryption make it more concise to observe the content being forwarded or shared. One can use email chat history feature to collect chat messages in the form of text. This collected data are in the form of unstructured data.

D. Others

The blogs, YouTube and others social content sharing services have different features, using that people can upload there multimedia messages without any limitations of size when compared to above services. Cross platform content

sharing make these services more interactive and user friendly but for analysis it increase complexity to analyze the contents shared in different formats from different platforms.

5 Conclusion

The *persuasion* plays an important role to make social network services more popular and preferred services. It grows rapidly as technology and connectivity to these services are easily available to end users. Observations on some popular social network platforms in terms of limitation and complexity of the persuasive user generated textual contents which leads to *cyberpsycho effect* are stated in this paper as observed during the analysis work.

These observations and analysis will be used for future work to generate more fruitful results. The analysis done in this paper, focuses on the persuasive text messages collected from popular social media i.e. Twitter, Facebook, and WhatsApp which collected in the form of English language. In future work, it may be extended for rigorous analysis toward different languages. And, the scripts created using R framework for sentiment analysis work may be done through *Hadoop* or other big-data frameworks.

References

1. Gupta, P., & Nene, M. J. (2016). CyberPsycho Attacks: Techniques, Causes, Effects and Recommendations to End-Users. International Journal of Computer Applications, 156(11).
2. Qualman, E. (2010). Socialnomics: How social media transforms the way we live and do business. John Wiley & Sons.
3. Johansson, F., Brynielsson, J., & Quijano, M. N. (2012, August). Estimating citizen alertness in crises using social media monitoring and analysis. In Intelligence and Security Informatics Conference (EISIC), 2012 European (pp. 189–196). IEEE.
4. Rekha, K. G. (2015). Influence of Social Media in Indian Election 2014-a Study on Voters in Thrissur. International Journal of Emerging Research in Management & Technology, 4(4), 7–10.
5. Nulty, P., Theocharis, Y., Popa, S. A., Parnet, O., & Benoit, K. (2016). Social media and political communication in the 2014 elections to the European Parliament. Electoral Studies, 44, 429–444.
6. O'Connor, B., Balasubramanyan, R., Routledge, B. R., & Smith, N. A. (2010). From tweets to polls: Linking text sentiment to public opinion time series. ICWSM, 11(122–129), 1-2.
7. Chu, Z., Widjaja, I., & Wang, H. (2012, June). Detecting social spam campaigns on twitter. In International Conference on Applied Cryptography and Network Security (pp. 455–472). Springer Berlin Heidelberg.
8. Gao, H., Chen, Y., Lee, K., Palsetia, D., & Choudhary, A. N. (2012, February). Towards Online Spam Filtering in Social Networks. In NDSS (Vol. 12, pp. 1–16).

9. Yang, C., Harkreader, R., Zhang, J., Shin, S., & Gu, G. (2012, April). Analyzing spammers' social networks for fun and profit: a case study of cyber criminal ecosystem on twitter. In Proceedings of the 21st international conference on World Wide Web (pp. 71–80). ACM.
10. Ahkter, J. K., & Soria, S. (2010). Sentiment analysis: Facebook status messages. Unpublished master's thesis, Stanford, CA.
11. Mittal, N., Agarwal, B., Agarwal, S., Agarwal, S., & Gupta, P. (2013). A hybrid approach for twitter sentiment analysis. In 10th International Conference on Natural Language Processing (ICON-2013) (pp. 116–120).
12. Gupta, P., & Nene, M. J. (2017). An Approach to analyze cyberpsycho attacks enabled using persuasive messages, in press.
13. Gupta, P., & Nene, M. J. (2017). Analysis of text messages in social media to investigate cyberpsycho attacks. unpublished.

FPGA Implementation of Single-Precision Floating Point Multiplication with Karatsuba Algorithm Using Vedic Mathematics

K.V. Gowreesrinivas and P. Samundiswary

Abstract With increasing computations used in signal processing applications, the Floating point arithmetic plays vital role in reality. Multiplication plays a major role in performance of signal processing applications among all the arithmetic operations such as addition, subtraction, and division. 24-bit multiplier required for mantissa bits multiplication required for single-precision numbers, so the maximum performance typically based on the utilization of area and delay of the multiplier. In this paper, a high-performance single-precision floating point multiplier is designed based on Karatsuba algorithm with Vedic technique and used different regular adders like carry select, ripple carry adders for exponent addition. This requires less hardware to complete multiplication compared to that existing multipliers Further, the performance parameters comparison was done in terms of area and delay. All modules are developed by using Verilog HDL and simulated with Xilinx ISE tool.

1 Introduction

The development in technology demands for high-performance Floating Point Units with greater throughput. In past, many number of high-speed FPUs are developed. Floating point is influenced by multiplication and addition operations, Floating point addition is working on the sequence of mantissa calculations like swapping, shifting, adding, normalizing, and rounding. Generally a typical floating point adder compares the exponents of the two input operands, swaps, and shifts the

K.V. Gowreesrinivas (✉) · P. Samundiswary
Department of Electronics Engineering, Pondicherry University, Kalapet 605014, Puducherry, India
e-mail: srinuu43306@gmail.com

P. Samundiswary
e-mail: samundiswary_pdy@yahoo.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_53

mantissa of the smaller number to get them aligned. It is mandatory to adjust the sign if any one of the incoming numbers is signed number, then first mantissas of given numbers are added and that result needs another sign adjustment if it is negative result. Finally, the adder renormalizes the summation result and adjusts the exponent accordingly, and truncates the resulting mantissa using an appropriate rounding scheme [1]. In order to achieve still high-speed floating point, addition performance is improved by the speed of the blocks which are present in the critical path like variable shifter, comparator, carry propagate adder, normalization logic and rounding hardware. An in divisible operation. Floating Point Multiplication algorithm is shown in Fig. 1.

The Floating point number in Normalized form is given by [2]:

$$Z = (-1)^{S} * 2^{(E-\text{bias})} * (1.\text{M})$$

The Procedure for two floating point numbers multiplication is explained below:

(i) Multiplication of Significands, i.e., [$1.M_1$ * $1.M_2$]
(ii) Placing the decimal point in multiplication result
(iii) Addition of exponents, i.e., [E_1 + E_2 − Bias]
(iv) Sign calculation using XOR operation of MSB bits
(v) Normalizing the result and rounding the implementation
(vi) Verification of Underflow and Overflow.

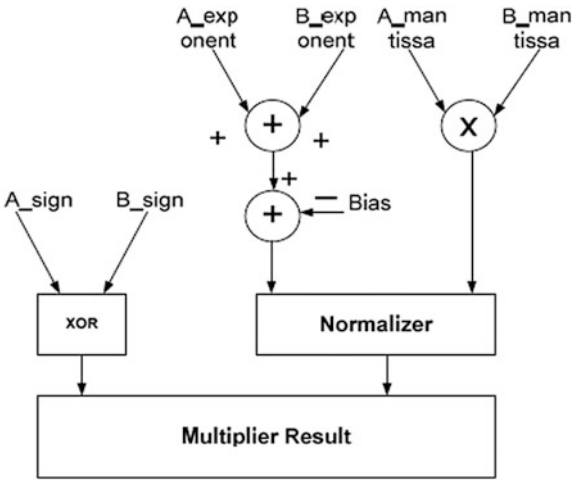


Fig. 1 Floating point multiplication algorithm

2 Different Multipliers

2.1 FP Multiplication Using Array and Wallace Tree Multiplier

For N-bit multiplication of Array multiplier $N - 1$ stages are needed to get final result, where N is the multiplier length. It requires less area and more propagation delay due to next stage will wait for previous stage carry to perform addition [3]. In order to overcome this problem, Wallace Tree multiplier was introduced. It requires $N + 1$ stages for N-bit multiplication and carry save technique is used in this to improve the speed [4].

2.2 FP Multiplication Using Vedic Multiplier

Vedic multiplier is designed based on the Urdhava Triyakbhayam sutras. By using this concept, multiplication of two numbers can be done [5, 6]. In this, the partial products creation can be performed using vertical and crosswise manner and then parallel addition of these partial products are done by using different adders. The mantissa bits of the two numbers are given to the multiplier unit which works on the principle of Vedic mathematics. In this, the partial product creation and their sum are produced in single stage and which decreases the carry propagation from LSB to MSB. The delay of the multiplier is small as compared to the available multiplier structures. The Mantissa computation Unit influences whole functioning of the and it needs 24-bit multiplier for multiplication of mantissa bits [7]. For this, VM method is most suitable for the development of the mantissa block and this gives better in performance with respect to delay and power consumption. The Vedic multiplication system depends on sixteen sutras for solving entire range of mathematical problems. In this, generation of the partial products are taking place simultaneously and due to this the delay gets decrease (Figs. 2 and 3).

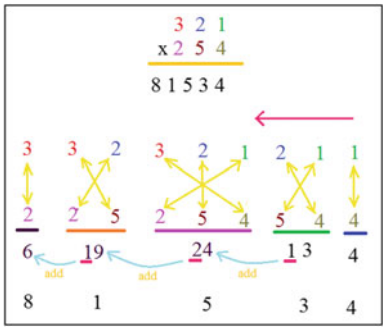


Fig. 2 3-Bit decimal numbers using VM

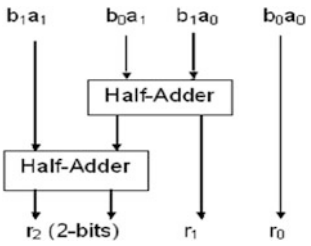


Fig. 3 2-Bit binary numbers Vedic

2.3 *Karatsuba–Vedic Multiplier*

As the bit width goes high then the time required for the multiplication is more. So in order to make the multiplication more efficient with respect to complexity and speed, the proposed model is developed using Karatsuba algorithm with Vedic multiplication [8]. Figure 4 represents the multiplication using Karatsuba algorithm. This decreases required amount of multipliers for performing multiplication by replacing adders and subtractors in place of multipliers, which needs less time to complete the operation. For example, take 2-numbers of each having 2-digits, for that it uses 4-multipliers but Karatsuba algorithm can complete the task by utilizing only 3 multipliers and two subtractors. This algorithm becomes more efficient as the bit width of the input increases [9]. The efficiency of Karatsuba multiplication is optimal when bit width of inputs is more than 16. In this, design of the mantissa multiplier by using Karatsuba with Vedic was discussed [10]. The multiplication is done for 24-bit that means 23-bits mantissa and 1-implied bit. Since, as number of bits are more in mantissa, Karatsuba algorithm was used for mantissa multiplication.

Karatsuba Algorithm is explained below: Consider two mantissa parts of given two numbers W and X

1. Divide the mantissa into 3-parts, each part having 8-bits namely $W0$, $W1$, $W2$ and $X0$, $X1$, $X2$ for the inputs W and X, respectively.
2. Operation of Karatsuba multiplication is explained with few equations written below. This concept uses sufficient amount of adders in places of few multipliers to increase resource efficiency.

$$
\begin{aligned}
W &= W_2 2^{2n} + W_1 2^n + W_0 \\
X &= X_2 2^{2n} + X_1 2^n + X_0 \\
WX &= W_2X_2 2^{4n} + (W_2X_1 + W_1X_2)2^{3n} + [(W_2X_0 + W_0X_2) + W_1X_1]2^{2n} \\
&\quad + (W_0X_1 + W_1X_0)2^n + W_0X_0
\end{aligned}
$$

3. This model requires 9-multipliers and 8-adders to get complete result.
4. In this Vedic multiplier was used to perform mantissa multiplication and carry select and ripple carry adder are used for addition operation [11].

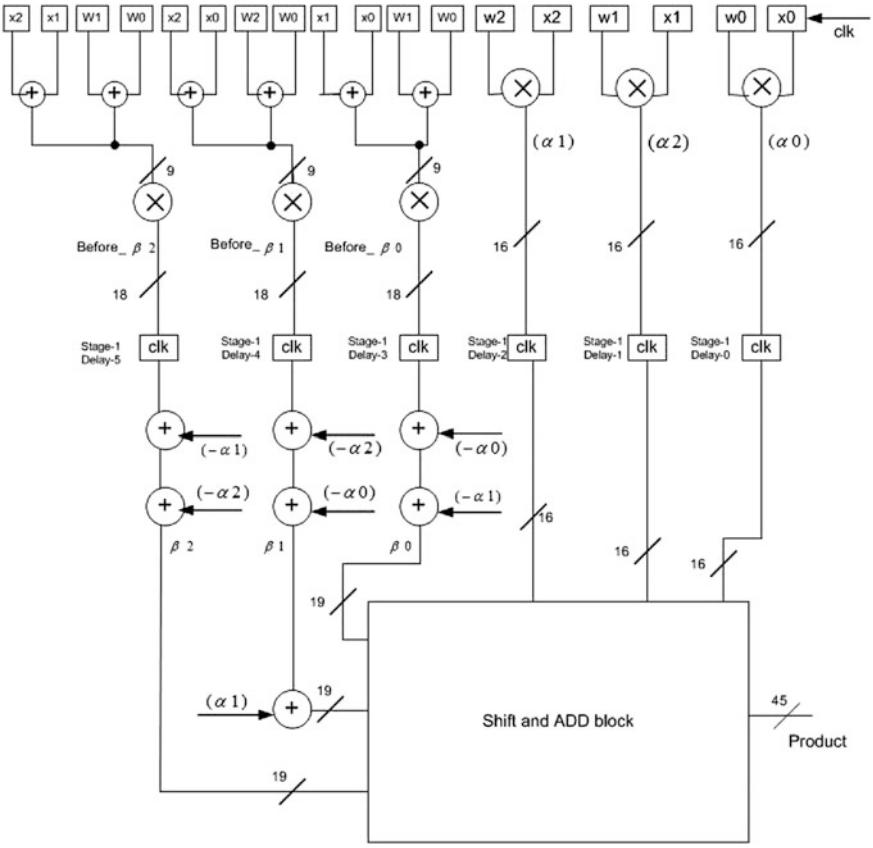


Fig. 4 Karatsuba multiplier structure

5. It is used to minimize the amount of multiplications needed to six by replacing the number of adders to 17. Already calculated terms can be reused in subsequent stages.

$$\beta 2 = W_2X_1 + W_1X_2 \quad \beta 1 = W_2X_0 + W_0X_2 \quad \beta 0 = W_0X_1 + W_1X_0$$
$$\alpha_2 = W_2X_2 \quad \alpha_1 = W_1X_1 \quad \alpha_0 = W_0X_0$$
$$\beta 2 = (W_2 + W_1)(X_2 + X_1) - \alpha_2 - \alpha_1 \quad \beta 1 = (W_2 + W_0)(X_2 + X_0) - \alpha_2 - \alpha_0$$
$$\beta 0 = (W_1 + W_0)(X_1 + X_0) - \alpha_1 - \alpha_0$$
$$WX = \alpha_2 2^{4n} + \beta 22^{3n} + (\beta 1 + \alpha_1)\, 2^{2n} + \beta 02^n + \alpha_0.$$

3 Simulation Environment

Single-precision floating point multiplication is implemented with Karastuba algorithm using Vedic technique and various adders available. The constraints that here considered are the area and speed. Here various multipliers like Array, Wallace tree, and Vedic multiplier are simulated using Xilinx ISE From the results tabulated in Table 1, it is inferred that single-precision floating point multiplier with Karatsuba using Vedic technique is the good combination for developing single-precision floating point multiplier.

3.1 Karatsuba–Vedic Multiplier

(i) Area of the SPFPM using Karatsuba algorithm and Vedic Multiplier (Figs. 5 and 6).
(ii) RTL of the SPFPM using Karatsuba algorithm and Vedic Multiplier (Figs. 7 and 8).
(iii) Delay of the SPFPM using Karatsuba algorithm (Fig. 9).
(iv) Delay of the SPFPM using Vedic Multiplier (Fig. 10).

Table 1 Comparison of SPFM using different multipliers

SPFM using different multipliers	No. of slice LUTs	No. of slices	Delay (ns)
Wallace tree	1132	647	47.98
Array	828	657	83.49
Vedic	824	473	27.35
Karatsuba–Vedic	198	106	12.97

Device Utilization Summary				[-]
Logic Utilization	**Used**	**Available**	**Utilization**	**Note(s)**
Number of 4 input LUTs	198	9,312	2%	
Number of occupied Slices	106	4,656	2%	
Number of Slices containing only related logic	106	106	100%	
Number of Slices containing unrelated logic	0	106	0%	
Total Number of 4 input LUTs	198	9,312	2%	
Number of bonded IOBs	72	232	31%	
Average Fanout of Non-Clock Nets	3.39			

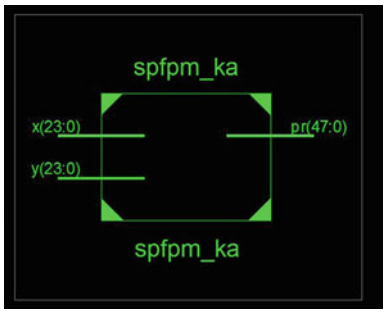
Fig. 5 Area of the Karatsuba algorithm

spfpm_vm_csla Project Status (12/21/2016 - 04:36:14)			
Project File:	spfpm_vm_csla.xise	**Parser Errors:**	No Errors
Module Name:	spfpm_nor_vedic	**Implementation State:**	Synthesized
Target Device:	xc3s500e-4fg320	**•Errors:**	No Errors
Product Version:	ISE 12.1	**•Warnings:**	59 Warnings (6 new)
Design Goal:	Balanced	**•Routing Results:**	
Design Strategy:	Xilinx Default (unlocked)	**•Timing Constraints:**	
Environment:	System Settings	**•Final Timing Score:**	

Device Utilization Summary (estimated values)			[-]
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slices	473	4656	10%
Number of 4 input LUTs	824	9312	8%
Number of bonded IOBs	94	232	40%

Fig. 6 Area of the Vedic multiplier

Fig. 7 Area of the Karatsuba algorithm



From the Simulation results of Figs. 5 and 6, it is inferred that Vedic multiplier need 388 slices and 676 Look up tables and karatsuba algorithm using Vedic multiplier requires 75 slices and 133 look up tables that means the area required is very less compared with Vedic multiplier. In case of Propagation delay, 25.9 ns required for Vedic multiplier where as Karatsuba algorithm need 12.97 ns that means its works at faster rate compared to Vedic multiplier

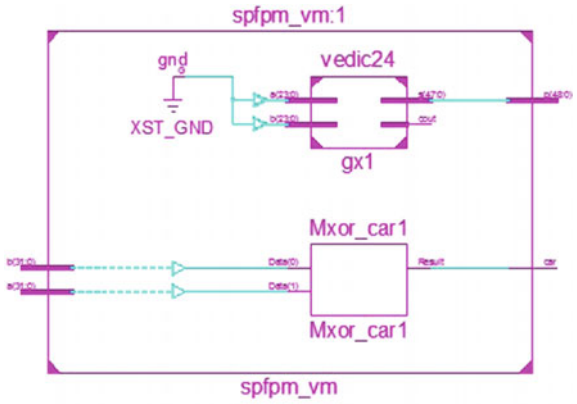


Fig. 8 Area of the Vedic multiplier

```
Delay:               23.836ns (Levels of Logic = 16)
  Source:            b<0> (PAD)
  Destination:       mult<23> (PAD)

  Data Path: b<0> to mult<23>
                                Gate     Net
    Cell:in->out      fanout   Delay   Delay  Logical Name (Net N
    ----------------------------------------  ------------
     IBUF:I->O             14   1.218   1.175  b_0_IBUF (b_0_IBUF)
     LUT4:I0->O             1   0.704   0.499  g6/g100/Mxor_s_xo<0
     LUT3:I1->O             3   0.704   0.610  g6/g100/Mxor_s_xo<0
     LUT4:I1->O             2   0.704   0.622  g18/g100/Mxor_s_xo<
     LUT4:I0->O             3   0.704   0.706  g18/g101/car_and000
     LUT2:I0->O             2   0.704   0.622  g32/g101/Mxor_s_xo<
     LUT4:I0->O             2   0.704   0.482  g46/car1 (c<46>)
     LUT4:I2->O             2   0.704   0.622  g62/Mxor_s_xo<0>1 (
     LUT4:I0->O             2   0.704   0.622  g76/car1 (c<76>)
     LUT4:I0->O             2   0.704   0.622  g78/car1 (c<78>)
     LUT4:I0->O             2   0.704   0.622  g80/car1 (c<80>)
     LUT4:I0->O             2   0.704   0.622  g82/car1 (c<82>)
     LUT4:I0->O             2   0.704   0.622  g84/car1 (c<84>)
     LUT4:I0->O             2   0.704   0.622  g86/car1 (c<86>)
     LUT4:I0->O             1   0.704   0.420  g88/car1 (mult_23_O
     OBUF:I->O                  3.272          mult_23_OBUF (mult<
    ----------------------------------------
    Total                      23.836ns (14.346ns logic, 9.490ns r
                                        (60.2% logic, 39.8% route)
```

Fig. 9 Delay of the SPFPM using Karatsuba algorithm

```
Timing constraint: Default path analysis
  Total number of paths / destination ports: 1354629 / 48
-------------------------------------------------------------------------
Delay:               25.902ns (Levels of Logic = 21)
  Source:            a<18> (PAD)
  Destination:       p<23> (PAD)

  Data Path: a<18> to p<23>
                              Gate     Net
    Cell:in->out      fanout   Delay   Delay  Logical Name (Net Name)
    ----------------------------------------  ------------
     IBUF:I->O             54   1.228   1.850  a_18_IBUF (a_18_IBUF)
     LUT4:I0->O             2   0.254   1.072  gx1/z3/g4/zz5/z15/Mxor_s_xo<0>1 (gx1/z3/
     LUT6:I0->O             2   0.254   1.047  gx1/z3/g4/x2/z73/Mxor_s_xo<0>1 (gx1/z3/g
     LUT5:I0->O             2   0.254   0.893  gx1/z3/g4/zz9/z73/car1 (gx1/z3/g4/zz9/c<
     LUT6:I2->O             3   0.254   0.651  gx1/z3/g4/zz9/z74/Mxor_s_xo<0>1 (gx1/z3/
     LUT6:I5->O             3   0.254   0.651  gx1/z3/g7/z68/Mxor_s_xo<0>21 (N45)
     LUT5:I4->O             2   0.254   1.047  gx1/z3/g7/z68/Mxor_s_xo<0>1 (gx1/q2<2>)
     LUT6:I1->O             3   0.254   0.759  gx1/z5/z31/car1 (gx1/z5/c<2>)
     LUT5:I3->O             3   0.250   0.759  gx1/z5/z33/car1 (gx1/z5/c<4>)
     LUT5:I3->O             3   0.250   0.759  gx1/z5/z35/car1 (gx1/z5/c<6>)
     LUT5:I3->O             3   0.250   0.759  gx1/z5/z37/car1 (gx1/z5/c<8>)
     LUT5:I3->O             4   0.250   0.792  gx1/z5/z39/car1 (gx1/z5/c<10>)
     LUT5:I3->O             4   0.250   0.792  gx1/z5/z41/car1 (gx1/z5/c<12>)
     LUT5:I3->O             4   0.250   0.792  gx1/z5/z44/car1 (gx1/z5/c<14>)
     LUT6:I4->O             4   0.250   0.792  gx1/z5/z46/car1 (gx1/z5/c<16>)
     LUT6:I4->O             4   0.250   0.792  gx1/z5/z48/car1 (gx1/z5/c<18>)
     LUT5:I3->O             2   0.250   1.047  gx1/z5/z50/Mxor_s_xo<0>1 (gx1/temp1<20>)
     LUT5:I0->O             3   0.254   0.759  gx1/z6/z62/car1 (gx1/z6/c<8>)
     LUT6:I4->O             1   0.250   0.580  gx1/z6/z64/car1 (gx1/z6/c<10>)
     LUT6:I5->O             1   0.254   0.579  gx1/z6/z65/Mxor_s_xo<0>1 (p_23_OBUF)
     OBUF:I->O                  2.715          p_23_OBUF (p<23>)
    ----------------------------------------
    Total                     25.902ns (8.729ns logic, 17.173ns route)
                                       (33.7% logic, 66.3% route)
```

Fig. 10 Delay of the SPFPM using Vedic multiplier

3.2 Delay Comparison Environment

See Table 1.

4 Conclusion

The single-precision floating point multiplier optimization in terms of complexity and propagation delay in digital signal processing applications is the main problem and the whole system performance can be enhanced by minimizing occupied area. In this paper, a single-precision floating point multipliers is developed with

Combination of Karatsuba algorithm using Vedic multiplier for the multiplication of two mantissa numbers. Further, the performance analysis of newly proposed single-precision floating point multiplier with existing multipliers are done. From the results it is observed that single-precision multiplier using the combination Karatsuba–Vedic multiplier provides better performance with respect to complexity and speed.

Acknowledgements Authors are very grateful to DEITY Scheme, New Delhi (Visveswaraya Ph. D. Fellowship) for assisting financial support to do the Research work.

References

1. Neelima Koppala1, RohitSreerama, PaidiSatish, "Performance Comparison of Fast Multipliers Implemented on Variable Precision Floating Point Multiplication Algorithm", International Journal of Computer Applications in Engineering Sciences, vol. 2, pp. 55–59, 2012.
2. KV Gowreesrinivas, P Samundiswary, "Comparative Study of Performance of Single Precision Floating Point Multiplier Using Vedic Multiplier and different types of Adders" Proceedings of International Conference on Control, Instrumentation, Communication and Computational Technologies, Kanyakumari, pp. 558–563, Dec 2016.
3. Suma Nair, TSR Sudarshan" An Asynchronous Double Precision Floating Point Multiplier", Proceedings of International conference on Electrical, Computer and Communication Technologies", Nagercoil, pp. 1–5, 2015.
4. Jitesh R Shinde, Suresh S Salankar, "VLSI Implementation of Bit-Serial Architecture based Multiplier in Floating Point Arithmetic" Proceedings of International Conference on Advances in Computing, Communications and Informatics, Vol-3, pp. 1672–1677, Kerala, Aug 2015.
5. Ravi Kishore Kodali, Lakshmi Boppana and Sai Sourabh Yenamachintala "FPGA Implementation of Vedic Floating Point Multiplier", Proceedings of International Conference on Electrical and Computer Engineering, Warangal, vol. 2, pp. 325–328, Dec 2015.
6. Sivanandam K, Kumar P, "Run Time Reconfigurable Modified Vedic Multiplier for High Speed Applications", Proceedings of International Conference on Computing, for Sustainable Global Development, Mar 2015.
7. Sunesh. V, Satishkumar P, "Design and Implementation of fast Floating point Multiplier Unit," Proceedings of International Conference on VLSI systems, Architectures, Technology and Applications, Banglore, January 2015.
8. S. Arish, RK Sharma, "An Efficient Floating Point Design for high Speed Applications using Karatsuba Algorithm and Urdhva Tiryagbhyam algorithm", Proceedings of International Conference on Signal Processing and Communication", Vijayawada, pp. 99–104, Mar 2015.
9. A.M. Mehta, C. Bidhul, S. Joseph, and P. Jayakrishnan, "Implementation of single precision floating point multiplier using karatsuba algorithm," Proceedings of International Conference on Green Computing, Communication and Conservation of Energy, pp. 254–256, Dec2013.
10. N Jitendra Babu, Rajkumar Sarma, "A Novel Low Power and High Speed Multiply-Accumulate Unit Design for Floating-Point Numbers", Proceedings of International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials, Chennai, pp. 411–417, May 2015.
11. E. George Walters III, "24-Bit Significand Multiplier for FPGA Floating Point Multiplication", Proceedings of International Conference on Signals, Systems and Computers, pp. 717–721, April 2015.

On the Reduction of Partial Products Using Wallace Tree Multiplier

Ayyagari Sai Ramya, B.S.S.V. Ramesh Babu, K.S.N. Raju, B. Ravi Chandra, A. Sirisha and E. Srikala

Abstract In order to carry out any arithmetic operation, a basic multiplication operation plays a vital role. Multiplication of any signed (or) unsigned integers can be done using a multiplier. Speed is a major corner in any processing system which in turn depends on the multiplier which acts as a basic building block. There are wide varieties of multiplier architectures that are possible multiplier among them but it cannot perform operations faster. Another possible multiplier is the "Wallace" tree multiplier which can perform operations faster, but it can give fruitful results for unsigned integers. Wallace tree multiplier gives not only speed but also a reduce delay with the help of carry save algorithm and also it uses full adders. Verilog code is simulated and designs are synthesized using Xilinx tool. In this paper, Wallace tree multiplier is compared with conventional multiplier to prove the speed of the Wallace tree multiplier as well the reduced power consumption.

1 Introduction

Multiplication is a very important and powerful operation in any processing architecture speed is an important factor while performing any operation. Any signed (or) unsigned integers are possible out of which array multiplier is the

A.S. Ramya (✉) · B.S.S.V.Ramesh Babu · A. Sirisha · E. Srikala
Department of ECE, Raghu Institute of Technology, Visakhapatnam, India
e-mail: ramya.ayyagari@gmail.com

B.S.S.V.Ramesh Babu
e-mail: rameshbssv@gmail.com

E. Srikala
e-mail: srikala.e@gmail.com

K.S.N. Raju
Department of ECE, MVGR College of Engineering, Vizianagaram, India

B. Ravi Chandra
Department of ECE, NSR Institute of Technology, Visakhapatnam, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_54

simplest multiplier. Similarly some multipliers which can perform well are also available. But as the speed is the major concern, we need a multiplier which performs operations faster of size of the multiplier increases [1]. The performance will also increase but reduces speed, increases power consumption and of course delay. Hence, Wallace tree is the best choice for increased speed. In this paper the speed can be further increased by reducing the area of the traditional Wallace reduction tree can reduce latency depending on the carry save addition algorithm. In this paper, a comparative study is the done with respect to area and delay [2]. The remaining part of the paper is as follows: in Sect. 2 basic approach for traditional Wallace tree multiplier is evaluated. Section 3 comprises the logic for the multiplication and reduction of partial products is discussed. In Sect. 4, simulation results are carried out and the paper is concluded with Sect. 5.

2 Traditional Wallace Tree Multiplier

Basically, any multiplier will undergo three stages for its computation. First, partial products are generated using AND array and these intermediate results are more in number which must be added to reduce them and the second stage is the traditional Wallace tree multiplier reduces these products with the help of full adder and half adder circuits preferably carry save adder these will be added with the help of a paper adder [3, 4]. Here carry propagate adder may be the best choice. A Wallace tree multiplier is having number of full adders in its stages of computation [5]. The traditional Wallace Tree multiplier is shown in Fig. 1.

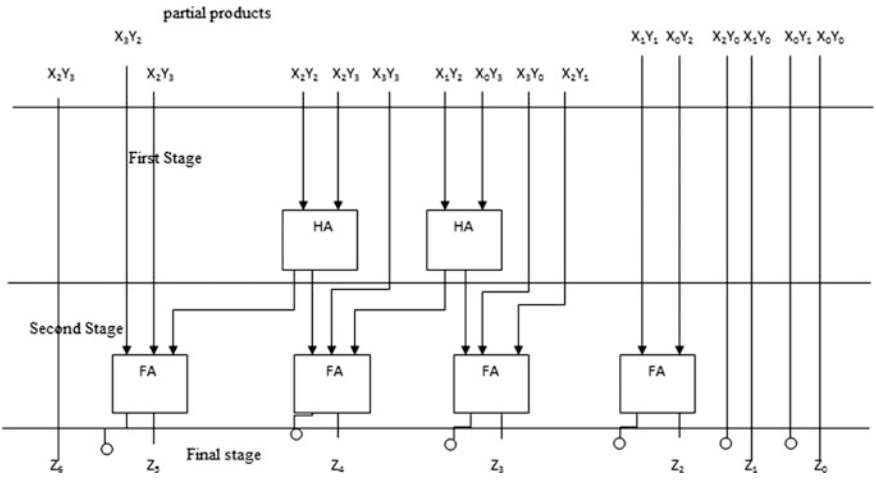


Fig. 1 Traditional wallace tree multiplier

Delay will be added as numbers of stages are getting increased. The intermediate results that are obtained in first and second stages are not dependent on one another. But dependent on the inputs that are obtained from AND array [6]. At the higher stages the resultant value is dependent on the previous C_{out} value. If we are having '*n*' number of stages, the same thing repeats to all the stages which incurs the propagation delay. In Fig. 2, carry save adder along with RTL circuit.

3 Proposed Architecture

In this computation traditional, Wallace tree multiplier uses AND array for generating partial products, carry save adder in the next stage and also a carry propagate adder in the last stage. Due to these full adders, the delay is increased. As speed is the main constraint delay must be reduced which can be possible by reducing no. of adders [7]. Hence in place of adders, compressors can be used that is a Wallace tree can be represented by a tree of 3/2, 4/2 (or) 5/2 adders. This proposed architecture also comprises of three stages similar to the traditional one. The first stage here is the decomposition of i/p into partial products. And these can be reduced using compressors and in final stage we use carry select adder. Carry save adder is used to reduce the delay. But the advantage with carry select adder is addition of these partial products can be done in multiple stages. It consists of ripple **carry** adder and a multiplier. With the help of carry select adder speed gets improved. Figure 3 is the Carry Select Adder with its RTL Circuit.

3.1 3/2 Full Adder

The 3/2 full adder is a 3:2 compressor which means it can produce two outputs sum and carry from three inputs. This 3/2 Full adder is very much useful in speed enhancing. Figure 4 shows 3/2 full adder circuit.

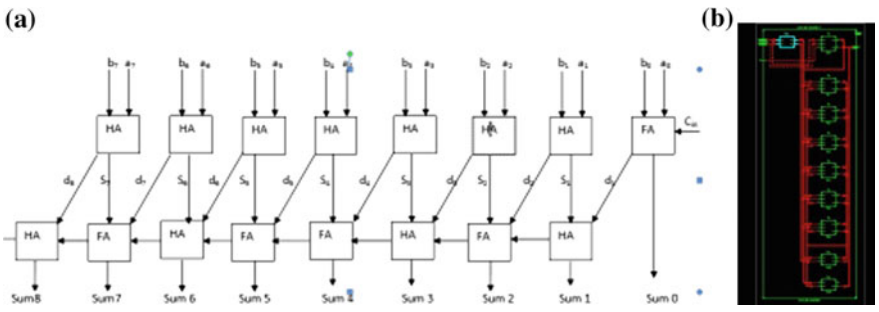


Fig. 2 **a** Carry save adder. **b** RTL circuit

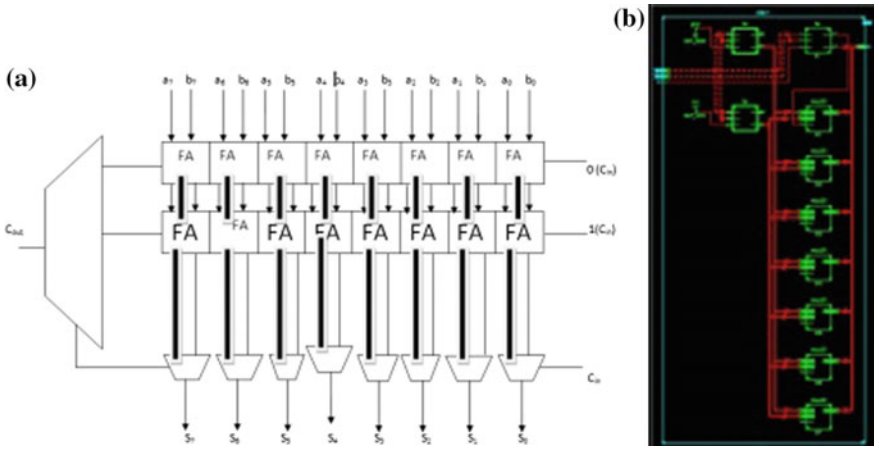
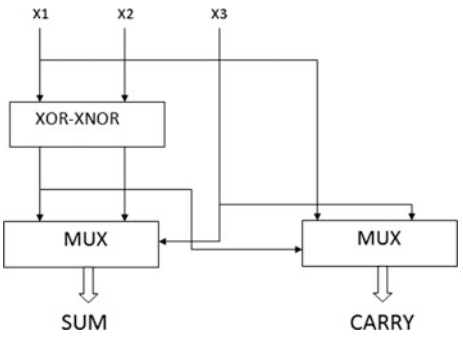


Fig. 3 **a** Carry select adder. **b** RTL circuit

Fig. 4 3/2 full adder



3.2 4/2 Full Adder

It produces two outputs sum and carry from four outputs. 4:2 compressor is a 5 bit adder due to sum and carry. In general, output is obtained from five inputs. Carry propagation delay can be greatly reduced as the value of C_{out} depends only on the inputs provided but not on the carry input C_{in}. Figure 5 shows the 3/2 Full adder.

3.3 5/2 Full Adder

This stage is very much useful for avoiding Carry propagation delay. This can be achieved by compressing the carry propagation to a single stage. Figure 6 shows the 5/2 Full adder.

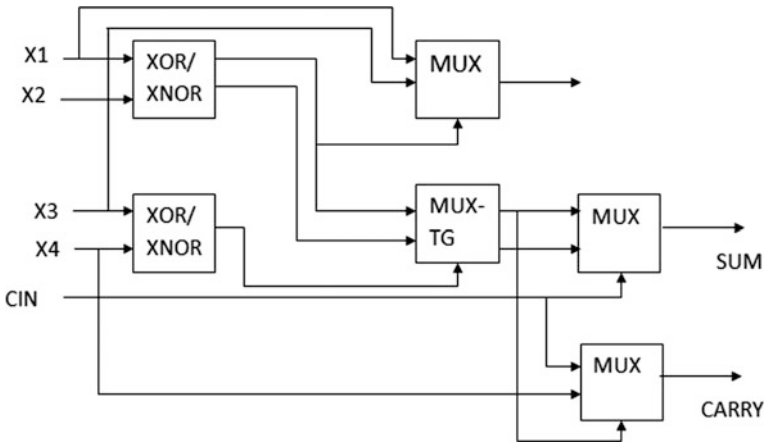


Fig. 5 4/2 full adder

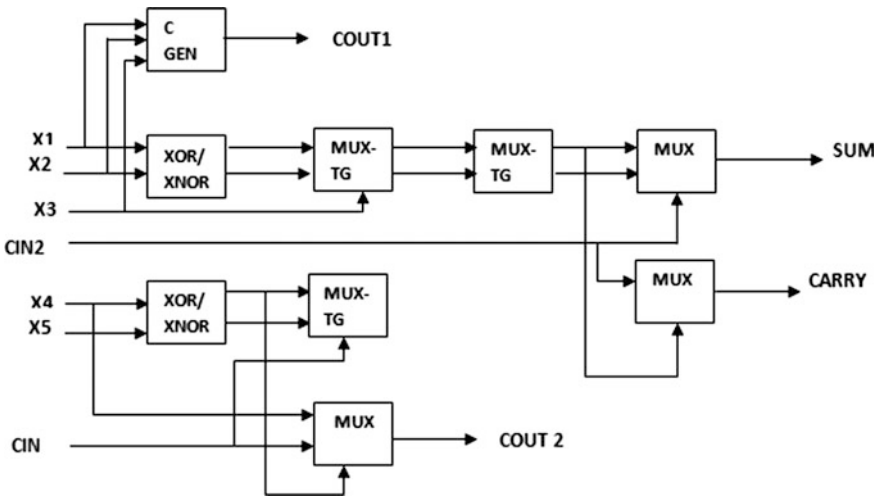


Fig. 6 5/2 full adder

Second stage of the proposed Wallace Tree multiplier comprises 4/2 adders where two full adders combined. In the third stage we have 5/2 full adders where three full adders are combined. So the proposed Wallace tree multiplier is implemented by using these compressors. In this process, interconnections must be taken care as these will establish a relation from one stage to the other. At high stages, these compressors will give longest delay path, which in turn reduces the latency.

4 Simulation Results

Verilog code for a proposed architecture is simulated using Xilinx tool. Figure 7 represents the simulation result for the Basic unit which is a traditional Wallace tree multiplier.

Figure 8 is 4/2 Full adder which is a 4:2 compressor. This compressor is going to reduce the partial products to two from four inputs.

Figure 9 is 5/2 Full adder which is a 5:2 compressor. This compressor is going to reduce the partial products to two from five inputs.

In Fig. 10, the result of Carry select adder which is used in the final stage of the proposed Wallace tree multiplier.

Figure 11 is the simulation result of the proposed Wallace tree multiplier.

In Table 1 comparative study is done between area and latency. From Table 1, it can be shown that proposed Wallace tree multiplier is having less slice utilization compared with the traditional Wallace tree multiplier. And also the latency for proposed one is lesser compare with the traditional one which indicates that the propagation delay is reduced by compressing partial products which are obtained amid of multiplication.

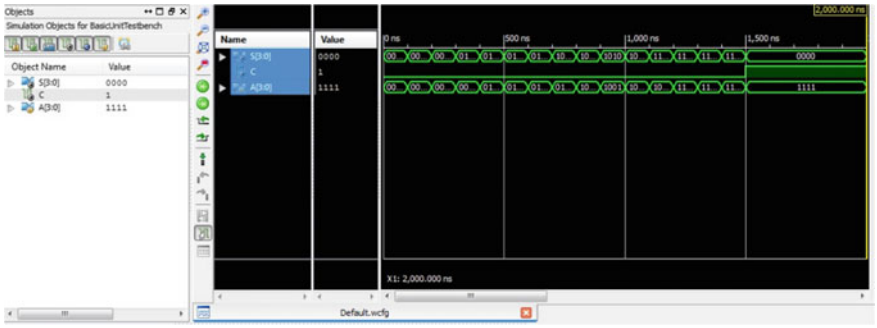


Fig. 7 Basic unit

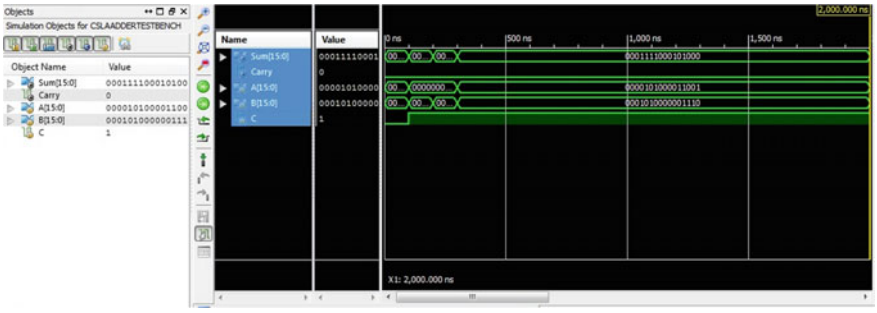


Fig. 8 4:2 compressor

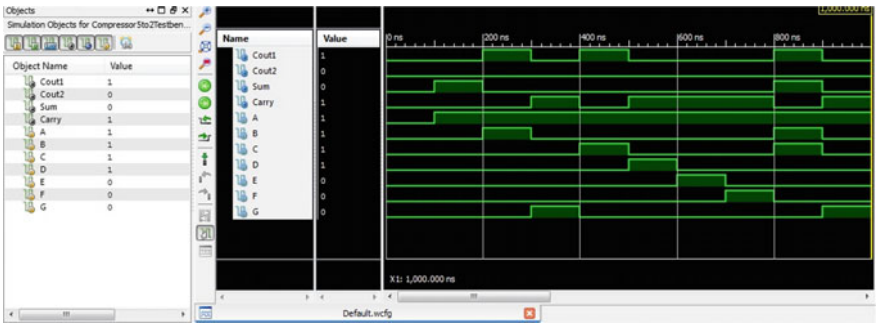


Fig. 9 5:2 compressor

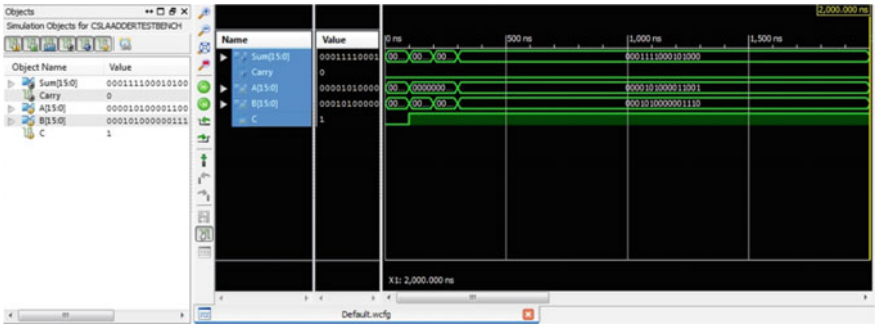


Fig. 10 CSLA

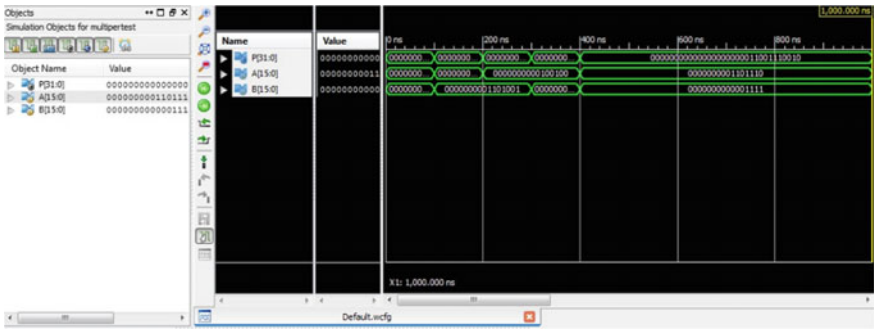


Fig. 11 Multiplier test

Table 1 Comparison between area and latency

	Number of transistors	Latency
Traditional wallace tree multiplier	2990	28
Proposed wallace tree multiplier	2690	15

5 Conclusion

The proposed Wallace tree multiplexer has simulated and also synthesized using Xilinx and the analysis is done for different parameters such as number of transistors used and the latency. It can be concluded that the proposed Wallace tree is having good latency when compared with the traditional multiplier. From this, we can also conclude that the proposed Wallace tree multiplier is faster than the conventional Wallace tree multiplier which can be around 40%. Hence, this proposed Wallace tree multiplier is recommended when a high speed, low power and low latency multiplier is needed.

References

1. Ron S. Waters and Earl E. Swartzlander: A Reduced Complexity Wallace Multiplier Reduction, IEEE TRANS ON COMP. 59(8) (2010) 1134–1137.
2. C. S. Wallace: A Suggestion for a Fast Multiplier, IEEE Trans. Electronic Computers, 13(1) (1964) 14–17.
3. Shahzad Asif and Yinan Kong: Low Area Wallace Multiplier, VLSI Design. (2014).
4. M. J. Rao and S. Dubey: A high speed and area efficient Booth recoded Wallace tree multiplier for Fast Arithmetic Circuits, Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics. (2012) 220–223.
5. S. Murugeswari and S. K. Mohideen: Design of area efficient and low power multipliers using multiplexer based full adder, 2nd International Conference on Current Trends in Engineering and technology (ICCTET). (2014) 388–392.
6. S. Rajaram and K. Vanithamani: Improvement of Wallace multipliers using Parallel prefix adders, Proceedings of 2011 International Conference on Signal Processing Communication Computing and Networking Technologies (ICSCCN 2011).
7. P. Anita and P. Ramanathan: A new hybrid multiplier using Dadda and Wallace method, International Conference on Electronics and Communication Systems (ICECS). (2014).

Approaches to Fault Localization in Combinatorial Testing: A Survey

Rekha Jayaram and R. Krishnan

Abstract Software program debugging involves Fault Localization which is very expensive and a time consuming task. Hence, high demand for the correct fault localization approach that can help programmers in locating faults with less manual interference. This necessity has given rise to developing different fault localization techniques each of which tries to achieve the localization process in a very effective manner. This paper tries to provide an outline to some of these approaches and also mentions the key issues observed in these approaches.

1 Introduction

Combinatorial Testing (CT) or Combinatorial Interacting testing is one of the most widely used black box testing methods. It is based on the technique of combinatorics. CT is used to automate the process of creating combinations of parameters and values that determine the functionality of a Software system. Combinatorial testing significantly reduces the cost of testing and increases the quality of a software system. It has been proven to be very effective in systems where faults occur due to interactions of its many components. CT tests rare conditions and produces high code coverage.

R. Jayaram (✉)
Department of Information Science & Engineering, Dayananda Sagar College of Engineering, Bangalore 560078, Karnataka, India
e-mail: rekhajayaram20@gmail.com

R. Krishnan
Department of Computer Science & Engineering, Dayananda Sagar College of Engineering, Bangalore 560078, Karnataka, India
e-mail: krishnanr1234@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_55

2 Related Work

An error in a software or a fault in a computer program is a Bug. This bug results in incorrect or unexpected results or exhibits unintended behavior. Most bugs rise from human errors made during design or developmental phases. A study was conducted by the Department of Commerce's National Institute of Standards and Technology in 2002 [1]. This study suggests that software bugs cost the US economy $59.5 billion per year. The cost of finding and fixing defects increases over time. The later a bug is found in the Software development life cycle, the costlier it becomes. Such scenarios make effective testing necessary.

Every software developed needs to be tested before being given to the customer. Software Testing is used to improve the quality of a software. Testing is required to identify errors and defects that creep in during design and development phases. Testing ensures customer reliability and satisfaction. Different types of faults can be targeted by different testing methods.

Any given system will have many parameters involved in it. Testing such a system involves testing each of these parameters and identifying their effects on the system. Every parameter can trigger a set of faults in the system. A combination of these parameters can trigger different types of faults which were not otherwise identified while testing them individually. This is the basis for combinatorial testing, where all possible, discrete combinations of the parameters involved are tested.

Combinatorial testing can be used to identify failures that are caused by interacting parameters. CT uses a less number of test cases for the same. If a test case triggers a fault in the system, it shows that there exists one or more defects in the program. Not all parameters in the test case are relevant to the defect found. Locating the particular parameter that caused the fault helps in applying this information to facilitate the process of debugging.

Every failure gives a set of failure indications. Fault localization is the process of identifying the exact source of a failure from these indications. A fault localization process should try to locate the fault based on some accepted optimality criteria. It should take into consideration the relationships among events and in a large network, it should be carried out in a distributed fashion.

3 Combinatorial Testing

Software systems are large and contain various parameters each of which needs to be considered while testing. Combinatorial testing takes into consideration these parameters and their interactions. It then performs failure detection that is caused by these interactions. The output of CT can help in identifying the parameter combinations that triggered failures in the system. These combinations which trigger failures help programmers in detecting faults in the software. A parameter

combination can be called as failure-inducing if all the tests that contain this combination will fail [2, 3].

Real-life systems consists of many parameters. A study suggests that a maximum of only six of these parameters will be involved in a failure that occurs in these systems [4, 5]. Experiments have shown that using CT we can reduce the number of test case executions needed for effective failure detection [6].

Combinatorial Testing uses arrays called as Covering Arrays (CA) or Mixed Covering Arrays (MCA) as test suites for failure detection [7]. In a CA array, n depicts the size of the array and also the number of rows in this array and k depicts the number of parameters involved and also the number of columns of this array. All the possible parameter combinations can be depicted in a subarray of this CA. If the number of parameters covered in the CA is t then we say the strength of this CA is t. The parameters in MCA may have many different values. ACTS [8] is a type of a test generation tool which is used to construct t-way combinatorial test sets.

After selecting the values for the parameters, these parameters are combined to form a covering array. This array then leads to the creation of test cases for Combinatorial testing [6]. The Covering array thus generated can be used as a test suite which can test many different parameter-value combinations. Nie and Leung show in [6] that CT does not require any prior implementation knowledge of the Software Under Test (SUT) and only the basic system configuration knowledge is sufficient to help identify input parameters and the different values these parameters can take.

Combinatorial testing can be used to test a product line. A group of products which share hardware and code among them is called a product line. A feature model is modeled using the commonalities and differences between these products. Increase in number of choices in the feature model results in an increase in the number of products in that product line. Hence, testing these product lines is very challenging. Combinatorial interaction testing is one approach to test such product lines. Johansen et al. present a technique for automatic and responsive interactive testing of product lines in [9]. This technique helps developers to identify if a new feature in a product line works well with the existing features. The technique has been evaluated using the results of two applications, one being a simulation model of the safety module of a product line and the other is the Eclipse IDE product line. Combinatorial testing is an agile method. Once set up, changes in the product line does not require any manual changes to be made for this type of testing.

Some of the disadvantages of Combinatorial testing are discussed by Nie and Leung in [6] such as, it provides a shortcut to testing as it does not test all the parameter combinations. An improper selection of parameters and their values will lower its fault detection capability and a failure in identifying all parameter interactions will result in CT not testing the missed interactions.

Some of the limitations of Combinatorial testing as discussed by Johansen et al. in [9] are that it will not test if a new feature works with other existing features. Also, the automated tests that are used to test the features will influence the quality of the results generated.

4 Fault Localization Based on Combinatorial Testing

Combinatorial testing detects parameter interactions that trigger system faults. It will localize the faults that get triggered by these combinations. If a test case triggers a fault in a system, it shows that there exist one or more defects in the program. But not all parameters in the test case are relevant to defects. Locating the exact parameter in the test case that is relevant to the fault helps in applying this information to facilitate the process of debugging. A detected fault needs to be investigated, located and then removed. [10, 11] suggest that faults in software are mostly generated by only a few variables which interact frequently.

Fault localization is a search over the space of program components, e.g., statements, variables and values to find suspicious entities that might have participated in a program failure [12]. It involves understanding of numerous components and their interactions with the rest of the system.

In combinatorial testing, the study of fault localization techniques could be categorized into adaptive and nonadaptive methods according to the dependencies between additional test cases and running results [13]. The current section gives a brief on some of the approaches for fault localization in combinatorial testing.

4.1 Delta Debugging

Delta debugging framework is a collection of techniques for minimizing failing test cases and isolating the failure-inducing part of them [12]. This method was first proposed by Zeller and Hildebrandt [2]. The main idea of this method is to identify the interaction that is relevant to the faults by modifying the input parameters.

This method has two basic algorithms namely, (1) *Simplification*, which locates an interaction that is faulty and (2) *Isolation*, which locates a component that caused the system failure. Here, a fault triggering test case is identified and some of its parameters are modified. After modifying the parameters, the test case is run again to see if the fault still occurs. If the test case fails again, then the parameters that were modified are not related to the fault that occurred in the first place. Else these are the parameters that cause the test case to fail.

Li et al. talk about fault localization built on the test results of Combinatorial Testing using an approach based on a principle of Delta Debugging called Isolation [14]. Both methods of isolation namely, Repetitive Isolation (RI) and Strengthened Repetitive Isolation (SRI) are discussed here. Both these methods differ in terms of how much information of the testing done will be used by them. RI uses a failed test case as input, which will then be given to the Isolation algorithm. This algorithm is then executed repetitively. The SRI algorithm also uses the Isolation algorithm, the input here is a schema which was initially considered as fault inducing. The input for SRI is minimal as compared to that of RI. Hence, SRI is a better type of the RI algorithm. Empirical results show that the SRI algorithm results in fewer test cases as compared to RI [14].

Techniques such as Faulty Interaction Characterization (FIC) [7] and its binary search alternative, FIC_BS [7] take as input one test case from a test suite that is used for combinatorial testing. The output of these techniques will be combinations that may cause the test case to fail. The idea behind these techniques consists of changing the parameter values in the failed test case. The process of changing these values will be carried out in a systematic manner. This technique concentrates on identifying failure-inducing combinations. FIC is similar to Delta Debugging in that it modifies one parameter in a test case which has n-parameters once. This process is then repeated *n* times and the minimal fault interactions are calculated.

4.2 Tools for Fault Localization

Ghandehari et al. [15] present a fault localization tool called BEN which is based on CT. The primarily idea of BEN is based on three different types of suspiciousness, that of the component, combination and the environment [3]. It works on the assumption that the combinatorial test set has been executed and the execution status of each test case is known. Output of BEN are statements at different levels of their possibility of being fault inducing.

BEN consists of two main phases namely, (1) *Inducing Combination Identification* which uses an iterative framework. Here, the primary combinatorial test set is first analyzed to see if any combination is suspicious. It then generates suspicious combinations on the basis of their possibility of inducing a failure. A set of new test cases are then generated which should be executed. Upon execution, the results are used to identify the possibility of a combination being suspicious. This possibility depends on two key factors, namely, suspiciousness of the combination and that of the environment where the execution took place. (2) *Faulty Statement Identification* in which an inducing combination is used to produce a small group of tests, which consists of one test case that has failed, called the Core member and the other test cases are called the Derived members. The difference between these two groups is that, the derived members do not contain a failure-inducing combination but the Core member does. The traces collected after execution of the core member are compared with the traces of execution of each derived member. This comparison is utilized to arrange statements in terms of their probability of introducing a fault.

Zheng et al. propose Complete Fault Interaction Location or comFIL [13]. comFIL can be divided into two phases namely, (1) *Generating the canFIS for fault location*: The original test cases will first be executed. These test cases will then be allocated to two groups, where the first group consist test cases that trigger faults and the second group consists test cases that do not trigger faults. It then identifies the set of interactions that cover the first group but not the second and call this as the Candidate Faulty Interaction Set or canFIS. (2) *Generating the minimal fault interaction set*: Additional test cases are generated to select interactions in canFIS and finally the minimal fault interaction set is obtained. Empirical results show that comFIL has a

higher capability of getting safe value for parameters. A major limitation of comFIL is that an increase in the number of input parameters affects its efficiency.

4.3 Failure-Inducing Combination Based Fault Localization

One standard approach to fault localization leverages the idea of a spectrum of a program. Ghandehari et al. talk about a fault localization approach that is based on spectrums [16]. This spectrum captures certain features of a testcase execution [17], namely program slices and program paths, function call counts and use-def chains [18]. Tarantula [19], set union, interaction set and nearest neighbor [18] are some examples of spectrum-based methods. These methods are used for fault identification by comparing the passed test case spectrum and failed test case spectrum.

The approach discussed in [16] is based on the idea of nearest neighbor approach. The main idea here is that the faulty statements appear mostly in the execution traces of a failed test case and these statements do not occur in the execution traces of a passed test case. This approach works in two steps namely, (1) *Test Generation*, which generates a group of tests that contain one failed test case, called the core member, and a maximum of t passed test cases, called the derived members and (2) *Rank Generation*, which compares the spectrum generated by the core member with the spectrums of each of the derived members. This comparison is then used to arrange the statements in terms of their probability of introducing a fault. [16] presents the first effort that utilizes the idea of such a combination for identifying the location of faults in the program code. This method is different as compared to what is discussed by Renieres and Reiss in [18] in terms of execution of many test cases before identifying a failed test case and then selecting its nearest neighbors.

Tarantula [19] takes the traces information of execution of both the passed and failed test cases. It then checks the statements coverage in the traces. This information is used to work out the suspiciousness of every statement. Suspiciousness of a statement is the ratio of the failed test case that executes the statement divided by the sum of the ratios of both failed test cases and passed test cases that execute the same statement [19]. The statement which gives the highest score is checked for faults first. Experiments have reported that Tarantula performs better than other spectrum-based approaches [20].

Other approaches that use spectrums such as set union, set intersection and nearest neighbor have been reported by Renieres and Reiss in [18]. The nearest neighbor method discussed by Renieres and Reiss in [18] identifies the spectrum of one run that has passed and is very similar to the spectrum of a run that has failed. These two spectra are used to generate a difference set. This set is then searched for the fault.

5 Conclusion

Locating a fault in a system is a very tedious task. Although many techniques exist that can narrow this search, one method does not necessarily work well with all systems. Choosing an effective fault localization mechanism requires an in-depth knowledge of the system in question. This would require a systematic fault localization method based on proper analysis and proven through rigorous case studies. Hence, even though various techniques are available, the method of localizing faults is not efficient. Even with constant improvement in these methods, systems are also becoming more complex. Thus, the challenges that the fault localization approaches need to address are also growing. Hence, a substantial amount of research work still needs to be done in this regard. Networks are prone to faults and errors. Locating these faults require lot of human intervention. Using the results of combinatorial testing for fault localization in networks would simplify this problem.

References

1. Software Errors Cost U.S. Economy $59.5 Billion Annually, https://web.archive.org/web/20090610052743/http://www.nist.gov/public_affairs/releases/n02-10.htm.
2. Zeller, A. and Hildebrandt, R.: Simplifying and isolating failure-inducing input. In: IEEE Transactions on Software Engineering, 28(2), pp. 183–200. (2002).
3. Ghandehari, L.S.G., Lei, Y., Xie, T., Kuhn, R. and Kacker, R.: Identifying failure-inducing combinations in a combinatorial test set. In: 2012 IEEE Fifth International Conference on Software Testing, Verification and Validation (pp. 370–379). (2012).
4. Kuhn, D.R. and Okum, V.: Pseudo-exhaustive testing for software. In: 2006 30th Annual IEEE/NASA Software Engineering Workshop (pp. 153–158). (2006).
5. Kuhn, D.R., Wallace, D.R. and Gallo, A.M.: Software fault interactions and implications for software testing. In: IEEE transactions on software engineering, 30 (6), pp. 418–421. (2004).
6. Nie, C. and Leung, H.: A survey of combinatorial testing. In: ACM Computing Surveys (CSUR), 43(2), p. 11. (2011).
7. Zhang, Z. and Zhang, J.: Characterizing failure-causing parameter interactions by adaptive testing. In: Proceedings of the 2011 International Symposium on Software Testing and Analysis (pp. 331–341). (2011).
8. Borazjany, M.N., Yu, L., Lei, Y., Kacker, R. and Kuhn, R.: Combinatorial testing of ACTS: A case study. In: 2012 IEEE Fifth International Conference on Software Testing, Verification and Validation (pp. 591–600). (2012).
9. Johansen, M.F., Haugen, Ø., Fleurey, F., Carlson, E., Endresen, J. and Wien, T.: A technique for agile and automatic interaction testing for product lines. In: IFIP International Conference on Testing Software and Systems (pp. 39–54). Springer Berlin Heidelberg. (2012).
10. Kuhn, D.R. and Reilly, M.J.: An investigation of the applicability of design of experiments to software testing. In: Software Engineering Workshop, 2002. Proceedings. 27th Annual NASA Goddard/IEEE (pp. 91–95). (2002).
11. Kuhn, D.R., Wallace, D.R. and Gallo, A.M.: Software fault interactions and implications for software testing. In: IEEE transactions on software engineering, 30(6), pp. 418–421. (2004).
12. Alipour, M.A.: Automated fault localization techniques: a survey. Oregon State University. (2012).

13. Zheng, W., Wu, X., Hu, D. and Zhu, Q.: Locating Minimal Fault Interaction in Combinatorial Testing. In: Advances in Software Engineering, May 29, 2016. (2016).
14. Li, J., Nie, C. and Lei, Y.: Improved delta debugging based on combinatorial testing. In: 2012 12th International Conference on Quality Software (pp. 102–105). (2012).
15. Ghandehari, L.S., Chandrasekaran, J., Lei, Y., Kacker, R. and Kuhn, D.R.: BEN: A combinatorial testing-based fault localization tool. In: Software Testing, Verification and Validation Workshops (ICSTW), 2015 IEEE Eighth International Conference on (pp. 1–4). (2015).
16. Ghandehari, L.S., Lei, Y., Kung, D., Kacker, R. and Kuhn, R.: Fault localization based on failure-inducing combinations. In: 2013 IEEE 24th International Symposium on Software Reliability Engineering (ISSRE) (pp. 168–177). (2013).
17. Wong, W.E., Gao, R., Li, Y., Abreu, R. and Wotawa, F.: A survey on software fault localization. In: IEEE Transactions on Software Engineering, 42(8), pp. 707–740. (2016).
18. Renieres, M. and Reiss, S.P.: Fault localization with nearest neighbor queries. In: Automated Software Engineering, 2003. Proceedings. 18th IEEE International Conference on (pp. 30–39). (2003).
19. Jones, J.A., Harrold, M.J. and Stasko, J.: Visualization of test information to assist fault localization. In: Proceedings of the 24th international conference on Software engineering (pp. 467–477). (2002).
20. Lo, D., Jiang, L. and Budi, A.: Comprehensive evaluation of association measures for fault localization. In: Software Maintenance (ICSM), 2010 IEEE International Conference on (pp. 1–10). (2010).

Software Fault Prediction Using Machine-Learning Techniques

Deepak Sharma and Pravin Chandra

Abstract Machine-learning techniques are used to find the defect, fault, ambiguity, and bad smell to accomplish quality, maintainability, and reusability in software. Software fault prediction techniques are used to predict software faults by using statistical techniques. However, Machine-learning techniques are also valuable in detecting software fault. This paper presents an overview of software fault prediction using machine-learning techniques to predict the occurrence of faults. This paper also presents the conventional techniques. It aims at describing the problem of fault proneness.

1 Introduction

Software fault prediction (SFP) is a mechanism which can be used for software metrics to improve the software quality (SQ). SFP comes into vast research practice in Computer Science for locating fault [1]. In the current scenario, software applications have become an attraction of its users because it consists of attractive features and users want to access those features without knowing anything. However, the point of fascination is that it has become a public requirement where human beings can connect themselves and share data.

In this article, our intuition is to explain application areas of machine learning techniques (MLT) for improving results of software faults (SF) and software quality (SQ) [2]. Moreover, future scope in which effective use of MLT is made in SFP. Figure 1 shows that software faults in terms of reliability, security, maintainability, etc., can be predicted with MLT as well as statistical techniques (ST) for improving SQ.

D. Sharma (✉) · P. Chandra
University School of Information and Communication Technology,
Guru Gobind Singh Indraprastha University, Dwarka 110078, Delhi, India
e-mail: deepakdixit151@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation,
Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_56

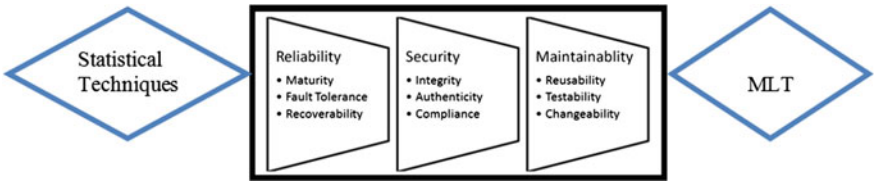


Fig. 1 Software fault prediction

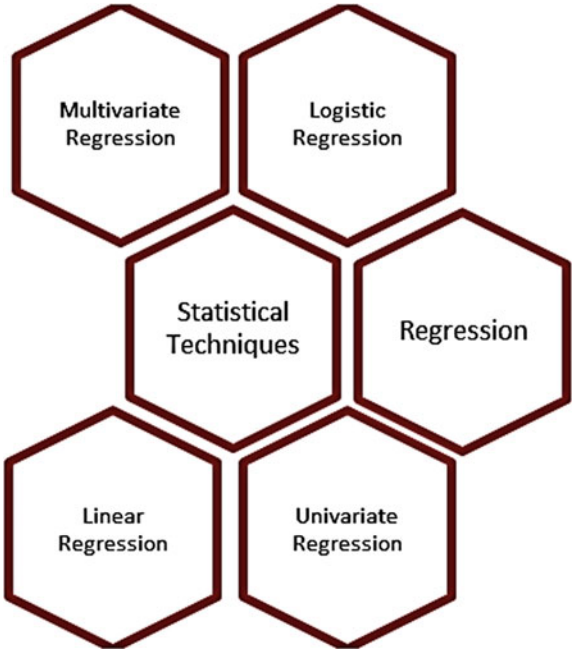


Fig. 2 Alternating hexagon of statistical techniques

2 Conventional Fault Prediction Techniques

In SFP, some of the traditional ST are used which includes logistic regression (LR), linear regression (LIR), univariate regression (UR), and multivariate regression (MR) [2] have become reliable for researchers in locating faults but these techniques are not useful for the novel research. Thus, researchers came up with the use of artificial intelligence (AI) [3] and its techniques [4]. Also researchers are exploring various aspects of AI to solve SFP [5]. The ST has their own profits [6] means they are highly efficient in finding the known faults [7] but the Statistical Technique [8] for SFP [9] is less helpful as numbers of incorrect faults are low. Figure 2 illustrates the types of ST which have been proposed in the literature.

3 SFP Using MLT

This research aims to hybrid such MLT which improves the SQ and fault prediction. MLT includes decision tree (DT), bayesian learner (BL), supervised learning algorithm (SLA), neural network (NN), support vector machines (SVMs), rule-based learning (RBL), and evolutionary algorithms (EA) with its sub-techniques. The intention behind using MLT in SFP will better software reliability, and achieve the target of fault predictions by using AI [10]. Initially, for SFP one not only needs to predict faults but also the number of occurrences of these faults [11] in that particular software [12]. Figure 3, illustrates the Machine learning techniques as per literature [13].

3.1 Decision Trees

Decision tree (DT) is an MLT which is used for classification, regression, and other important problems of SFP in model development and metrics. DT consist the following techniques in Fig. 4 on the next page.

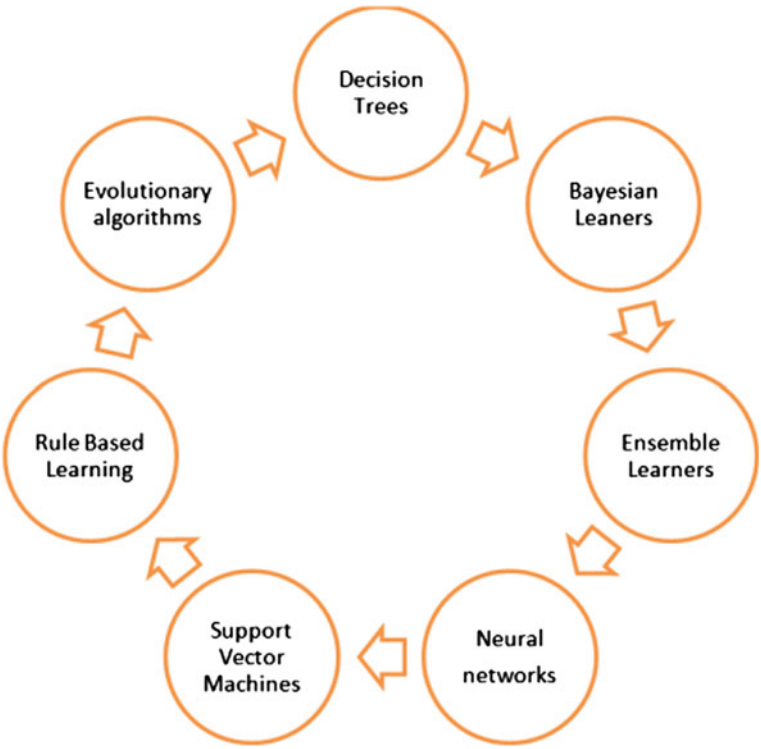


Fig. 3 Machine learning techniques as per literature

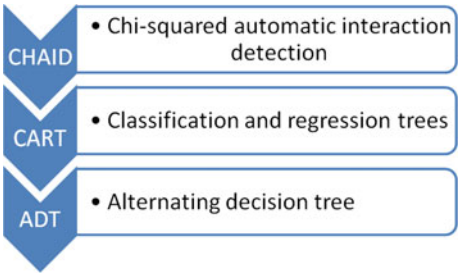


Fig. 4 Vertical chevron list of DT techniques

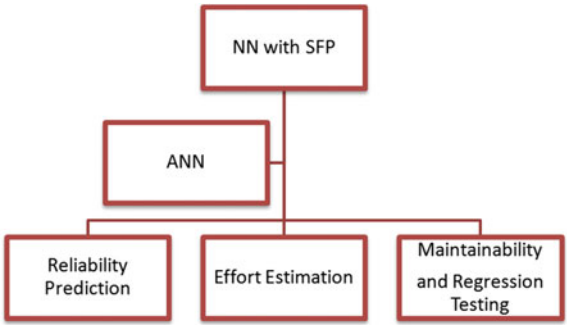


Fig. 5 NN with SFP

3.2 Bayesian Learner

Bayesian learner (BL) is an MLT in which statistical inference is calculated. This technique is used to change the SQ and documentation with one outcome [14] which is software reusability (SR) [15]. Bayesian regularization based training algorithm has been recommended for training back propagation networks. Figure 5 illustrates the research directions of SFP with NN [16] specifically, Reliability prediction and effort estimation [17]. These techniques are used to predict software defects and faults.

3.3 Ensemble Learners

EL consists of supervised learning algorithm (SLA) [18] which has the quality to train the illustrations first and then utilized to generate predictions [19]. The trained SLA represents a single hypothesis (SH) [20]. Single Hypothesis [5], however, is not automatically consists of the hypothesis space of the models from which it is built [21].

3.4 Neural Networks

Neural network (NN) in SFP gives solutions for different types of fault problems like reusability of software, traceability, etc. [18]. In 2011, an advanced technique was proposed for SR [22]. This technique [12] can be used to check model randomly through input and output. These are accurate for almost all perceptible capacity function [23]. The Backpropagation [24] is a training technique for multilayer systems networks [18].

3.5 Support Vector Machines

In MLT, support vector machines (SVMs) are the support vector networks (SVN) in supervised learning model algorithms [25]. SVNs are associated learning algorithms in which data analysis can be done for classification and regression analysis. Figure 6, illustrates the idea of input and feature space [26].

3.6 Rule-Based Learning

In MLT, rule-based learning (RBL) is used as a technique to store and control learning to translate data in a supportive way [27]. They are frequently used in AI-based applications and research.

3.7 Evolutionary Algorithms

In MLT, evolutionary algorithms (EA), consists of genetic algorithms (GA), differential evolution (DA), metaheuristic and particle swarm optimization (PSO), ant colony optimization (ACO), firefly algorithm (FA), swarm intelligence (SI), cuckoo search (CS), and ideas about probability:

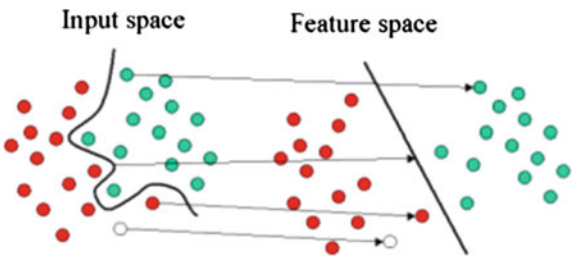


Fig. 6 Support vector machines (input and feature space) [34]

Table 1 Classification of ML techniques (idea taken from [13])

MLT techniques classification of MLT for SFP	
DT	CHAID: chi-squared automatic interaction detection CART: classification and regression trees ADT: alternating decision tree
BL	NB: naive bayes, BN: bayesian networks, WNB: weighted bayesian networks, TNB: transfer bayesian networks
RBL	OneR, NNge: neighbor with generalization and Ripper
NN	MLP: multilayer perceptron, RBF: radial basis function, PNN: probabilistic neural network
EA	SA-PNN: simulated annealing probabilistic neural network, GP: genetic programming, ACO: ant colony optimization
EL	RF: random forest, LB: logit boost, AB: adaboost
Miscellaneous	VP: voted perceptron, AIRS: artificial immune system, KNN: K-nearest neighbor, VF 1: voting feature intervals. RP: recursive partitioning

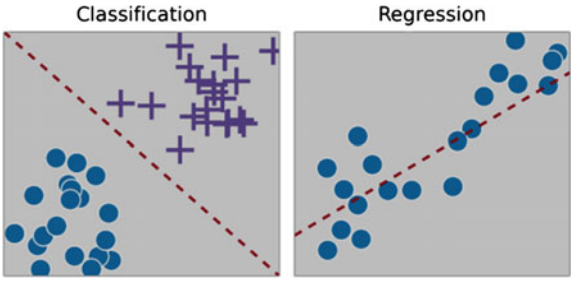


Fig. 7 Difference between classification and regression (adapted from [35] http://ipython-books.github.io/featured-04/)

Bayesian network and chaos theory comes under soft computing techniques (SCT) [28]. These techniques are fast and efficient in SFP model development [29]. Table 1 shows the classification of MLT.

4 Current Trends in Software Fault Prediction Model Development

In a recent work on MLT-based SFP, it was revealed that software quality estimation [30] is a challenging task in software engineering [31]. To obtain better results for SQ, it is mandatory to do research and deep analysis in the SFP. Here the SFP means the direction to attributes like trustworthiness, fault tolerance, compliance, time complexity, effort estimation, etc.

Researchers have also argued that MLT-based prediction of faults [32] and defects in levels of software development life cycle (SDLC) is not an easy task. Thus, it is intended to highlight the experiments [16] of MLT-based SFP [33]. Figure 7, illustrates the research directions of SFP with MLT [17] in which comparison between the MLT classification and ST regression is shown.

5 Conclusion and Future Research Directions

The above research focuses on MLT and its accomplishments with respect to SFP model development. MLT analysis includes a visionary analysis of such techniques looking at the different paradigm of taxonomy and previously developed classes for SFP and SQ. This study may become the ground to prepare a plan for a novel study, which is beneficial and idealistic to recognize and regulate the existing work and to find areas for empirical analysis. This study is a travelog of the biography in the area, beginning with the research in MLT specifically in Software Fault Prediction, Software Quality, and their model development. In this study, software issues related to fault prediction, upcoming research, and results are presented. The analysis of each MLT concludes with the applications of important characteristics and especially a vertical chevron list of DT techniques about the efficiency of the corresponding technique presented.

References

1. Srivastava, P. R., & Kim, T. H.: Application of genetic algorithm in software testing. International Journal of software Engineering and its Applications, 3(4), 87–96 (2009).
2. e Abreu, F. B., & Melo, W.: Evaluating the impact of object-oriented design on software quality. In Software Metrics Symposium, 1996., Proceedings of the 3rd International (pp. 90–99). IEEE (1996, March).
3. Abubakar, A., AlGhamdi, J., & Ahmed, M.: Can Cohesion Predict Fault Density?. In IEEE International Conference on Computer Systems and Applications, 2006. (pp. 890–893). IEEE (2006, March).
4. Al Dallal, J.: Improving the applicability of object-oriented class cohesion metrics. Information and Software Technology, 53(9), 914–928 (2011).
5. Briand, L. C., Wüst, J., Ikonomovski, S. V., & Lounis, H.: Investigating quality factors in object-oriented designs: an industrial case study. In Proceedings of the 21st international conference on Software engineering (pp. 345–354). ACM(1999, May).
6. Aggarwal, K. K., Singh, Y., Kaur, A., & Malhotra, R.: Empirical analysis for investigating the effect of object-oriented metrics on fault proneness: a replicated case study. Software process: Improvement and practice, 14(1), 39–62 (2009).
7. Aggarwal, K. K., Singh, Y., Kaur, A., & Malh.: Investigating effect of Design Metrics on Fault Proneness in Object-Oriented Systems. Journal of Object Technology, 6(10), 127–141 (2007).
8. Al Dallal, J., & Briand, L. C.: An object-oriented high-level design-based class cohesion metric. Information and software technology, 52(12), 1346–1361 (2010).
9. Alshayeb, M., & Li, W.: An empirical validation of object-oriented metrics in two different iterative software processes. IEEE Transactions on software engineering, 29(11), 1043–1049 (2003).
10. D'Ambros, M., Lanza, M., & Robbes, R.: On the relationship between change coupling and software defects. Transactions, 15257(13186), 9373 (2009).
11. Andersson, C., & Runeson, P.: A replicated quantitative analysis of fault distributions in complex software systems. IEEE Transactions on Software Engineering, 33(5), 273–286 (2007).

12. Arisholm, E., Briand, L. C., & Johannessen, E. B.: A systematic and comprehensive investigation of methods to build and evaluate fault prediction models. Journal of Systems and Software, 83(1), 2–17 (2010).
13. Malhotra, R.: A systematic review of machine learning techniques for software fault prediction. Applied Soft Computing, 27, 504–518 (2015).
14. Basili, V. R., Briand, L. C., & Melo, W. L.: A validation of object-oriented design metrics as quality indicators. IEEE Transactions on software engineering, 22(10), 751–761 (1996).
15. Binkley, A. B., & Schach, S. R.: Validation of the coupling dependency metric as a predictor of run-time failures and maintenance measures. In Proceedings of the 20th international conference on Software engineering (pp. 452–455). IEEE Computer Society (1998, April).
16. Eaddy, M., Zimmermann, T., Sherwood, K. D., Garg, V., Murphy, G. C., Nagappan, N., & Aho, A. V.: Do crosscutting concerns cause defects?. IEEE Transactions on Software Engineering, 34(4), 497–515 (2008).
17. El Emam, K., Benlarbi, S., Goel, N., & Rai, S. N.: The confounding effect of class size on the validity of object-oriented metrics. IEEE Transactions on Software Engineering, 27(7), 630–650 (2001).
18. Briand, L. C., Daly, J., Porter, V., & Wust, J.: Predicting fault-prone classes with design measures in object-oriented systems. In Software Reliability Engineering, 1998. Proceedings. The Ninth International Symposium on (pp. 334–343). IEEE (1998, November).
19. Briand, L. C., Wüst, J., Daly, J. W., & Porter, D. V.: Exploring the relationships between design measures and software quality in object-oriented systems. Journal of systems and software, 51(3), 245–273 (2000).
20. Briand, L. C., Wüst, J., & Lounis, H.: Replicated case studies for investigating quality factors in object-oriented designs. Empirical software engineering, 6(1), 11–58 (2001).
21. Briand, L. C., Melo, W. L., & Wust, J.: Assessing the applicability of fault-proneness models across object-oriented software projects. IEEE transactions on Software Engineering, 28(7), 706–720 (2002).
22. Briand, L., Devanbu, P., & Melo, W.: An investigation into coupling measures for C++. In Proceedings of the 19th international conference on Software engineering (pp. 412–421). ACM (1997, May).
23. Bacchelli, A., D'Ambros, M., & Lanza, M. Are popular classes more defect prone?. In International Conference on Fundamental Approaches to Software Engineering (pp. 59–73). (Springer Berlin Heidelberg 2010, March).
24. Binkley, A. B., & Schach, S. R. (1998). Prediction of run-time failures using static product quality metrics. Software Quality Journal, 7(2), 141–147.
25. Briand, L. C., Daly, J., Porter, V., &Wust, J.: A comprehensive empirical validation of design measures for object-oriented systems. In Software Metrics Symposium, 1998. Metrics 1998. Proceedings. Fifth International (pp. 246–257). IEEE (1998, November).
26. Burrows, R., Ferrari, F. C., Garcia, A., & Taïani, F.: An empirical evaluation of coupling metrics on aspect-oriented programs. In Proceedings of the 2010 ICSE Workshop on Emerging Trends in Software Metrics (pp. 53–58). ACM (2010, May).
27. Caglayan, B., Bener, A., & Koch, S.: Merits of using repository metrics in defect prediction for open source projects. In Proceedings of the 2009 ICSE Workshop on Emerging Trends in Free/Libre/Open Source Software Research and Development (pp. 31–36). IEEE Computer Society (2009, May).
28. Cartwright, M., & Shepperd, M.: An empirical investigation of an object-oriented software system. IEEE Transactions on software engineering, 26(8), 786–796 (2000).
29. Chowdhury, I., & Zulkernine, M.: Using complexity, coupling, and cohesion metrics as early indicators of vulnerabilities. Journal of Systems Architecture, 57(3), 294–313 (2011).
30. D'Ambros, M., Lanza, M., & Robbes, R.: Evaluating defect prediction approaches: a benchmark and an extensive comparison. Empirical Software Engineering, 17(4–5), 531–577 (2012).
31. El Emam, K., Melo, W., & Machado, J. C.: The prediction of faulty classes using object-oriented design metrics. Journal of Systems and Software, 56(1), 63–75 (2001).

32. D'Ambros, M., Lanza, M., & Robbes, R.: An extensive comparison of bug prediction approaches. In 2010 7th IEEE Working Conference on Mining Software Repositories (MSR 2010) (pp. 31–41). IEEE (2010, May).
33. Denaro, G., Lavazza, L., & Pezze, M.: An empirical evaluation of object oriented metrics in industrial setting. In The 5th CaberNet Plenary Workshop, Porto Santo, Madeira Archipelago, Portugal (2003, November).
34. http://www.statsoft.com/Textbook/Support-Vector-Machines.
35. http://ipython-books.github.io/featured-04/.

Mathematical Study for Reduction of Variables in Karnaugh Map

Molla Ramizur Rahman

Abstract Digital world has made life easier and luxurious in this era of electronics. Logic Design forms an essential area of discussion as it deals in modeling electronic circuits. Various reduction models exist in designing logics having advantages and limitations. It is important to understand the necessity and applicability for each of such techniques used at different situations. Karnaugh map technique is a well defined technique in boolean term reduction. The paper aims to find a new formula which can be used to find the number of variables reduced in a Karnaugh map and the number of variables to be expressed. Graphical natures of the reduced as well as expressed terms are plotted. The formula was derived from observational study by grouping various numbers of cells in different orders of K-map. A suitable example for a K-map of order four by grouping eight cells, was illustrated which will lead for better understanding and even a test for acceptability of the formula.

1 Introduction

Signals are functions which carries data or information used for interaction or communication between systems. Signals are essential and finds application in almost every electronics system. To minutely observe its use, it greatly dominates communicating applications where its use is not only limited to consumer and industrial telecommunication but also finds extended utility in radar and satellite communication. Signals are also used in biomedical industry for various imaging and clinical investigation processes.

There are two types of signals namely analog and digital. Analog signals are continuous and were extensively used globally. Digital signal are discrete. Digital systems are drawing attention especially in the field of computing and automated processes. On recent advancement in technology and vast research worldwide made digital electronics suitable due to its user friendly nature, and hence mostly used in

M.R. Rahman (✉)
Prin. L. N. Welingkar Institute of Management Development & Research, Mumbai, India
e-mail: ramizurscience@yahoo.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_57

several applications. It has already taken a leading age in all domains ranging from household application to industrial processes.

Digital mainly employs the concept of digits in its working principle. It uses the binary number system that is 1 and 0 indicating true or false, which can be termed as high or low from the view of electronics. It is very important to design the logic for proper functioning in digital systems. The algebra used in digital system is called Boolean algebra.

For designing any logic circuit, the major important stages may be truth table representation, framing logical statements, reduction using minimizing technique, and the most important and the desired part is design. Figure 1 shows a suitable flow diagram essential in designing. The traditional way of minimization is through the various Boolean laws. Typically, designing starts with truth table as shown in Fig. 1. If truth table is available we can frame logical statements, minimize it using boolean algebraic rules, thus can have logic statements without redundant terms and finally draw the circuit as shown by flow 1 in Fig. 1. Again we can directly draw the logic circuit without minimization, but it is undesired as it will contain some unwanted elements which would make the circuits complex and even costly. If the logical statement is available instead of truth table, we can directly applying Boolean laws to eliminate redundant terms and finally the design can be achieved. Another way of approach is to adopt Karnaugh map technique or Q–M technique and directly draw logic circuit from truth table as shown by flow 2 in Fig. 1.

There are various techniques for minimizing Boolean expression. They may be minimizing using algebraic technique using fundamental Boolean rules. The other most used method is Karnaugh map technique. Quine–McCluskey (Q–M) technique of reduction is another minimization technique convenient for reduction for higher variables.

Karnaugh map technique is a method of reducing Boolean expression without using Boolean formula or identities. Named after Maurice Karnaugh, this map is widely known as K-map. This is diagrammatic tabular representation of all the outputs in cells which are grouped on the basis of certain rules. Karnaugh can be

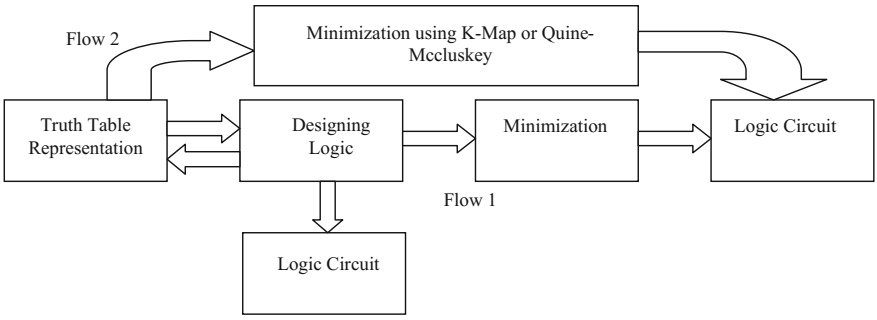


Fig. 1 Flow diagram for designing logic

used for reduction of any number of variables but finds difficulties for higher number of variables beyond 6 or 7 [1].

Mathematical study is one of the key things performed in this paper where formula is derived for reduced terms and expressed terms for K-map grouping. The author [2] discussed importance of mathematics by giving references showing its relations with all domains. Again mathematical study was observed in the work [3] where calculus was used for establishing a new way of obtaining condition for minimum angle of deviation. This paper again an evidence to suggest the mathematical importance in an electronic area and tends to analyze graphically.

The author investigates by studying various orders of K-map of different inputs and achieved to a formula which evaluates the number of variables reduced for different grouping. It also formulates the number of terms to be expressed. Analyzing graphical nature is very important. The author plotted the graphical nature for the formula derived for better understanding which led to the identification of some mathematical observations. Further illustration with example and verifications of the formula was performed.

Software is very important in all the domains including electronics. The paper [4] has evaluated the performance of software in India. Software is widely used to in this field of electronics to achieve significant accuracy in designing logic and simulation.

2 Literature Survey

The author [5] in his paper enhances a better approach for teaching of Karnaugh map as the map itself contains sufficient information which not only makes the faculty to make students understand Karnaugh map construction conveniently but also makes it advantageous to students to grab the concept easily. This self documenting approach provides unique identifier to construct the map which is being assigned to every element in Boolean minterm expression.

The author [6] in his study provides a rule-based system for minimizing Boolean functions with the help of Karnaugh map. Four variable Karnaugh map is illustrated, consists of 16 rules which forms Boolean algebra and their relationship are also shown. The authors [7] in their paper claims a better performing detailed algorithm which provides an online embedded algorithm of wireless virtualization consisting of online scheduling and embedded algorithm of Karnaugh map type.

The author [8] suggested that in sixteen cell Karnaugh map it is possible to minimize six variable logical functions by including up to four minterms where separations of columns of the map is such that even minterms and odd minterms are alternate to each other. This arrangement not only helped in finding prime implicants but also is helpful in plotting. The authors [9] in their paper provide a simple technique for processing and transmission of color images which uses Karnaugh map for deriving matrix sets. The absolute reconstruction is obtained in this method and at the bit level, functions like encryption and decryption are being performed.

The authors [10] made an effort to formulate a number of reduction rules which effectively reduces a quantum logical circuit having input variables of arbitrary number and one auxiliary qubit is used as output whereas input qubit remains same. The author [11] in his paper made an attempt to find symbolic reliability, having an advantage of pictorial insight, by reducing the system into simpler subsystem with the help of Bayesian decomposition whose success or failure are found by inspection and then by using Karnaugh map disjoint sum of product is formed.

The authors [12] in their work illustrated that Karnaugh map is not only a suitable method to be used in the branch condition for the reduction of complexity used in designing software but also can be used as verification purpose for the combination coverage. The author [13] in his work gave examples as well as derivation of some well known circuits and demonstration of a three dimensional Karnaugh map. The author had also considered the steering possibility of J-K and D type flipflop.

The authors [14] in their work used the method that makes use of unique identifiers, which indicates covered terms efficiently in Karnaugh map. The author [15] in his study proposed that Karnaugh map can be used for eight literals by a particular specific arrangement.

The author [16] mentioned e.c.l and m.o.s. logic applications and generalized Boolean function mapping from Karnaugh map and for function implementation eight two layered networks can be derived from eight useful maps which corresponds to any function.

The authors [17] in their paper made an attempt to develop fewer maps to solve two valued logical equations as it is in this method it is possible to identify between the do not care and impossible conditions by following successive elimination and hence is more direct than the followed rules.

The authors [18] in their work made an effort to introduce Karnaugh map technique to find disjunctively decomposable logic functions by evolving certain rules. The paper [19] aims to use Karnaugh map to model multi-string seven level converters which can be extended to 'n' level converter, determines expression for modulation signal with the help of double Fourier series and compares the switching losses of the above inverter with cascaded inverter and the result showed the multi string inverter is advantageous. The paper is an example of the application of Karnaugh map in the field of power electronics.

3 Results and Discussion

From the observations of the results of Karnaugh map, Table 1 depicts tabulation of different orders of Karnaugh map with respect to certain parameters. The parameters observed are mainly the reduced terms and the terms to be expressed. Taking in considerations for all possible groupings for particular order of the map, the reduced and expressed terms are obtained.

Table 1 Summary of observation of parameters by grouping different number of cells in K-map

S. No.	Order of K-map (n)	number of cells grouped (g)	number of reduced term (x)	Number of expressed term (e)
1	2	4	2	0
		2	1	1
		1	0	2
2	3	8	3	0
		4	2	1
		2	1	2
		1	0	3
3	4	16	4	0
		8	3	1
		4	2	2
		2	1	3
		1	0	4

Reduced terms are terms eliminated after grouping in an n-variable Karnaugh map whereas expressed terms are terms which cannot be eliminated even after grouping.

$$\text{Reduced term} + \text{expressed term} = \text{order of k-map.}$$

From Table 1 it is clear that

$$g = 2^x$$

where g is the number of variables grouped and x is the number of variables reduced.

Taking log on both sides

$$\log g = \log 2^x$$

$$\log g = x \log 2$$

$$x = \log g / \log 2$$

No. of variables expressed $e = n - x$.

where n is the order of K-map

$$e = n - \frac{\log g}{\log 2}$$

where n = 2, 3, 4….

Fig. 2 Grouping of eight cells in a K-map of order 4

cd \ ab	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

Let us understand by a simple illustration. Suppose the order of the K-map is 4 and number of cells to be grouped is 8 as shown in Fig. 2.

From the K-map, it is evident that the expression for such map is $y = b$. Initial total number of variables were 4 that is a, b, c, and d. On such particular grouping it is reduced to one that is only b. So number of variables reduced in this particular case is 3 (a, c and d) and number of variables expressed is 1 that is 'b'.

From the formula established.

Number of variables reduced, $x = \frac{\log 8}{\log 2}$

$$x = 3$$

Further, expressed term $e = 4 - 3 = 1$.

Thus, the formula derived is established with a suitable example and verified descriptively by drawing a Karnaugh map.

The graphical nature for the number of reduced term is as shown in Fig. 3. X-axis denotes the number of cells grouped where as y axis indicates the number of variables reduced. Strictly speaking the graph is discrete and has existence only at

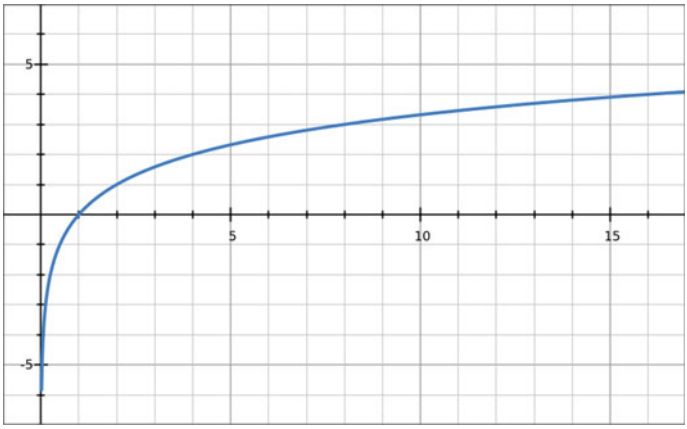


Fig. 3 Curve for number of reduced terms

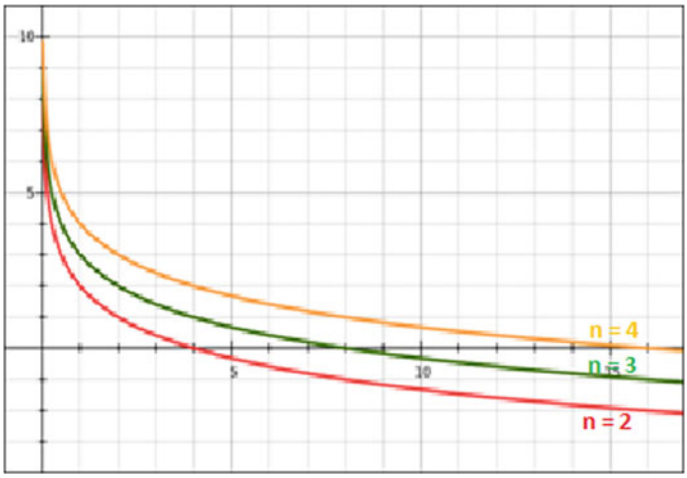


Fig. 4 Curve for number of expressed terms

2^z on x-axis where z belongs to whole numbers. But in order to understand the nature of the function, a continuous line graph is shown.

Figure 4 indicates the nature of number of expressed variables in K-map by plotting it on the y axis while x axis denotes number of variables grouped. The graph too follows discrete nature as discussed for Fig. 3. Both the graphs have significance only in the first quadrant.

Some Important Observations:

(1) Number of variables reduced in K-map is independent of order of the map.
(2) Number of variables expressed/written is a function of the order of K-map and hence we have different curve for different order of K-map.

4 Conclusions

By grouping various numbers of cells in different orders of K-map, a table is framed along with certain parameters. The investigations led to a mathematical expression for the number of reduced term and expressed terms in a functional approach. The formula established was demonstrated by a particular example which was further crosschecked by using minimizing technique of K-map. Graphs were plotted to have a clear view of the formula established. Some observations were jotted down during investigations which were related to the mathematical nature.

References

1. J. M. Yarbrough, *Digital logic: Applications and designs*.
2. M. R. Rahman, "Software and graphical approach for understanding friction on a body," in *Proceedings of the 3rd International Conference on Frontiers of Intelligent Computing: Theory and Applications (FICTA) 2014*. Springer International Publishing, 2015, pp. 637–644.
3. M. R. Rahman, "Alternate Derivation of Condition for minimum angle of deviation" *Undergraduate Academic Research Journal (UARJ)*, Vol. 1, Issue 3, 4 (2012), pp. 8–10.
4. M. R. Rahman, "Analyzing the performance of a software and IT growth with special reference to India," in *Information Systems Design and Intelligent Applications*. Springer Science+Business Media, 2016, pp. 591–598.
5. M. E. Holder, "A modified Karnaugh map technique," *IEEE Transactions on Education*, vol. 48, no. 1, pp. 206–207, Feb. 2005.
6. E. T. Lee, "An expert system for Karnaugh map minimization," *Proceedings IECON '91: 1991 International Conference on Industrial Electronics, Control and Instrumentation*, vol. 2, pp. 1517–1520.
7. M. Yang, Y. Li, L. Zeng, D. Jin, and L. Su, "Karnaugh-map like online embedding algorithm of wireless virtualization," pp. 594–598.
8. A. K. Halder, "Karnaugh map extended to six or more variables," *Electronics Letters*, vol. 18, no. 20, p. 868, 1982.
9. K. N. Plataniotis and S. Stergiopoulos, "A Karnaugh map {2, 2} secret sharing scheme for color images," *2009 16th International Conference on Digital Signal Processing*, pp. 1–6, Jul. 2009.
10. S.-A. Wang, C.-Y. Lu, I.-M. Tsai, and S.-Y. Kuo, "Modified Karnaugh map for quantum Boolean circuits construction," *2003 Third IEEE Conference on Nanotechnology, 2003. IEEE-NANO 2003.*, vol. 2, pp. 651–654.
11. A. M. Rushdi, "Symbolic reliability analysis with the aid of variable-entered Karnaugh maps," *IEEE Transactions on Reliability*, vol. R-32, no. 2, pp. 134–139, Jun. 1983.
12. R. Ye, T. Wangjin, and Z. li, "Applying Karnaugh map to design complex software branch conditions," *The 2nd International Conference on Information Science and Engineering*, pp. 4391–4393, Dec. 2010.
13. P. Cobham, "An extension of Karnaugh map technique to interface design," *Radio and Electronic Engineer*, vol. 38, no. 3, p. 131, 1969.
14. A. B. Marcovitz and C. M. Shub, "An improved algorithm for the simplification of switching functions using unique identifiers on a Karnaugh map," *IEEE Transactions on Computers*, vol. C-18, no. 4, pp. 376–378, Apr. 1969.
15. K. J. Dean, "An extension of the use of karnaugh maps in the minimization of logical functions," *Radio and Electronic Engineer*, vol. 35, no. 5, p. 294, 1968.
16. F. C. Evans, "Generalized karnaugh maps," *Radio and Electronic Engineer*, vol. 42, no. 1, p. 28, 1972.
17. J. H. Tucker and M. A. Tapia, "Using Karnaugh maps to solve Boolean equations by successive elimination," *Proceedings IEEE Southeastcon '92*, vol. 2, pp. 589–592.
18. M. B. Kermani, M. H. Mickle, and L. P. McNamee, "Identification of Disjunctively Decomposable logic functions employing a Karnaugh map," *IEEE Transactions on Computers*, vol. C-18, no. 3, pp. 277–279, Mar. 1969.
19. B. N. V. Angirekula and O. Ojo, "A Karnaugh mapping technique for the modeling of single phase multi string multi level inverter," *2014 IEEE Applied Power Electronics Conference and Exposition - APEC 2014*, pp. 239–246, Mar. 2014.

E-learning: Mode to Improve the Quality of Educational System

Ananthi Sheshasaayee and M. Nazreen Bee

Abstract Data mining plays a very important role in uncovering unseen information from large volumes of data. Educational data mining (EDM) is a specific data mining field applied in discovering invisible knowledge from the educational database. In EDM, e-learning environment is an important field to learn the context of learning environments. The intend of the research paper is to look up into the current trends in the e-learning environment. This paper mainly focuses, in understanding the research done and current trends in e-learning environment. This paper reports, how the previous scholars tackled the earlier/recent trends in e-learning research. This work makes use of Harzing's Publish software for analyzing and visualizing the conduct level of the research papers. This study utilizes cites space, for analyzing tendency in e-learning research and to summarize the learning model and design for educational technology system appropriately.

1 Introduction

Data mining (DM), is frequently called knowledge discovery in database (KDD). Data mining is a computer-based information system devoted for generating information and discover knowledge [1]. Educational data mining (EDM) methods belong to an assortment of learning and teaching experiences [2].

Educational data mining can be applied to discover patterns in data sets to automate the decision-making process of Instructors, students and administrators. Apply an e-learning in the educational process improves the excellence of practical

A. Sheshasaayee (✉) · M. Nazreen Bee
Quaid-e-Millath Government College for Women, Chennai, Tamil Nadu, India
e-mail: ananthi.research@gmail.com

M. Nazreen Bee
e-mail: nazreenm.research@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_58

training and provides an enhanced understanding of the educational system [1]. E-learning was formerly meant supporting a system for distance learning and technology based learning. This is why e-learning is now often called distance education learning. Distance education learning is based on a remote communication between students and teachers. The meaning of e-learning is evidently stated that, learning through electronic system provides abundant changes in the education system. Owing to accelerate scientific progress, the present learning system has seen abundant changes in the information and communication technology.

Researchers as well as academicians, institutors involved in e-learning research have a stable and very important effect in their field's development. E-learning is delivered via digital devices (such as a Personal Computer, laptop, tablet, or smart phones) that are deliberate to support e-learning. E-learning courses contain both content (information) and instructional methods (techniques) that helps people to gain knowledge of their course material. The forms of e-learning have the following features:

- Using an electronic devices store and transmit the course materials.
- Includes content and techniques to the learning objectives.
- Make use of media elements such as (animation, graphics, text, audio, and video materials).
- Make use of instructional methods such as examples, practice, assessment, and feedback to promote learning techniques.
- Helps learners to discover new knowledge and skills.

Three Metaphors for learning:

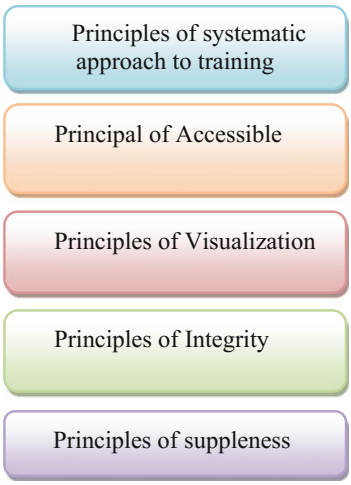
1. Learning implies accumulate the knowledge.
2. Learning implies adding information accession.
3. Learning implies making sense of knowledge creation.

1.1 The Principle of the Research

- The goal of this study is to find out the how the previous researches tackled the existing trends in the e-learning environment.
- This study utilized Cite Space, analyzing a citation of a paper using Harzing's publishes software.
- Discussion of existing research and some trend for future research are recommended.

1.2 Discussion in Previous Work

The e-learning background has such characteristics as flexibility, integrity, unrestricted space for communication and asynchronous use. EFL teaching in the e-learning environment came to the conclusion that, number of pedagogical principles act in new ways [3]. E-learning environment with EFL teaching is to create the conditions for independent work of students on extraction, processing, analysis, and structuring of educational information.



Classic systems for e-learning system use on devices with huge screen and high resolution systems; they most properly used in web environments. Internet browsers are very sufficient for use in the following operating system Mac OD, Windows, and Linux.

In e-learning system, students and teachers will implement collaborative teams in this system. The basic technique in collaborative learning is to solve the problems and converse with various roles. The teachers are instructors, observer, and academicians, while students are users, actors in a collaborative learning system [4] (Fig. 1).

The new generation of students in the twenty-first century is developing different intellectual styles is compared to the previous generation. The new intellectual styles are offering the learners to participate in the creation of new knowledge as a normal part of their knowledge society [5]. Students' learning styles were statically considerable for knowledge discovery (Table 1).

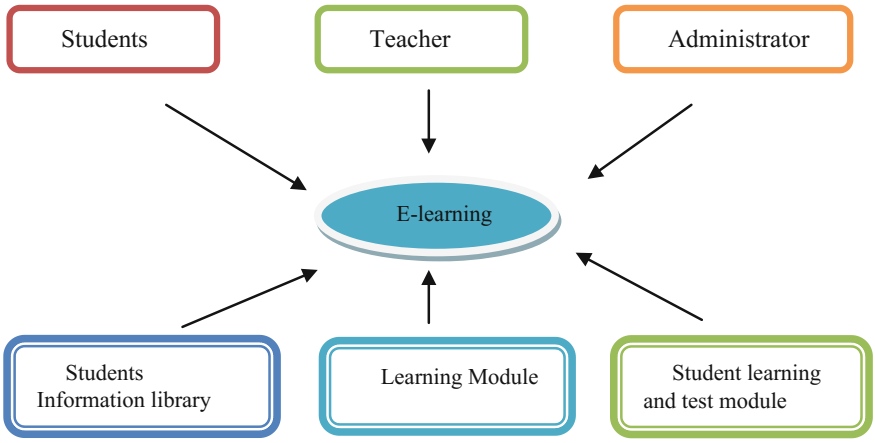


Fig. 1 Structure of e-learning system

Table 1 New intellectual styles in e-learning environment

New intellectual styles	Old intellectual styles
Random access	Step by step access
Identify student's learning style	Identify education system
Detect student's engaged concentration	Evaluate course work
Predict task completion	Estimate task completion
Technology as friend	Technology as foe
Graphics and animation	Text
Parallel processing	Linear processing
Fantastical design	Reality
Play and work situations	Work situation
Connected	Standalone

2 Architectural Design for Educational Technology System

A system architecture represents the interaction between the user and the system, learning through equipment via digital devices such as Animation, podcasts, video, images, PowerPoint Presentation, etc. An e-learning design shows importance to improving classroom-based teaching. An e-learning environment has uniqueness such as suppleness, integrity, unrestricted space for communication [14]. And it has the ability to represent the teaching information in the form of animation, blogs, text, audio, video, podcast, graphics, etc. (Fig. 2).

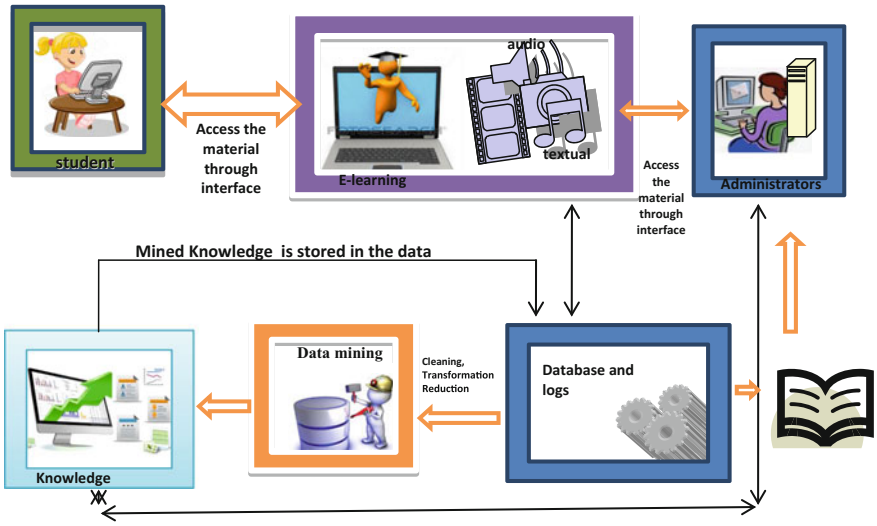


Fig. 2 System architecture for representing the interaction between the user and the system

3 Discussion on Selected Papers

This section mainly focus on how some of the earlier research scholars tackled the e-learning system from the year 2014 to 2016 as stated in Table 2. Conduct level of the research field are analyzed and visualized using a Harzing's publishes software as stated in Table 2. The number of citations that each paper received is affirmed in the table and also indicates the impact they make toward e-learning researchers and the field itself [14]. The main objectives, Platform, data mining model, and data mining tasks that each study carries are mentioned in Table 2.

4 Conclusion

Most of the academicians and researchers in Educational Data Mining (EDM) pay special attention towards the make use of e-learning system. After analyzing the techniques and methods, the introduction of new communication technologies, examined their peculiarities and formulated a better idea than the existing system. Data mining in an e-learning system favorably adapt students who needs sufficient knowledge as well as analyzing students who have faced difficulties in acquiring new knowledge. Data mining provides a wide range of solution to the students and evaluating the final score between a student's activity in the system and their assessment [15]. Using a Harzing's Publish software, analyzed and visualized the conduct level of the research field. This study utilized cites space for analyzing tendency in e-learning research.

Table 2 Insight into earlier research work in e-learning

References	Main objectives	Platform	Data mining model	Data mining tasks	Name of the publication	Number of citations
[6]	Reinforcing social media based learning, knowledge acquisition and learning evaluation	Collaborative and interactive	Prediction	Sequential pattern	Procedia—social and behavioral sciences 228 (2016)	0
[5]	Integration of web 2.0/web 3.0; tools with e-learning for knowledge society	E-learning	Prediction	Sequential pattern	Procedia computer science 92 (2016)	0
[7]	Construction of massive open online course (MOOC) based blend learning mode	Tradition/e-learning	Description	Classification	International conference on computer science and education (2015)	0
[2]	Implementing a contemporary blended learning model within the e-course	ELARS system	Description/prediction	Classification, clustering, analysis	IEEE transactions on education, vol. 59, no. 1, February 2016	2
[8]	Mining of computer game assisted e/m-learning systems in higher education	Computer game-based learning	Regression	Pattern evaluation	MIPRO 2014, 26–30 May 2014	1
[9]	Social recommender system for predicting the needs of students/instructors	E-learning	Prediction	Classification, sequential pattern mining	International conference on future internet of things and cloud (2014)	2
[10]	E-learning system based on learner's feedback and learner's multiple intelligences	E-learning	Prediction	Fuzzy item response theory	Programming and Systems (ISPS), IEEE, 2015	0
[11]	Analyzing the design of e-learning system	Designing an e-learning system	Prediction	Classification, statistical	International conference on information and communication technology	0

(continued)

Table 2 (continued)

References	Main objectives	Platform	Data mining model	Data mining tasks	Name of the publication	Number of citations
[12]	Automated formative assessment model for learning and teaching methods	E-learning	Prediction	Classification, association	Procedia—social and behavioral sciences 228 (2016)	0
[13]	Live migration destination selecting method for an e-learning environment	E-learning environment, disaster recovery	Description/prediction	Association classification, clustering, analysis	IEEE big data computing (2016)	1

References

1. Yanuschik, Olga V., Elena G. Pakhomova, and Khongorzul Batbold. "E-learning as a Way to Improve the Quality of Educational for International Students." *Procedia-Social and Behavioral Sciences* 215 (2015): 147–155.
2. Hoic-Bozic, Natasa, Martina Holenko Dlab, and Vedran Mornar. "Recommender System and Web 2.0 Tools to Enhance a Blended Learning Model." *IEEE Transactions on Education* 59.1 (2016): 39–44.
3. Julia Shishkovskaya et al. "EFL Teaching E-learning Environment: Updated Principles and Methods" *Procedia-Social and Behavioral Sciences* 206 (2015):199–204.
4. Xinhua et al. "An Innovative Web-Based Collaborative Learning Model and Application Structure*, Computer science and Software Engineering, 2008 International Conference on*. IEEE, 2008.
5. Bhubaneswar, "Integration of Web Services with E-Learning for Knowledge Society," *Procedia Computer Science 92 (2016) 155–160.*
6. Katerina Zdravkova, "Reinforcing social media based learning, knowledge acquisition and learning evaluation." *Procedia - Social and Behavioral Sciences 228 (2016) 16 – 23.*
7. Zhang Liqin, "Construction of a MOOC Based Blend Learning Mode," The 10th International Conference on Computer Science & Education (ICCSE 2015) July 22–24, 2015.
8. Juric, Petar, Maja Matetic, and Marija Brkic. "Data mining of computer game assisted e/m-learning systems in higher education." *Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2014, 37th International Convention on*. IEEE, 2014.
9. Alharbi, Hadeel, Ashoka Jayawardena, and Paul Kwan. "Social recommender system for predicting the needs of students/instructors: Review and proposed framework." *Future Internet of Things and Cloud (FiCloud), 2014 International Conference on*. IEEE, 2014.
10. Hafidi, Mohamed, and Mahnane Lamia. "A personalized adaptive e-learning system based on learner's feedback and learner's multiple intelligences."*Programming and Systems (ISPS), 2015 12th International Symposium on*. IEEE, 2015.
11. Hadiana, Ana. "Web based e-learning system analysis using Kansei Engineering." *Information and Communication Technology (ICoICT), 2015 3rd International Conference on*. IEEE, 2015.
12. Barana, Alice, and Marina Marchisio. "Ten good reasons to adopt an automated formative assessment model for learning and teaching Mathematics and scientific disciplines." *Procedia-Social and Behavioral Sciences* 228 (2016): 608–613.
13. Togawa, Satoshi, and Kazuhide Kanenishi. "Live migration destination selecting method for disaster recovery on e-learning environment." *2016 International Conference on Big Data and Smart Computing (BigComp)*. IEEE, 2016.
14. Xiao-Fan Lin et al. "Trends in E-learning Research from 2002–2013: Citation Analysis."*Programming and Systems (ISPS), 2015 15th International Conferences on Advanced Learning Technologies*. IEEE, 2015.
15. Alharbi, Hadeel, Ashoka Jayawardena, and Paul Kwan. "Social recommender system for predicting the needs of students/instructors: Review and proposed framework." *Future Internet of Things and Cloud (FiCloud), 2014 International Conference on*. IEEE, 2014.
16. Naser-Nick Manochehr. "The Influence of Learning Styles on Learners in E-learning Environments: An empirical Study." *2014 Information system- Cheer,* 2014.

Exploring Multilateral Cloud Computing Security Architectural Design Debt in Terms of Technical Debt

M. Manoj Kumar and A.N. Nandakumar

Abstract This work identifies various design debt causes in a cloud computing system from various dimensions of design debt. Even though immature, un-ripen coded service accessible over the Internet using the cloud computing paradigm may work fine and be wholly tolerable to the patron; but excess quantities will make a service progression that may lead to extreme specialist of software developers and finally an inflexible product. Delivery of the earliest primary beginning coded service without ripeness or maturity is like going into debts or arrears or due to obligation. A petite tiny debt rates progress so protracted as it is paid or rewarded back punctually with a rewrite/redraft/revising/reworking. The risk arises when the debt is not repaid and settled. Every miniature infinitesimal effort spent on imprecise code reckons as interest on that arrears/debt. Intact engineering business can be brought to be idle under the balance load of an unconsolidated, non-solicit implementation, execution, and performance discharging object-oriented, functional or procedural or otherwise. This work uses refactoring as a solution for the identified debt in the multilateral cloud security architecture to secure the cloud services.

1 Introduction

It is a widespread universal cloud computing services with unique certainty, faith and idea in the coder community that since design patterns put in a nutshell, is high-quality and verified design solutions, architecture solutions, security risk solutions one must exploit them throughout cloud service software coding, service architecting, building design, implementation, coding, and executing securely.

M. Manoj Kumar (✉)
Jain University, Bangalore, India
e-mail: dbamanoj@gmail.com

A.N. Nandakumar
Department of ISE, New Horizon College of Engineering, Bangalore, India
e-mail: nandakumar57@hotmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_59

However, during security design assessments, based on the past historic experience of facing security threats and one can come across many design use cases where design, prototype and related computing service patterns, security patterns have been used, but the eminence of the follow-on design is deprived and non-reliable with high fidelity on non-reliability and non-security. There is a breach leading crack and security holes in realizing the preferred cloud computing service, resources, security coding, design, and architecture eminence, yet while an assortment of patterns in practices and in literature has been applied. These holes could be exploited by attackers and Hackers leading to risk.

The trust is widespread in the coder, architects, and designer's security expert community that since the cloud computing service-related design, architecture, security, cloud service patterns encapsulates good and the security fool proof demonstrated design, architectural, security solutions, one be supposed to use while cloud computing service coding and implementation and also at the operation and execution of the service to stakeholders [1]. Though, our cloud security design appraisal, analysis we diagonally arrived across our experience literature survey, discussions with industry professionals, many cloud security design cases, use cases, and architectures in everyplace design-related patterns were used but the merit of the consequent design is trivial. There is a hole to accomplish the ideal cloud service/resource security design merits despite patterns are applied.

Abstractions for different observers each time, it views a change in coding/design/architecture structure. There are extreme cases, in multilateral collaboration pattern used in cloud computing when multiple patterns battle rival with one another and the crisis milieu make a conclusion on an appropriate pattern. But, while making the choices of pattern archetypes, we may notice two issues, namely: widespread code duplicity in Strategy hierarchy with replica along with the same carbon copy, with an amended in the array of the stepladder in turn modification of all tangible stratagems coding. As an alternative to strategy pattern one can use multilateral security implementation. Figure 1 represents the refactoring methodology for removing cloud computing architectural design smells [2, 3].

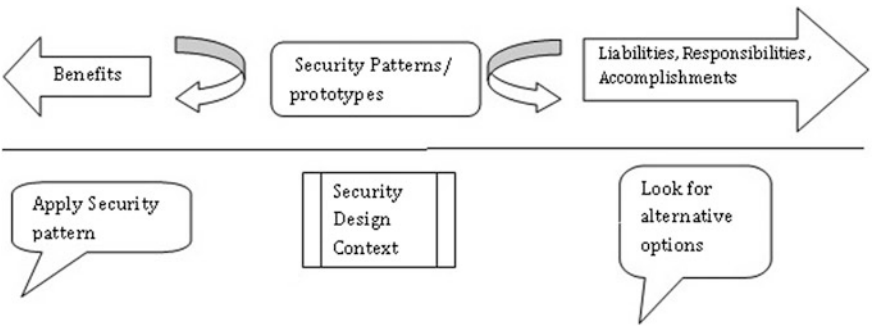


Fig. 1 Refactoring for cloud service architectural design smells

Two insights that we come out of our work practice with designing/architecting/coding in real production world cloud computing services or applications/resources are: security risk, threat/problem.

1. Context milieu circumstance, perspective framework stages participates with a big role in cloud service or resource security design and architecture.
2. Security risk, threat, attack, issues, problem patterns are anticipated excellent elucidation, but purely on whence we relate the situation and apply them in fitting right security design context and the problem/risk with measure.

2 Related Work and Motivation

Authors of [2–4] have provided research direction for architectural design smells. Author of [5] presents the guidelines for designing the framework of cloud architectural design in general. Author of [6] provides various QoS characteristics of the computing system Software as a Service. Author of [7] gives the balanced multilateral security architecture features in general using the various case studies, but the author have not identified the architectural design debt causing features and methodology to remove the architectural design smells. Authors of [8] discuss the technical debt in speculation and practice; they have also identified various dimensions of technical debt in terms of design and architecture smells. Authors of [9] have presented multilateral computing security architecture and framework. Using this [9] as the basis, this work discusses the various architectural design debt causing smells and its dimensions and methodology to resolve this using refactoring as a solution. Authors of [10–12] have highlighted the importance of multilateral security architectural design in the various platforms and applications in modern computing system. The above works motivated us to carry out this research work to identify multilateral security architecture design smells as a solution using refactoring methods to remove the smells and debt causes. Authors of [13] present test debt in a cloud computing system which is a dimension of technical debt. Authors of [14] present architectural design entropy, which occurs due to modern day computing system architectural design debts. It is an attempt in the direction of identifying various multilateral cloud computing system architectural design debts which is motivated to carry out the work.

3 Architectural Design Re-Factor Versus Rewrite

Due to messy chaotic, complexity, unpredictability, uncertain design", "The cloud computing has high service, resources and data center's related cloud computing technological arrears," and with amplified multifaceted complex section of code direct to scrap the service exposed to attack and hackers action posing threats and

risks exposing the internal data/service information to attacks but refactoring may make it better with first-class security" this lays us in deadlock with respect to "Re-factor or rewrite," few factors that force the dilemma and confusion to proceed, when it acquire more time, space, energy and effort than legitimately requisite to fix a bug that cause chances for attackers or hackers for the exploits or pose risk in future for action of attackers or hackers. And also pioneering a new feature in the software or hardware services due to high technical debt (including high complexity, with tightly or loosely coupled design, architecture, higher density, dependency, micro- or macro-services with increased complexity, uncertainty, unpredictability, and so on), the cloud computing service security and task becomes difficult to maintain [15].

Due to cloud computing, digital transformation describes a paradigm where the whole thing is connected-people, systems, applications, data, and devices, regarded as Internet of things, to make it using without any Internet of troubles with wearable devices are all linked and serving as intelligent inputs in sync with multilateral stakeholders data center in real time production of computing environment. The system of documentation tracing and systems of rendezvous commitment impeccably unites to connect and new trade dealing progression can be integrated, incorporated using the multilateral user experience, knowledge, skill, and practice is reliable, consistent with trustworthy using IT is competent to simply observe, monitor, and control systems to maintain them from spinning out of control.

The integration strategy comprises on IT to distribute and manage complex cloud computing environments, specifically the assimilation to integration architecture, design, requirement of the security and technology. Connecting different apps through their APIs, the data transformations, business processes and regulations of commitment integrate the computing business with the internet of things (IoT) is elastically scalable integration architecture, throttling yield and muggy ability to innovate using multilateral security collaboration with re-evaluating multilateral integration plan, the main three thoughtfulness to renovate the integration architecture, strengthen multilateral computing ability to innovate, and sharpen competitive edge using multilateral cooperation, collaboration, and multilateral balanced security.

3.1 Real Life Challenges in Refactoring Adoption

The importance of the reflection on documented history and precedent experiences and keeps the stakeholders to be trained from them. Our past experiences with refactoring architectural Design smells [16], requirement smells, security smells, and architecture smells in the preceding hardly a few years. We apprehend that while refactoring is a renowned practice, adopted it in real-world mission bowls up a variety of challenges.

We endeavor to locate collectively some of the challenges we have experienced and noticed generally, the disputes with refactoring is cataloged into three clusters namely management aspects, operational, and technical aspects.

3.2 Management Aspects

It is tough to convince multilateral configuration board management with a propos endeavor vital for refactoring.

In any service coding players, three major kinds of member stakeholders based on their stance toward refactoring:

1. Folks who campaigner refactoring, and espouse refactoring as a standard practice
2. Folks oppose refactoring, and gloomy interpretation to "get the threaded task completed", be it fixing defects, bugs, errors, caveat, security feature fixes, or adding, deleting, modifying new features due to high CTC (cost to company) without ROI (return on investments)
3. Folks who are in session on the edge delivery time or end tipping point—they can sway with rock and roll both the way depending on the technique they are swayed to espouse refactoring in the course of technological spat.

3.3 Issues for Applying Refactoring for Cloud Computing Security

3.3.1 Technological Aspects

a. Accessing the implied changes is very difficult while performing refactoring at very sweeping in complex cloud systems wares comprehending design, architecture, code, is complex and hard to use envisage forecast analytics to carry out refactoring may also lead to delicate bugs.
b. Refactoring in computing system artifacts, features, without or absence of pen testing, unit tests, modular tests, component tests, etc., where test cases, use cases are not offered with ample coverage is the prime practical restriction of refactoring due to non availability of the tests and test cases, user epic, scenarios, and user stories, At the moment of refactoring set up chicken-egg crisis, security risks, attack vector increases, hackers exploit, and threat increases.
c. Lacking the Multilateral collaboration and cooperation with globally distributed teams and cloud community stakeholders. Various security work packages integrating diverse versions with contradictory transforms craft the exercise yet

more excruciating, correspondence the anticipated changes crossways world-wide diversified multilateral community computing teams.

d. In legacy computing systems wares, the expertise and veteran practiced coders and staff who are aware of complete in-and-out details of the service documentations, related legacy code are deputed to other project, due to attrition or better opportunities they may have left the organization as they are no longer working in the project, it is harder to understand analyze the presented prototype, patterns design.
e. Complex refactoring is incredibly intricate and to accomplish via automated tools and but still conceded out manually.
f. Architectural Design smells, architectural smells, Code smells sensing automated tools may sense and ascertain "multifaceted versatile smells, which requires broad and repeated manual interference—the majority of the tools (to cart out well-known refactoring) are in infancy stage with research and trials with algorithms and mechanism instrumentation to accomplish it [17].

3.3.2 Administration Board Perspective

a. Convincing configuration board for acceptance of refactoring by convincing the performance and business reasons stating refactoring as pointless rework not using agile methods.
b. Enumerate the refactoring hard work required and profits of implementing.
c. Refactoring consumes more time for coders to recode and architects for re-architecting and designers for redesigning effort, space consumption of the resources.
d. The administration board needs to be convinced with feasibility study time spent is investment for future business which enhances the security of the product/service offered via cloud ecosystem, instead of looking out for instant outcome interns of profit, being immediate result-oriented, without discouraging the team for refactoring the features of the cloud service, refactoring through security pen testing, unit testing, module testing, load testing, web testing, exploratory testing, integration testing, features testing, monkey testing, GUI testing, features testing, adhoc testing, system testing, guerilla testing, integration testing, performance testing, etc.
e. Some organizations and corporation administrations instead of being result-oriented, discourage the refactoring, but realize the importance of refactoring only after the service or cloud ecosystem is broken, due to defects or bugs, and they do not think of Smells in architecture, designs, code, requirements, security loopholes, etc.
f. In our experience, we have realized the supervisors are hard nuts to splinter, and not simple to change their monolithic thinking style interns of statistical terms for performing refactoring tasks needs ROI, COC, effort, profits, savings to change their stance to adopt regular refactoring as a standard.

g. Practice and literature survey show that the metric criteria catalog may not demonstrate the quantity of fixed/attended/permanent smells, and it is not fully justifiable, due to modifications/alterations/changes due to refactoring may result in new smells if refactoring is not performed with care and due diligence and assiduity.

4 An Overview of Technical Debt

Technical Debt is an allegory created by Ward Cunningham in a 1992 testimony. The program code primarily resulting in specialized coders coding and releasing with inflexible product/service offered over cloud using the Internet. The immature infancy stage code/program may function and completely accepted by the client/stakeholders, but the excess code will make a code/product/service become unmonitored. Shipping untested inexperienced and not tested with pen testing is creating the debt. A debt is remunerated backside with punctual rewrite. Cloud computing Objects appear with bearable transaction price tag outlay. The jeopardy arises while the debt is not paid back. Every miniature effort spent on untested/un-perfect code accounts as interest on that debt. Entire cloud computing trade can be brought in a halted into static state and tilted to loss underneath the debt load of an untested and uncertified execution of the coded service, object-oriented sloping or else. Cloud computing service stakeholders supposed to be responsive/reactive of cloud technical debt and smells causing debt and strive to evade from incurring it.

Technical Debt = Architectural (Smells, Decay, Decay, Entropy) + Design Smells, Debt + Code Debt + Configuration Debt + Documentation Debt + Test Debt.

4.1 Components/Compartments of Technical Debt

Cloud computing Technical debt is an outcome of the prime aspect (the novel hack or attack or shortcut or risk), and accrued/hoarded interest as a penalty sustained when the prime cost/issues/treats/smells in Cloud computing design, architecture, code or service requirement is not present and met with rigid security pen testing and unit testing aligned with the maturity of the code is refactored. The interest factor is compounding interest, in scenery along with simple interest along with incurred debt, whist the more principal mortgage of refactoring of the cloud modules/services/apps/resources are ignored or postponed, the largest sum of the debt is accrued over time period. Henceforth the interest factor makes the cloud

technical debt a significant risk/issues/problem. The Cost to Company Cost of Change CTCCOC of refactoring fluctuates with increasing in the technical debt. And there are no hard work ways to lessen it. In acute cases, it may pilot to "Cloud computing technological liquidation/insolvency".

To decide the weather to go ahead with rewriting or refactoring, generally refactoring is always privileged, due to marker ready service in cloud computing, and also it constantly progresses the QOS to sustain and offer standard service competence in market to excel for a longer duration along with via with other competitors in the bazaar by offering innovative secured service in the market faster and low price flexible with cloud features and standards. For the period of prospect augmentations to the afford over cloud service, then, the deprived structural QOS of the service will affect the coding tasks of the cloud service enhancements for security system maintenance and hard to realize and investigate or enhance the service implementation/maintenance time duration and price cost ultimately hunt and halt the configuration board interest for achieving multilateral balance security.

There are compound compositional sources/categories of cloud computing technical debt.

a. **Code debt**: code photocopying, replica, de-duplication, static tool policy, standards, guideline, rules violations, and code smells.
b. **Design and architecture debt**: Architectural Design smells, design principle/rules/cloud computing system wares related security violations, and architectural policy violations.
c. **Test debt**: paradigms be short of unit, security pen tests, adhoc test, cloud service integration test, system wares testing and certification insufficient/derisory test coverage, failure of exposure, treatment and reporting, and improper test design.
d. **Documentation debt**: No documentation or citations for vital apprehensions, deprived documentation/records/requirements, archaic/out of service records.
e. **Defect debt**: paradigms unfixed, unstable, unreliable, unpredictable catalog of recognized defects.
f. **Cloud Service debt**: IAAS debt, PAAS debt, SAAS Debt.

4.2 Reasons for Technical Debt

As documented in literature and based on our experience, we explored Computing stakeholders and community has recognized numerous regular reasons that lead to technical debt [18].These comprise of:

a. Schedule, delivery deadline pressure, management pressure, quality configuration team pressure, testing team bugs pressure
b. Lack of high-quality/skilled designers, architects, specialists, analysts, coders, testers, and process, tools, analysis, security experts, domain experts

c. Lack of knowledge, facts, awareness, comprehension, analysis of technical debt
d. Lack of applying design principles, architecture guidelines, skills, and frameworks, requirements, and patterns applications

Deficiency in alertness of cloud computing service-related architectural Design smells, architecture smells, code smells, cloud service smells, and refactoring, rewriting, re-architecting, redesigning frequently, known the diverse costs and calendar, space, energy, time, constraints, security risks, security threats, attacks, hacks of a computing system service project/product, offered, supplied, consumed used, it may be tolerable to invite technical debt provisionally, for the short term, temporarily. The important is debt should be remunerated/repaid, early, timely, and instantly as possible. It is a widespread trust with certainty in the cloud coding community since cloud computing service design, architectural, and security patterns encapsulate first-class and proven design, architecture and security solutions, one be supposed to employ and exploit them to the maximum as often as possible during cloud service design, architecture, security service requirement, development, implementation and execution.

However, our survey experience on current practice related to design assessments, architectural assessments, coding standards assessments, Cloud SLA's assessments, analysis, security requirement guidelines, policy, rules, practices, assessments, certifications, auditing, accounting, authenticating, verification, validation use cases, etc. We have come across many design cases, architectures, frameworks, guideline where design patterns, architectural patterns, security patterns, coding patterns, service patterns, cloud computing service patterns have been utilized and implemented, executed in practice; but the excellence, and superiority of the resulting consequential design, architecture, framework, coding practice, security practice for cloud computing is deprived and meager. To overcome the crack/gap/hole in accomplishing the preferred design QOS by applying patterns.

The cloud services design predicaments can be deciphered in various ways. As security architectural framework designers, architects, security experts, we make certain design, architectures, code-related decisions based on our understanding, analysis, feasibility study using multilateral collaboration, corroboration, and expertise to resolve and decipher the dilemma, issues, various debts, attacks, hacks in lone solitary ways. To choose certain design, architecture, coding, security requirements, framework decision over others existing, the answer lies in the problem/risk/issue/smell context, multilateral balanced collaboration, corroboration, cooperation, to achieve multilateral balanced security, and other smells and Cloud computing debts. Each assessment choices fetch a clustered set of payback profits and a set of legal responsibility, liabilities, milestones, accountabilities, etc., among the multilateral stakeholders. We as a multilateral stakeholder with different roles in cloud computing business architects, designers, security experts, business analyzers are liable for investigating and exploring the profits and liability burdens and problems of a multilateral features decisions based on the problem context and security risks, smells and debt, caveats, holes in services produced offered consumed. We need to be aware of the technological, social, financial, administrative,

operational and business, responsibilities, strengths and weak points, Achilles points and constraints that emerge from the particular problem context to reason about how the remunerations, profits and liabilities of a design decision will affect the design, architecture, coding and security requirements.

Various patterns related to Cloud service architecture patterns, design patterns, coding patterns, service patterns, security patterns, computing patterns, user patterns, SLA's [service level agreements] use cases are indeed better and proven solution for the design, architecture, service requirement, SLA's, frameworks, security related problems, in a particular context, stakeholders view, using multilateral collaboration perspective. It is true that appropriate multi-party computing, multilateral, multi-tenant computing context, is a key in recipe ingredients to make a particular patterns service/application prolific for cloud computing system wares. Consequently, if a prototype outline fetches more profits than liability to a fussy and pick smells/issue/problem/threat context, it is usually measured as a good quality design/architecture/code/security requirement elucidation for that context using multilateral balanced security. The main concern and vigilance caution here—still if a pattern carries more profits than liabilities to a problem/smell/issue/attack/risk/threat context, a designer, architect, coder, security expert must assess and appraise whether the liabilities significantly reduce the QOS features—design, architecture, code, multilateral security features. Then they necessitated and addressed via auxiliary design, architecture, coding, implementation, execution multilateral balanced security decisions together with appliance of other patterns. If not, the computing actor/stakeholder may opt to ignore them.

In general, the two conclusions that we realized based on our experience and analyzing the real-world practice with regard to designing, architecting, analyzing, coding, and implementing and analyzing the real work cloud service apps/resources. In summary, there are two insights that have emerged from our experience with designing real-world software applications:

a. Context plays a gigantic and major role in cloud computing service design, security requirement, code and architecture.
b. Patterns are established and demonstrated good quality and viable solutions, whence we apply them in fitting the apt design, architecture, code, service, security context and the problem, issue, threat, risk, smell, holes or hack, and attack.

Grady Booch et. al coined four fundamental design principles which are widely accepted industry wise. The Design Principles viz. Abstraction, Encapsulation, Modularization, and Hierarchy for crafting, planning, building eminence object-oriented designs [19]. Theoretically, primary doctrines such as abstraction and modularization are relatively broad standards, high-level. However, our familiarity in crafting designs in practice for cloud computing services reveals that it is hard to use for design problems, we façade, this visage on a daily base as architects, designers and security experts. In the crater of abstraction, in this theory it is simple that "it is easy to abridge cloud service unit using reduction and

generalization technique"; in practice, it's hard to realize and appliance of the specific modus operandi, it is obligatory to follow and realize the conceptual modeling in practice, once the solution is explored we can use it as enabled method and apply each as the fundamental design principles. Various common strategies that can be engaged to "conceal variant" are:

(a) Detach and break up the algorithm from the patrons trade module that use it,
(b) Part the abstraction from its execution so with the aim to vary independently both of them.
(c) Split policy and guiding principle from the accomplishment and execution.

In the case of cloud computing service application, in which the security is the prime concern and frequently encryption technique is used for securing the information stored in the cloud. Reuse the existing algorithms in novel contexts. Simply append the help in prop up for new algorithms?

There are many solutions for this problem, but here is a solution that isolates algorithms as a separate hierarchy. By employing runtime polymorphism, a new algorithm can be plugged at runtime. We can reuse these algorithms in different contexts. To identify the solution structure, it's as the "Strategy pattern" which "decouples an abstraction from its implementation so that the two can very independent". The application of design patterns for applying the principle of encapsulation. On the other hand, applying principles might not result in a design that employs patterns. In addition, "Software entities should be open for extension, but closed for modification".

Case Study 1: In [3], we can find that refactoring is performed to target and tackle the architectural violations and improve the structure of the dependency cycles. Current computing software systems like cloud computing software systems are with varied degree complexity, in-depth unpredictable and prolonged idiosyncrasies. Like the MAC-OS code, Microsoft OS, Windows, and other Linux OS flavors have typically grown to several millions of LOC since the cloud era. Architecture Evolution styles and patterns (example the Micro-services and container service patterns [5]) with supporting scalability with time scheduling and computing size pretense the risk based computing system behavioral and structural features vulnerabilities in the system software. Thus, intervallic constant architecture and design with code base refactoring is binding to maintain the computing system's structural and behavioral performances and functional and non functional quality requirements of an evolving computing system. For illustration, a foremost refactoring endeavor which was performed from Windows 2003 to Windows-NT and windows XP version into Windows Vista, then failure led-to complete refactoring to windows 7 and recent refactoring from Windows 8 to Windows 10. It was clear for continuous refactoring, version to accommodate the new features.

Case Study 2: The Java language features and its development were carried with bulk refactoring by developing language library and compiling features added with the needs of the modern needs of virtualization features supporting, and aspect oriented features support, etc. Since 1990s major refactoring was carried out by

evolving libraries with complexities improvement with JAVA–JDK and JRE to the current version of Java 9 evolutions.

5 Conclusion

Since high-level principles such as abstraction, encapsulation, modularization, and hierarchy are quite generic, it is usually difficult to understand how to apply them in practice. To solve this problem, we can break down the fundamental principles to more granular "enabling techniques", which helps us to understand the fundamental principles to a greater depth, but also ease the task of applying the principle in real-world situations. Increasingly complex and demanding business environment evolves with integration strategy and architecture. The security architecture design and technology stakeholders chosen should facilitate user to deliver a modular approach to integration that supports new security requirements such as micro-services-based security development. The key solution should include open standards and open source software, both in provisos of technology and permit the model to distribute the profit of open source while extenuating, mitigating the risks. In this work an attempt is made to identify various architectural design debts causing factors in a present day computing system with special reference to multilateral security architectural design. To overcome the architectural design, debt refactoring is the existing solution to repay the debt which also helps in reducing the vulnerabilities in the present day computing system.

Acknowledgements I sincerely thank the management of Jyothy Institute of Technology, Bangalore for their continuous support. I thank Mr. Manu A.R., Research Scholar, ISE Dept, CORI LAB, PESIT, Bangalore, Ganesh Samrthayam Active IEEE Member renowned author for their timely help and guidance.

References

1. "Security Guidance for Critical Areas of Focus in Cloud Computing v3, Cloud Security Alliance, http://www.cloudsecurityalliance.org/guidance, accessed on 09-01-2017.
2. Ganesh Samarthyam, Girish, Suryanarayana, Tushar Sharma, Shrinath Gupta, "MIDAS: a design quality assessment method for industrial software", ICSE '13 Proceedings of the 2013 International Conference on Software Engineering, pp 911–920, IEEE Press Piscataway, NJ, USA, 2013.
3. Girish Suryanarayana, Ganesh Samarthyam, Tushar Sharma, Refactoring for Software Design Smells: Managing Technical Debt, Morgan Kaufmann, 2014.
4. ISO/IEC 25010:2011, Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – System and software quality models, ISO/IEC, 2011.
5. Krzysztof Cwalina, Brad Abrams "Framework Design Guidelines: Conventions, Idioms, and Patterns for Reusable.NET Libraries, "Addison Wesley, 2005.

6. Lukas Burkon, “Quality of Service Attributes for Software as a Service”, JOURNAL OF SYSTEMS INTEGRATION 2013/3.
7. Kai Rannenberg, “Multilateral security a concept and examples for balanced security”, NSPW ‘00, Proceedings of the 2000 workshop on New security paradigms, Ballycotton, Country Cork, Ireland, ACM NY, September 18–21,2000.
8. Philippe Kruchten, Robert L. Nord and Ipek Ozkaya, “Technical Debt: From Metaphor to Theory and Practice”, Software Engineering Institute, IEEE Software, publishe d by the IEEE computer society, 2012 IEEE.
9. Manu A. R.,Vinod Kumar Agrawal, K. N. Balasubramanya Murthy, Manoj Kumar M, “Towards Realizing the Secured Multilateral Co-Operative Computing Architectural Framework”, Cloud Computing in Emerging Markets (CCEM), 2014 IEEE International Conference on 15–17 Oct. 2014.
10. Pengfei Sun, Qingni Shen, Liang Gu, Yangwei Li, Sihan Qing,, “Multilateral Security Architecture for Virtualization Platform in Multi-tenancy Cloud Environment”, 13Th IEEE Joint International Computer Science and Information Technology Conference (JICSIT), 2013.
11. A R Manu; Jitendra Kumar Patel; Shakil Akhtar; V K Agrawal; K N Bala Subramanya Murthy, “Docker container security via heuristics-based multilateral security-conceptual and pragmatic study”, IEEE, (ICCPCT), 2016.
12. AR Manu, Jitendra Kumar Patel, Shakil Akhtar, VK Agrawal, KN Bala Subramanya Murthy, A study, analysis and deep dive on cloud PAAS security in terms of Docker container security, IEEE, (ICCPCT), 2016.
13. Manu A R, Vinod Kumar Agrawal, K N Bala Subramanya Murthy, V Suma,” Exploring Cloud computing technological test debt”, Springer Joint International Conference on Intelligent Computing and Applications (ICICA 2016) & Power, Circuit and Information Technologies (ICPCIT-2016).
14. Manu A R, Shakil Akhtar, Vinod Kumar Agrawal, K N Bala Subramanya Murthy, V Suma, “ Exploring the Architectural Entropy in computing systems”, Springer Joint International Conference on Intelligent Computing and Applications (ICICA 2016) & Power, Circuit and Information Technologies (ICPCIT-2016) (20th–22nd December, 2016).
15. Architecture: Form, Space, and Order, Francis D. K. Ching, Fourth Edition, Wiley, 2014.
16. http://www.designsmells.com, accessed on 09-01-2017.
17. Nicolae Garleanu, Jeffrey Zwiebel, “Design and Renegotiation of Debt Covenants”, September 2006, http://faculty.haas.berkeley.edu/garleanu/coven.pdf, accessed on 09-01-2017.
18. Rick Kazman, Yuanfang Cai, Ran Mo, Qiong Feng, Lu Xiao, Serge Haziyev, Volodymyr Fedak, Andriy Shapochka, “A Case Study in Locating the Architectural Roots of Technical Debt”, 2015 IEEE/ACM 37th IEEE International Conference on Software Engineering.
19. Bobbi J. Young, Grady Booch, Michael W. Engel, and Robert A. Maksimchuk, “Object-Oriented Analysis and Design with Applications”, 3rd Edition, Addison Wesley

Improved Data Hiding Technique Based on Audio and Video Steganography

Suresh Limkar, Aditya Nemade, Amruta Badgujar and Rupali Kate

Abstract In today's world, steganography is achieved through various different factors like LSB replacement, DCT, etc., in various forms. In which the embedding of the data was used to be successful but at the cost of degrading the quality of the file behind which a secret message was embedded. Earlier techniques used were only for a particular subdomain like only file, only audio, and only video embedding. We have a proposed a new technique, in which the file of all format extensions like pdf, txt, doc, etc., are embedded behind a video without degrading the quality of the video. Video is dividing into number of frames along with dividing the secret file into various numbers of frames and then embedding each frame behind one another. The steganography achieved previously was near to 90–95% but we have achieved a success rate of near to 99%, as the pixels and properties of the video are unchanged, whereas earlier they used to be disrupted or degraded.

1 Introduction

Security has been always an indispensable means of secure communication even in today's technologically progressed era. It is demanded to assure confidentiality, integrity, authenticity, and availability of user's secret information. A modern day security system should be able to mitigate the security and other types of possible threats.

S. Limkar (✉) · A. Nemade · A. Badgujar · R. Kate
Department of Computer Engineering, AISSMS IOIT, Pune 411001, India
e-mail: sureshlimkar@gmail.com

A. Nemade
e-mail: adityanemade@gmail.com

A. Badgujar
e-mail: angel.amrut05@gmail.com

R. Kate
e-mail: rupalirkate2015@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_60

There are various techniques used to achieve steganography. Depending upon the conditions of steganography, a particular method is chosen. Steganography is achieved with respect to a hidden text into audio file using discrete wavelet transform (DWT), singular value decomposition (SVD), LSB (Least Significant Bit), and Computer Forensic [1]. Furthermore, for video steganography that is to hide a text behind a video was implemented through the use of LSB replacement, Mean, MSE, and PSNR [2]. The above two techniques are the basics for successful implementation of audio–video steganography. The audio steganography is a branch of video steganography where in the hiding of data in video along with the audio of the video file. The technique needs to be advantageous in terms of Imperceptibility, Robustness and Capacity—the three challenges of steganography having the methods used were SNR analysis and HLLAS and also produces a strong encryption mystery key which gives enhanced security to concealing the mystery discourse information inside the cover picture [3, 4]. Also, the spatial space territory of steganography incorporates distinctive sort of calculations to disguise the message bits and working standard of every calculation gives mystery in information transmission [5]. The security of steganography algorithm is based on statistics and steganalysis taken place by identifying statistically anomalous patterns in the image pixels that is the process of identifying the hidden information from the cover image by the third parties [6]. Steganography requires security which is provided by security algorithms. The mystery message is embedded in the sound record as clamor and GA is fundamentally utilized for enhancement reason alongside PKE calculation, LSB, RSA, HAS, and HVS [7]. Different techniques like Multipoint, ZKA, Diacritics, KVA, ZWC, Remarks, HTML code, and MS Word Symbols calculations likewise give extra and important insurance of secret information [8]. One more necessary factor in the steganography field is dividing an audio or a video file into number of frames, which help in for embedding the hidden data frame by frame behind the cover file which increases the security level of the hidden data. This is brought about because of a vigorous element SR calculation to ease the execution debasement as a result of off base movement estimation and sudden scene changes [9]. The scene change calculation for distinguishing scene changes and enhancements; for example, break down with insignificant translating of a MPEG/MPEG2 bit stream [10]. This is useful for video indexing and compressed domain editing.

Rest of the paper is organized as Sect. 2 discusses related work, Sect. 3 discusses proposed work, Sect. 4 discusses about result, and Sect. 5 discusses about conclusion followed by references.

2 Related Work

Kakde et al. [1] proposed a strategy to conceal the mystery data behind picture and sound of video document by utilizing discrete wavelet transforms (DWT), singular value decomposition (SVD) technique, and fourth piece LSB (Least Significant Bit) substitution. The principle of the proposed technique is strong encryption due to

triple-layered security but it results into two or more noise shares, which causes increase in the interception risk.

Dixit et al. [2] proposed a strategy to shroud content into a cover video document which utilized the methods like LSB Replacement, peak signal to noise ratio (PSNR), mean square error (MSE), and Mean. Principle preferred standpoint of this technique is security against gatecrashers and picture, content, sound, video can be the cover media still disturbed pixels and pixel burst were watched and anybody could without much of a stretch see that there is a mystery message behind the video.

Datta et al. [3] proposed to secure sound steganography methods utilizing the calculation for implanting and extraction which had points of interest for least bending and high indistinctness; however the programmers could gage the sound signs.

Shelke and Jagtap [5] proposed to various steganography plans which are expounded furthermore its advantages and downsides are appeared. Strategies like optimal pixel adjustment process (OPAP), diamond encoding (DE), and exploiting modification direction (EMD) were proposed and its focal points are that it minimizes the contortion after information implanting and is additionally less costly than other spatial area methods yet some of the time information would be lost furthermore the unpredictability level is high.

Kulkarni and Patil [4], proposed a procedure where in symmetric key is produced which comprises of reshuffling and mystery game plan of mystery flag information bits in cover flag information bits additionally have played out the encryption procedure on mystery discourse flag information bits level to accomplish more noteworthy quality of encryption which is covered up inside the cover picture, calculation for mystery key era furthermore calculation for mystery enter stowing away in cover picture at transmitter end giving the upside of n number of mixes of characters and numbers which secures the information from system programmers yet because of flag capture attempt.

Mani et al. [6] proposed a technique utilizing the calculation for cover picture is isolated into noncovered windows and afterward and afterward every window is separated into subsections, and among them subareas are chosen in "Z" design. In next stride from the chose subareas, pixels are chosen in "alpha" example techniques like LSB Algorithm, Entropy, and Mean Squared Error SNR gives the upside of the high perceptual straightforwardness furthermore easy to actualize, however, which prompts to including additional clamor which thusly devastates the mystery message.

Johri and Kumar [7], proposed a hereditary programming to expand the vigor of the information so that the mystery information couldn't be perceptible beyond what many would consider possible by utilizing strategies like Genetic calculation, fourth LSB layer and SHA-1 calculation. Which had preferences that lessening the difference between the first cover document and stego-record yet incapable in keeping up the nature of stego-record.

Odeh et al. [8], proposed a model that conceals mystery information in the content record by controlling the textual style design or embeddings extraordinary

images in the content document. Besides, the recommended calculations can be connected to both Unicode and ASCII code dialects, paying little mind to the content record organize. Utilizing the calculation for HTML, Kashida. Multipoint Letter, Left Remark, Right Remark, Steganography and Zero Width gave the favorable circumstances like building up safe correspondence, protection was improved alongside secure information sharing and had extra assurance of copy-righted items yet it was hard to blend the calculations which high payload limit and expanded the size and in addition cost.

Kim et al. [9], proposed a novel estimation approval procedure to accomplish powerful picture recreation comes about under inexplicit movement estimation. Strategy utilized was SR calculation is a picture preparing system that can recoup HR picture from various LR pictures with points of interest strong execution of its recreation quality even with mistakes in the assessed movement.

Meng et al. [10], proposed the location of sudden scene change and unique altering impacts, for example, breakdown in a packed MPEG/MPEG-2 bit stream with insignificant interpreting of the bit stream. Strategy utilized as a part of this framework has five phases: negligible unraveling, parsing, measurable, discovery, and choice stages giving favorable position in preparing pace to seeking a video database of packed picture groupings can be drastically made strides.

The earlier implemented techniques lacked in the quality of the file as well as the security with the file. We have proposed a far much better technique to maintain the original quality of the file along with a huge security system to protect the data.

3 Proposed Work

In this paper, we proposed a new method which hides secret information behind audio and video files. The data hidden behind these files can belong to any format viz. doc, pdf, txt. We have combined security algorithms like RSA, DES, and Triple DES along with Scene Change Algorithm. The combination of these algorithms is presented in a new form of algorithm (Fig. 1).

The above data flow diagram is furthermore elaborated in Fig. 2.

Encryption

1. Take video/audio input from the user.
2. Take secret file txt/pdf/doc from the user.
3. Divide the audio/video into frames.
4. Similarly, divide the secret file into frames.
5. Embed the frames from steps 3, 4.
6. The resulting frames get divided into bits.
7. Public key is generated using RSA/DES/Triple DES algorithm.
8. Encryption key is generated by the user.
9. Using the keys generated by steps 7 and 8, a hidden file is created.

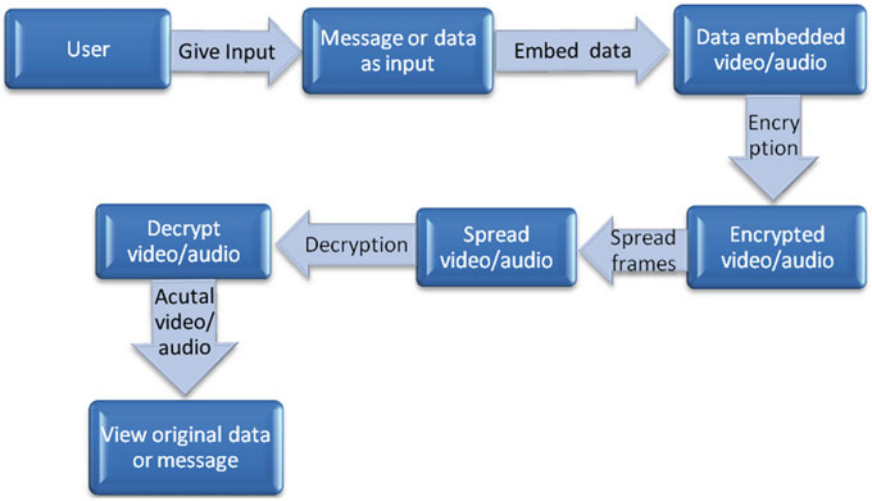


Fig. 1 Data flow of the proposed method

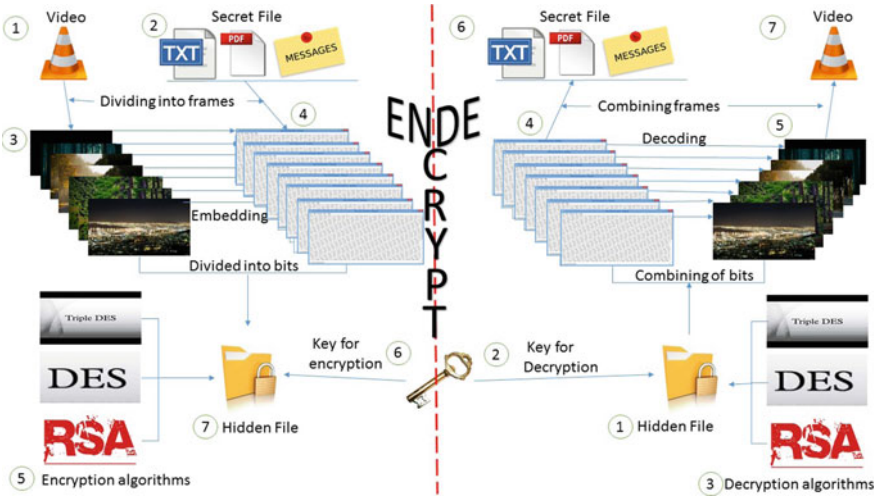


Fig. 2 Architecture diagram

Decryption

1. The decryption key is generated
2. Public key is generated using RSA/DES/Triple DES algorithm
3. The bits from the hidden file then combine together to form separate frames consisting of the media file and the secret file

4. The frames are then decoded to get separated into the original secret file and a media file(audio/video)

Algorithm

1|Take audio/video input from the user. Assume it to be 'X1'.
2|Split 'X1' into frames viz. f1, f2, f3…. fn.
3|Take hidden data from the user. It can belong to the following formats: pdf, txt, doc. Assume it to be 'D'.
4|Split 'D' into frames viz. d1, d2, d3…. dn.
5|Pick one frame or image for further processing.
6|Split f1 into Red, Green, Blue planes (R, G and B respectively).
7|For each pixel in R, perform the following:
8|Let b [0] = LSB/RSA/DES/triple DES of the current pixel in R.
9|Let b [1] = Next LSB/RSA/DES/triple DES of the current pixel in R.
10|If b = 00 then
11|Go to the next pixel.
12|Else if b = 01 then
13|Call recovery to recover secret data of data d1 from the current pixel G.
14|De-scramble data of user with key k [1].
15|Else if b = 10 then
16|Call recovery to recover secret data of data d2 from the current pixel B.
17|De-scramble data of user with key k [2].
18|Call recovery to recover secret data of d1 and d2 from the current pixel of both G and B.
19|De-scramble data of the user with data d1 and d2 with keys k [1] and k [2] respectively.
20|Store the resulting data behind the video.
21|The final video obtained is a steganographed video.

4 Result Analysis

As you can see the result analysis below, there are no changes observed the in original and steganographed files, whether it be the quality the file or its properties. Their properties remain unchanged which is also a critical area to focus on because if the properties change then the file would be vulnerable. The quality is the top most priority to maintain as it is the first thing if distorted then to be identified as a hidden file. But we have maintained the front as well backend of the file which is nearly providing 100% results.

Format	Original image	Steganographed image
480p	 **Properties:** Len: 00:00:18 Size: 68.8 kb Dim: 640 × 360	 **Properties:** Length: 00:00:18 Size: 68.8 kb Dim: 640 × 360
720p	 **Properties:** Len: 00:00:18 Size: 230 kb Dim: 1280 × 720	 **Properties:** Len: 00:00:18 Size: 230 kb Dim: 1280 × 720

5 Conclusion

In this paper, a new aspect has been provided using scene change detection algorithm for steganography along with encryption algorithms. This proposed scheme gives near 100% results which makes it better than previous techniques used for steganography. Though it is bit expensive and time consuming because of the use of scene change detection algorithm along with encryption algorithms which makes it robust. The result provided by this technique is directly related to the properties of input provided. Having its applications ubiquitously, it can be applied anywhere, where one wants to keep the data a secret and share it over a network. Example military, where secrecy has to be maintained in messages passed over network.

References

1. Y. Kakde, P. Gonnade and P. Dahiwale, "Audio-video steganography," Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015 International Conference on, Coimbatore, 2015, pp. 1–6.
2. M. Dixit, N. Bhide, S. Khankhoje and R. Ukarande, "Video Steganography," Pervasive Computing (ICPC), 2015 International Conference on, Pune, 2015, pp. 1–4.
3. B. Datta, S. Tat and S. K. Bandyopadhyay, "Robust high capacity audio steganography using modulo operator," Computer, Communication, Control and Information Technology (C3IT), 2015 Third International Conference on, Hooghly, 2015, pp. 1–5.
4. S. A. Kulkarni and S. B. Patil, "A robust encryption method for speech data hiding in digital images for optimized security," Pervasive Computing (ICPC), 2015 International Conference on, Pune, 2015, pp. 1–5.
5. S. G. Shelke and S. K. Jagtap, "Analysis of Spatial Domain Image Steganography Techniques," Computing Communication Control and Automation (ICCUBEA), 2015 International Conference on, Pune, 2015, pp. 665–667.
6. M. R. Mani, V. Lalithya and P. S. Rekha, "An innovative approach for pattern based image steganography," Signal Processing, Informatics, Communication and Energy Systems (SPICES), 2015 IEEE International Conference on, Kozhikode, 2015, pp. 1–4.
7. P. Johri, A. Kumar and Amba, "Review paper on text and audio steganography using GA," Computing, Communication & Automation (ICCCA), 2015 International Conference on, Noida, 2015, pp. 190–192.
8. A. Odeh, K. Elleithy, M. Faezipour and E. Abdelfattah, "Highly efficient novel text steganography algorithms," Systems, Applications and Technology Conference (LISAT), 2015 IEEE Long Island, Farmingdale, NY, 2015, pp. 1–7.
9. Kim, M., Ku, B., Chung, D. et al. EURASIP J. Adv. Signal Process. (2011) 2011: 103. doi: 10.1186/1687-6180-2011-103.
10. Jianhao Meng; Yujen Juan and Shih-Fu Chang "Scene change detection in an MPEG-compressed video sequence", Proc. SPIE 2419, Digital Video Compression: Algorithms and Technologies 1995, 14 (April 17, 1995).

Multi-owner Architecture System Using Visual Cryptography and Watermarking for Secure Ownership in Cloud Environment

Suresh Limkar, Rajas N. Bhalerao, Priya D. Shinde and Abhishek B. Raut

Abstract Cloud computing is the best way for storing and computing data over an internet. Data can be shared in the form of texts, images, audio, and video. Sharing data securely over internet is a key issue. Cloud computing faces serious issues like security, integrity, and confidentiality of data. The most popular existing techniques for achieving data security faced conflicts like generation of large keys, the heavy computation of large keys, and collision attack of malicious users and also it meant for single owner. To overcome the limitations of existing techniques, we proposed a scheme and implemented image encryption and decryption using symmetric key. In the proposed system, we aim to improve security which implement three algorithms namely, visual cryptography (VC), AES (Advanced Encryption Standards), and watermarking. In this paper, the secret image is divided into multiple shares according to the number of users by visual cryptography, later AES is used. For more authentication and copyright protection, watermarking is used. In the obtained result, security is improved and also a key size is decreased which leads to data sharing among multiple authenticated owners securely without any conflict and original image is regenerated by combining all the shares.

S. Limkar (✉) · R.N. Bhalerao · P.D. Shinde
Department of Computer Engineering, AISSMS IOIT, Pune 411001, India
e-mail: sureshlimkar@gmail.com

R.N. Bhalerao
e-mail: rajas.bhalerao@gmail.com

P.D. Shinde
e-mail: priyadshinde989@gmail.com

A.B. Raut
Department of Computer Engineering, Indira COEM, Pune, India
e-mail: abhishek.raut1707@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_61

1 Introduction

Cloud computing is a new technology which provides users with multiple benefits. Cloud is used globally in industries and businesses for computation, coordination, and storage. Also has scientific, consumer/social application. But cloud cannot be trusted due to downfalls in security reasons. In this paper, we are aiming to improve security of data sharing in cloud using various security algorithms.

The proposed system is used to share (send/receive) data (images) over cloud [1] using various cryptography algorithms and watermarking [2]. The main aim of this system is to attain high level security. In the former systems, only a single user could gain access to the data, but the forth put system allows multiple users to gain access to the same data. There is a use of multiple smaller in size keys as compared to the previously used large in size keys [3]. Security has always been the main issue when it comes to data sharing over cloud, to tackle this problem we are using the main algorithms namely Visual Cryptography, AES (Advanced Encryption Standards), and Watermarking. Visual Cryptography [4, 5] creates multiple shares of the requested image and encrypts each of it. The number of shares created is dependent on the number users requesting to view the same image. AES [6] is used for higher level of encryption. AES and watermarking [7] is used to detect changes that are made to the shares while transferring. AES [8] also ensures high performance encryption. Copyright protection is done using watermarking [9].

The end result of the system is that the image will be successfully transferred to the authenticated used in real time. If there are any changes made or tampering done to any of the shares then the final image will not be viewed by any of the users. This way no hacking of the image will be possible.

In this paper Sect. 2 is related work, III is proposed system, then algorithm, experiment, result followed by conclusion and references.

2 Related Work

Security Protection between Users Mobile Media Cloud [1] was proposed by Wang, Wu, Chen, and Wang. The main objective was to achieve secure multimedia data transmission between users cloud. The technologies used were DCT RS code watermarking, Image hiding, and Image secret sharing. The advantages of the system were high Security Performance, User-oriented, Good media quality, reduced overhead. The disadvantage was image data was carried in single carrier. So, overcome this problem in the proposed system the image is divided into number of shares, i.e., carrier. Advance Secure Multi-Owner Data Sharing for Dynamic Groups in Cloud [10] was proposed by Parjanya, Prasanna Kumar. The objective of was to achieve secure method for data sharing for users in different groups. The technologies used were MONA, User revocation. Advantages of this system were Security, User Revocation, Privacy, Less computation, Scalability, and Reliability.

Disadvantages were it needs large numbers of backup group managers. Since user revocation is not always recommendable. So, the new proposed system avoids the use of user revocation. Threshold Cryptography-Based Data Security in Cloud Computing [3] was proposed by Saroj, Chauhan, Vats. The main objective of the system was Secure communication between DO, CSP and user, and Secure access to data. The techniques used were Threshold cryptography, Diffie-Hellman algorithm, MD5. Advantages were Less number of keys, Data security, Confidentiality, Integrity, and high performance. Disadvantage of this system was High computation power for DH algorithm. Usage of DH algorithm for encryption/decryption propose used very large computational power. So it is eliminated and rather the use of AES is introduced in the proposed system. Digital Image Sharing by Diverse Image Media [4] proposed by Lee and Chiu. The main objective was to divide digital image into number of shares. The techniques used were NVSS algorithm, Decryption Encryption algorithm. Advantages of system were User friendly, High security, Quality image, Low risk transmission. And, disadvantages were generation of noise like share.

This work suggested the concept of NVSS algorithm, i.e., Share Generation and distribution. Visual Cryptography-Based Watermarking [2] proposed by Cimato, Yang, and Wu. Their objective was to achieve security of multimedia data Dividing image into N shares. The techniques used were Visual Cryptography, Digital Watermarking. Advantages were Highly Secure, Easy implementation, Highly robust, Error recovery. And Disadvantages could be Imperceptible Watermark, Poor quality Image, Image revealing by stalkers. Previously, only VC and watermarking were used, but in new proposed system the use of AES algorithm has been introduced for additional layer of security. steganography-based visual cryptography (SBVC) [5] proposed by Mukherjee, Ghoshal. The objective was Enhancing Security of image by Steganography VC (hiding data into other image). The techniques used were Cryptography Steganograhy. Advantages were High Security, Authentication, Integrity, Less computation, and the disadvantage could be Low image quality. Generation of 128-Bit Blended Key for AES Algorithm [6] given by Sridevi Priya, Karthigaikumar, and SivaMangai. The objective was Generation of a key using Biometrics for encryption. The techniques used were AES algorithm, Biometrics, Fuzzy commitment scheme. Advantages were Security, Performance, Efficiency, Flexibility, and Attack Resistant. And the disadvantages were Generation of many Keys. Previously, the emphasis was mainly on security of data forgetting about the performance of system. In order to secure data, number of keys were generated, thus depleting the performance of system. So it is desirable to reduce many key with the help of AES algorithm which provide high security and performance. HD Image Encryption Algorithm on AES Modification [8] given by Wadi, Zainal. The objective was Modification of AES algorithm to cipher HD image. The techniques used were Mix-column transformation, Key schedule, Sbox. Advantages were High Security Performance, less hardware, less Encryption time, and less computation. And disadvantage was implementation of AES algorithm is bit difficult for HD images Study Based on Chaotic Encryption, Digital Watermark [7] given byYu1 and Zhao. Their objective was Using Watermarking using chaotic

System-encrypting scrambling for authentication. Techniques were Chaotic Scrambling algorithm, Magic Square. Advantages of the system were Copyright Protection, Simple, High integrity, and Prevent Tampering. Disadvantages were Non-Perception, Reliability, Robustness of Watermark Image Watermark Algorithm App in Eco-Tourism digital Museums [9] given by Wu, Jiang, and Cao. The objective was to ensure digital copyright protection safety in digital Museums. The techniques used were DCT embedding watermarking Detection. Advantages were Imperceptibility, Robustness, Security, Invisibility, and Provability. And disadvantages were difficulty in balancing between Robustness and Invisibility.

None of the author had worked on Non-perception, poor quality image, security in multi-owner architecture. In this paper, we are emphasizing on overcoming all these disadvantages and improving security, scalability, and robustness.

3 Proposed System

The proposed system is a multi-owner system with the help of which any one can securely share images to multiple owners on cloud, since cloud does not ensure security, confidentiality and integrity. Applying Visual Cryptography each user in a group shares a part of the image. Encryption and decryption techniques are performed on each share of the image created by visual cryptography. To add additional layer of security and to check for any tampering done to any single share watermarking will be used. Organization or individuals consuming cloud services must understand the delineation of responsibilities over computing environment and implication of security and privacy. Therefore, proposed system ensures cloud computing solutions that satisfy organization's security and privacy requirements. The final outcome of the proposed system is that the image is successfully transferred to the authenticated users in real time and by fusing the shares of image together, the image will be produced. If there is any tampering done to the image then the user's access to image will be restricted. The image goes through to multiple encryption and decryption with the help of which tampering or hacking of data will be difficult.

Previously, the image was carried as a single information carrier so to overcome the failure due to loss of single carrier we divide a single image into number of shares and carriers. Previously the emphasis was mainly on security of data, forgetting about the performance of the system. Tackling the problem of asymmetric key generation and performance, it is desirable to use AES algorithm which provides high security and performance as well. Earlier, mostly only VC and watermarking were used, but in this new system the use of AES algorithm has been introduced for top-notch security.

In the proposed system there are three entities the client, the server, and the agent. The client first registers, using a username and password. The users' username and password along with his key gets stored in the database on the cloud server. The database used in the system is MySQL. The user then logs-in and

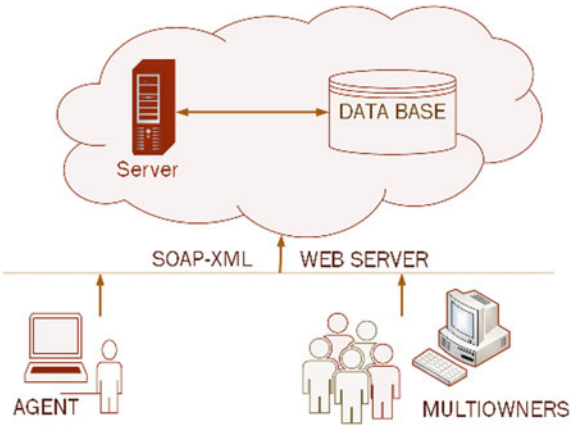


Fig. 1 System architecture

requests the agent to send an image. The agent receives the request and on receiving it, the agent first verifies if the user is authentic or not. Post authentication the agent selects the users and uploads the image on the server. Once the image is uploaded on the server in the first place, it undergoes visual cryptography where the image is divided into manifold shares. Generated shares are equivalent to the number of users. Then image encryption (AES) is performed on each share. Third, watermarking is executed on each share to check for the tampering done to the image in any case. After providing the three-level security to the image, it is sent to the clients end via e-mail.

Once the image is received on the client side, authentication of the image shares is done using de-watermarking. As soon as watermarking is performed, the shares undergo decryption (AES). Lastly using reverse visual cryptography, the shares of image are united thus enabling the users to view the original image. Consequently, if any individual tries to get access to the image without authentication he will not be able to access it if any tampering is done to the image which will be detected through watermarking. Even if any of the users' private key is missing then no user will be able to view the image (Fig. 1).

3.1 Visual Cryptography

Visual Cryptography [4], scheme is a special encryption technique which allows cryptography in which visual information like images, text, etc., can be encrypted.

Here image is spilt down into n shares and only n share owner could decrypt the image while any n-1 shares cannot reveal any information about the original image. Each share is printed on separate transparency and decryption is performed by overlaying the shares. Only when all shares are overlaid the original image can be viewed (Fig. 2).

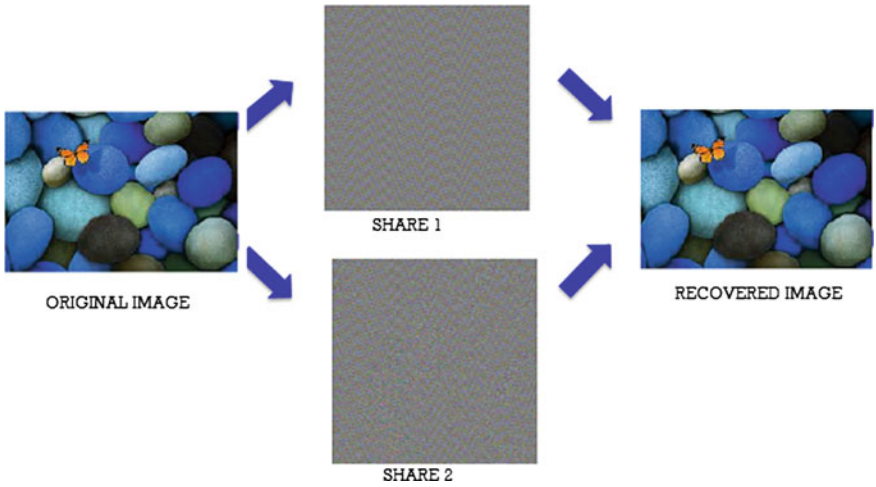


Fig. 2 Share generation

3.2 Advanced Encryption Standard (AES)

AES stands for Advanced Encryption Standard [6], which encrypts and decrypts data block, it was originally known as Rijndal. In this paper, we are using 10 rounds. The key size, which is 128 bits, depends on the number of rounds. Every sub-key corresponds to a processing round in AES therefore each sub-key is also called as a round key. AES offers high security, flexibility, efficiency, and performance making is much more tolerant against attacks as compared to others techniques.

3.3 Watermarking

A watermark is a kind of marker which clandestinely ingrains a noise signal into the data mostly an image. It is used to determine the authenticity of these signal's copyright. Watermarking is a methodology with which digital information is hidden within the carrier signals, there is no affiliation between the signal carried and the information which id hidden. Using watermarking the data is only marked, the access of the data is not controlled nor is it demeaned. The process of watermarking is partitioned into three prominent steps: embedding, attack, and detection. In embedding, the host or the image and the data to be embedded is accepted by an algorithm, and then a watermarked signal is produced. Then this watermarked digital signal is dispatched to the user. If any modifications are to the data, it is called an attack. There are various numbers of such modifications namely, lousy compression of the data, cropping an image, or intentionally adding noise. To

extract the watermark from the attacked image, a detection/extraction algorithm is used. During the transmission if the data remains unchanged, then watermark can be extracted as it is still present.

Algorithm

Algorithm for proposed system is

Input: Original image from agent.

Output: Securely regenerated original image after sharing.

1. calculate gray scale level: black if H(V)>= d and white if H(V)<d-αm.
2. Any matrix B in C0 or C1 OR operation on any K of n rows satisfies H(V) <d-αm and H(V)>= d.
3. Rn<<(n-1)bytes
4. Sn=((n+1)*XOR(1*S1)XOR(3*S2)XOR(3*S3)
5. Wn=W0..n*XOR*g[Wn-1]
6. (R,G,B)=pixel[count]&0xff
   Count ++
7. col=((R<<16)|(G<<8)| B)&0xffffff
8. `b=col & 0xff;`
   `g=(col>>8) & 0xff;`
   `r=(col>>16) & 0xff;`
9. `al=(col>>24) & 0xff;`
10. α=R+G+B/3
11. End

4 Experiments and Result

The result of the system is recovery and generation of original image on user's side by assembling the shares of participated users.

The image is initially sent by agent which undergoes Visual Cryptography (splitting of image into n shares), Advanced Standard Encryption (encryption and decryption of shares), and Watermarking (authentication and copyright protection) to users (Fig. 3).

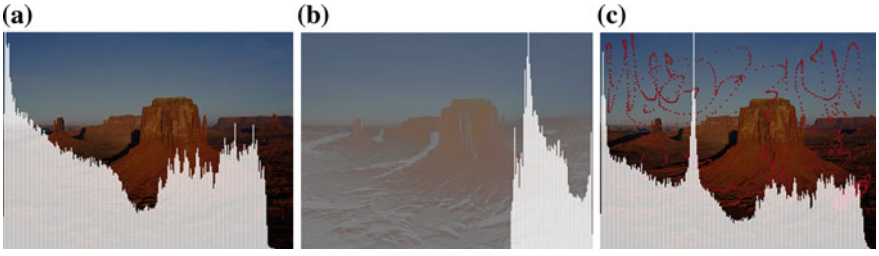


Fig. 3 **a** Original image. **b** Watermarked image. **c** Tampered image

This system can be mainly used for military purposes by the government. Newer and better versions of arms and ammunitions are designed on a regular basis. These designs need to be shared securely. If any terrorist organization or government of any other country gets hold of these designs, it could pose a major threat for our country. The system can also be used for industrial purposes for product designs to prevent other companies from copying the products, automobile industries, electrical and electronic appliance industries, etc. It can also be used by photographers, architects, painters, interior designers, and animators to share their designs, photographs, or any other kind of artwork with a carefree mind.

5 Conclusion

In this paper, there is trend toward scenario where multiple security techniques have been implemented. The proposed approach can manage the security challenges on cloud to realize full potential of cloud computing. This work provides three major contribution security and privacy on cloud, authentication, or copyright of image and confidentiality of multimedia data.

Visual cryptography is specially used for encryption, hide, and share information in the form of images. It can be viewed by the human eye only if decryption is done using the correct key. Secret information along with different features are inserted onto the original image using watermarking. This allows access to the ownership of the modified image. Problems faced by tampering and verification are solved by watermarking. Sensitive data is encrypted using AES which is a symmetric key algorithm.

The susceptibilities in cloud are studied and understood, the new system introduces a technology that eliminates various issues like data loss, data breaches, service traffic hijacking.

References

1. H. Wang, S. Wu, M. Chen and W. Wang, "Security protection between users and the mobile media cloud," in *IEEE Communications Magazine*, vol. 52, no. 3, pp. 73–79, March 2014.
2. Ritesh Mukherjee and NabinGhosha, "*Steganography Based Visual Cryptography (SBVC)*", Springer, 10.1007/978-3-642-35314-7_63, 2013.
3. Mr. Parjanya C. A Mr. Prasanna Kumar M," *Advanced secure multi-owner data sharing for dynamic groups in cloud*", IJARCSSE, ISSN:2277 128X, 2014.
4. Stelvio Cimato, James C. N. Yang, and Chih-Cheng Wu," *Visual Cryptography Based Watermarking*", Springer, pp. 91–109, 2014.
5. S. Sridevi Sathya Priya, P. Karthigaikumar 2, and N.M. SivaMangai, "*Generation of 128-Bit Blended Key for AES Algorithm*", Springer International Publishing Switzerland, 10.1007/s11277-014-1888-7, 2013.

6. Salim MuhsinWadi, Nasharuddin Zain, "*High Definition Image Encryption Algorithm Based on AES Modification*", Springer Science+Business Media, New York, 10.1007/s11277-014-1888-7, 2014.
7. Li-hua Wu, Wen-juan Jiang and Junkuo Cao, "*Research of Image Watermarking Algorithm and Application in Eco-Tourism Digital Museums Copyrights Protection*", Springer International Publishing Switzerland, 10.1007/978-3-319-03449-2_23, 2014.
8. Guang Yu1 and Xue Jun Zhao, "*Study Based on Chaotic Encryption and Digital Watermarking Algorithm*", Springer-Verlag Berlin Heidelberg, pp. 619–625, 2012.
9. Kai-Hui Lee and Pei-Ling Chiu, "*Digital Image Sharing by Diverse Image Media*", IEEE Transactions on Information Forensics and Security, Vol. 9, No. 1, January 2014.
10. S. K. Saroj, S. K. Chauhan, A. K. Sharma and S. Vats, "Threshold Cryptography Based Data Security in Cloud Computing," *Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on*, Ghaziabad, 2015, pp. 202–207.

Movie Recommender Engine Using Collaborative Filtering

Howal Sadanand, Desai Vrushali, Nerlekar Rohan, Mote Avadhut, Vanjari Rushikesh and Rananaware Harshada

Abstract The purpose of this paper is to research and form the hybrid algorithm using different collaborative algorithms to achieve the smart clustering to get efficient results. The volume of data which includes both unstructured and structured, and its knowledge has fully grown heavily in recent days. Recommendation system is changing into growingly widespread as they are victimization all over in E-commerce space. Managing large amount of data and information and testing both trained data and tested data to give best recommendation are the main aspects of the project. A massive framework which is used for processing distributed data called Apache Spark is used in the project. As compared to old mapping functions, Spark handles repetitive algorithms, interactive algorithms, and stripped down intervals of time (Swapna in A recommendation engine using Apache Spark, 2015) [1].

H. Sadanand (✉) · D. Vrushali · N. Rohan · M. Avadhut · V. Rushikesh · R. Harshada
Information Technology, Rajarambapu Institute of Technology, Islampur 415414, Maharashtra, India
e-mail: sadanand.howal@ritindia.edu

D. Vrushali
e-mail: vrushd36@gmail.com

N. Rohan
e-mail: rohanerlekar@gmail.com

M. Avadhut
e-mail: ganeshmote13@gmail.com

V. Rushikesh
e-mail: rcvanjari54@gmail.com

R. Harshada
e-mail: harshada935@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_62

1 Introduction

Recommender systems are a vital part of the informative websites, business websites and e-commerce system. Recommender system plays a significant role within the social media like Facebook, Twitter, YouTube etc. picture show recommendation system aims to supply the most effective picture show recommendation victimization the past information wherever in algorithms area unit accustomed value the results. They represent a strong methodology for enabling users to filter through massive data and products areas. Nearly 20 years of analysis on cooperative filtering have diode to a varied set of algorithms and an upscale assortment of tools for evaluating their performance. Data mining techniques are the results of a protracted method of analysis and products development.

2 Literature Survey

The major literature survey is done by data science community. The book DATA MINING concepts and Techniques by Jiewei Han has mentioned various collaborative filtering techniques [2]. By reading and analyzing IEEE conference paper by Sasmita Panigrahi, Rakesh Ku, Lenka, and Anaya Stitipragyan "A Hybrid Distributed Collaborative Filtering Recommender Engine using Apache Spark" we got an idea of recommendation system using collaborative filtering [3]. We are going to execute the idea on Apache Spark. The paper "Hybrid web recommender systems" written by Robin Burke talks about variety of algorithms have been for getting recommendation, including content-based collaborative and other algorithms. This paper surveys the hierarchical pattern of actual and possible hybrid recommenders, and introduces a great hybrid system that combines the knowledge based recommendation and collaborative filtering to recommend restaurant. It purely relies on the physical characteristics of the user [4].

The paper "Clustering Methods for Collaborative filtering" by authors Lyle H. Ungar and Dean P. Foster discusses about a new method of grouping and clustering of items. The methods used in this paper to optimize the model estimations give the best base rates and link probabilities. Hence, for better results of algorithm it is necessary to use appropriate input methods [5].

The review article "A New Parallel Item-Based Collaborative Filtering Algorithm Based on Hadoop" by Qun Liu, Xiaobing Li* talks about various features extraction methods that can be used for filtering using parallelization design for Item-Based Collaborative Filtering. They describe various features and feature extraction methods. The overall article gives the idea about constructing user's preference vectors and computing co-occurrence matrix [6]. We aim to study these methods and use the best suited one among them and combine the best suited techniques to achieve the better results.

The authors Reena Pagare and Shalmali A. Patil in their paper titled as "Study of Collaborative Filtering Recommendation Algorithm—Scalability Issue" talk about statistical approach of problems in filtering techniques of datasets. The paper discusses about challenges in recommendation system. So from this paper, we get an idea to analyze the scalability of the algorithms. They talk about challenging problem of collaborative filtering [7].

The Paper "Recommendation System Based on Collaborative Filtering" by Zheng Wen gives the proper idea to connect the choice of characteristics based on "matching" of user's profile specific characteristics of an item. Collaborative filtering algorithm such as sparse matrix SVD approach model both user's and movies by giving them coordinates in a low dimensional feature space [8].

The authors A.H.M. Ragab, A.F.S. Mashat and A.M. Khedra in their paper entitled "HRSPCA: Hybrid Recommender System For Predicting College Admission" talks about hybrid recommender based on data mining techniques and knowledge discovery rules for tracking college admission problems. This paper gives an absolute idea about high prediction accuracy rate, flexibility in advantage as the clustered hybrid algorithms to perform attributes task faster and fairly [9].

Data mining techniques area unit the results of a protracted method of analysis and products development. This evolution began once business information was initial keep on computers, continuing with enhancements in information access, and a lot of recently, generated technologies that permit users to navigate through their information in real time. Data mining takes this biological process on the far side retrospective information access and navigation to prospective and proactive data delivery. Data processing tools predict future trends and behaviors, permitting businesses to create proactive, knowledge-driven choices. The machine-driven prospective analyses offered by data processing move on the far side the analyses of past events provided by retrospective tools typical of call support systems. Data processing tools will answer business queries that historically were too time intense to resolve. They scour databases for hidden patterns, finding prophetic data that specialists could miss as a result of it lies outside their expectations.

3 Problem Life Cycle

A. The amount of huge information in present days is leading to number of choices and alarming growth of data available [1]. Internet is full of choices and there are various recommendations available for everyone in field of movies, books, links, etc. [1].
B. Recommenders are used to suggest information products and services to the regular customers based on the history, transactions and feedback [4]. Here the similarity between user–user and item-item is used. In the growing field of Big-data, the number of products, customers and provider are increasing

tremendously. Hence recommendation system becomes need and a growing challenge to produce results.

C. Many such systems recommend items to user are CF technologies [2]. Major problems of CF are scalability, cold start, sparsity which can be reduced with the help of hybrid systems using combination of different algorithms.

3.1 Problem Formulation

In movie recommender a movie is an entity which is considered and recommendation is done using similar entities [1]. Using most relevant similar entities from a large number of dataset based on users query, recommendation can be given. Movies are rated, this helps to retrieve other entities which are more relevant based on relevance, authority, popularity etc. Below output, input, and data of the recommender and problem are stated [1].

Input: A Movie
Output: Recommender movies when given input.
Movie Data: Unstructured data and Semi structured data
Movie: An object, structured data

Using victimization huge processing Apache Spark to provide answer to make movie recommender using huge processing is the problem. The goal of associate film recommender over huge information is to style a system that is efficient, climbable, and provides most effective doable answers for an oversized style of questions. Mentioning below the challenges faced by Recommender:

1. Unstructured Dataset: Movie recommender of big-data includes storing and processing the huge unstructured data [1].
2. Movie Disambiguation and Movie Resolution: "XYZ" may refer to actor as well as movie "XYZ." Also different strings can mean differently in different cases [1].
3. Movie Ranks: For a particular Movie, the user may not be interested in all results available. The results need to be ranked. Many features of ranking are available like page rank, click frequency etc.

3.2 Terminology

The following terms are widely used in the report:

- Movies: It is an object with unique properties and id. It is an abstract concept which is meaningful [1].

- Similarity: It is a numerical value calculated using similarity functions. It also tells us relevance of a query and a movie [1].
- Popularity: It is a measure to count the popularity of a certain movie compared to other entities [1].
- Property/Field: Movie's attribute.

3.3 Problem Analysis

Why Recommender Systems?

1. Given the increasing amount and growing variety of products, services and information, which are daily made available on the Internet, and the introduction of new e-business services [10], making a choice from such wide range of options can be somewhat complex and difficult to manage.
2. It can be argued that while being able to choose is good, having so many options to choose from is not always more rewarding.
3. To prevent overwhelmed users from making poor decisions, recommender systems came into focus, facilitating users' access to information about the items they are most likely to be interested, whether such items are books, movies, music, videos, Web pages, news or services, among others.

Why hybrid system?
A combination of different approaches and algorithms combine to increase the potency of recommendation system is called as hybrid system. Hybrid system helps to correct the present system additionally. The content and cooperative filtering face the cold start problem. Hybrid system will help to solve this problem to some extent [1].

- Why MovieLens Dataset?

1. Due to copyright, Netflix data is not available for download. So, to perform the recommendation evaluation on the movies domain, the MovieLens data is used.
2. The MovieLens dataset consists of anonymous ratings of movies collected by the GroupLens Research that currently uses a movie recommendation system based on collaborative filtering.
3. The MovieLens data set contains approximately 10 million ratings from 71,567 users on 10,681 movies. Ratings are made on a 5-star scale [11] (whole-star ratings only) and each user has at least 20 ratings.
4. The data set was collected and made available by GroupLens Research at their webpage.

A massive framework which is used for processing distributed data called Apache Spark which has Hadoop MapReduce and it is extension model having additional use [1]. This is often a short tutorial that explains the fundamentals of Spark Core programming.

An idea of how one entity is correlated with another entity is given by Pearson Correlation coefficient. A measure of linear dependency between two variables, items or users is given by this algorithm as attribute function [1]. But this dependency is not based on whole dataset but a part of dataset is used which are similar on high level [1].

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\left(N\sum X^2 - (\sum X)^2\right)\left(N\sum Y^2 - (\sum Y)^2\right)}}$$

Pearson Correlation Coefficient
where

N Numbers of Pairs of Scores
Σxy Sum of Product of Paired Scores
Σx Sum of x Scores
Σy Sum of y Scores
Σx^2 Sum of Paired x Scores
Σy^2 Sum of Paired y Scores

4 Proposed System

Module 1: Implementation of basic algorithms in java, using eclipse and mahout.
Module 2: Study and research of Collaborative filtering.
Module 3: Study and implementation of effective new recommendation algorithms combination such as: Tanimoto Algorithm, Pearsons Algorithm, Slope Algorithm, SVD Algorithm.
Module 4: Study and research regarding Content-based recommendation and implement hybrid algorithm (Fig. 1).

5 Test Bed

We have tested this algorithms using simulation of system on following requirements:

- Laptop with core i5 processor, 8 GB RAM

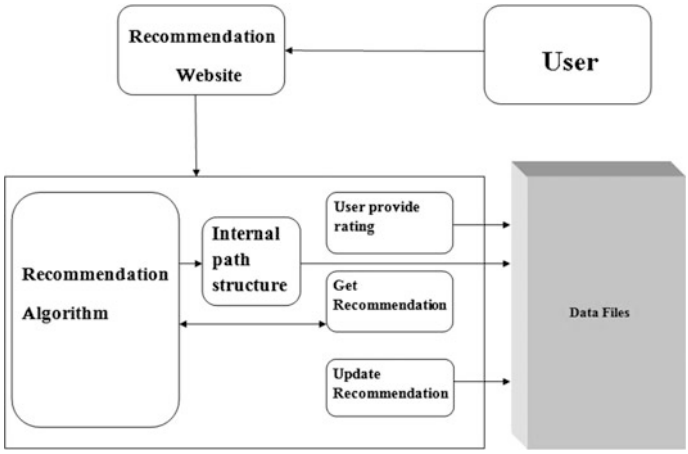


Fig. 1 System architecture

Table 1 Time required for processing the datasets

Dataset size	1 K	10 K	100 K	10 M
Time required (s)	**0.80**	**2.0**	**4.0**	**4.57**

6 Implementation and Result Analysis

We have implemented recommendation system algorithms using Item similarity, user-user neighborhood approach, Tanimoto coefficient Algorithm, Pearson coefficient Algorithm, Slope One Algorithm, SVD Algorithm using mahout libraries using JAVA platform in Eclipse on Linux platform.

Table 1 shows the time taken by each dataset to process from asymmetrical data to symmetrical data.

6.1 Graphs

The graphs give a brief comparison of our models with different standard algorithm (Figs. 2, 3, 4, and 5).

7 Conclusion and Future Work

We successfully implemented basic algorithms in java, using eclipse and mahout libraries. The implemented algorithms are: item–item, user–user similarity, tanimoto, Pearson coefficient, Slope one, and SVD recommendation. We studied and

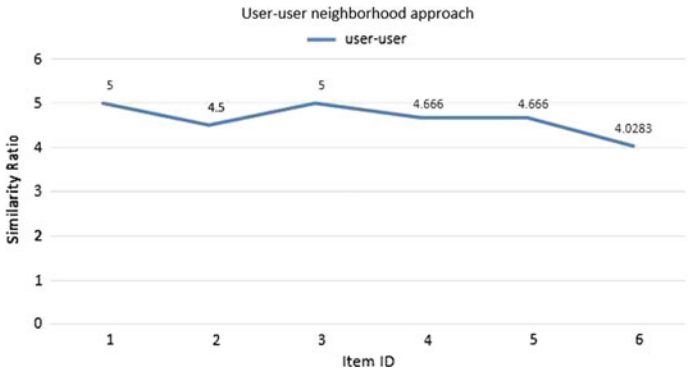


Fig. 2 User–user approach

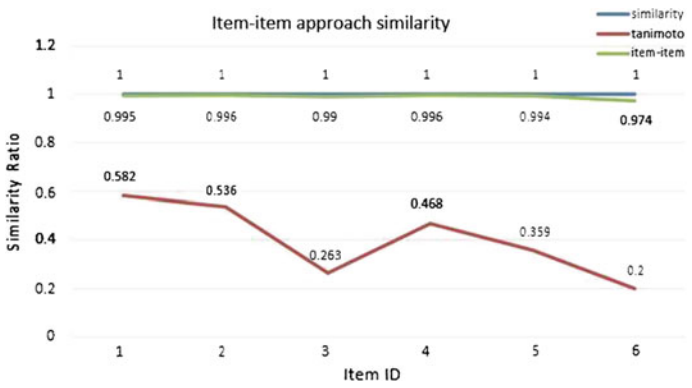


Fig. 3 Item–item approach

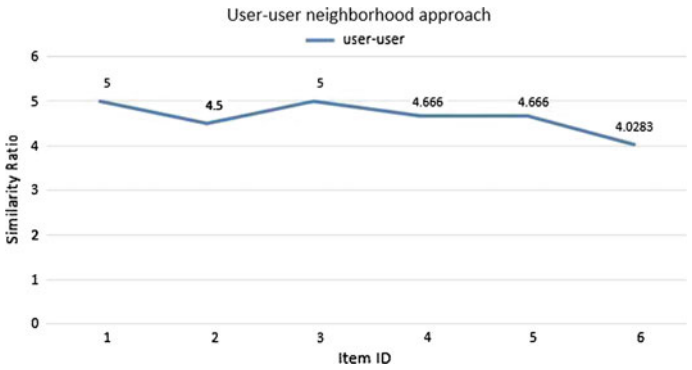


Fig. 4 User–user neighborhood approach

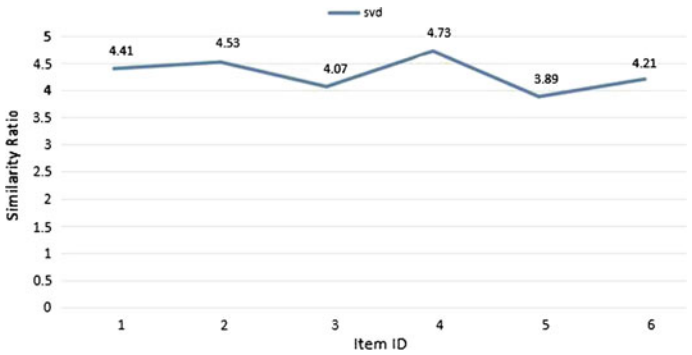


Fig. 5 SVD approach

filtered Collaborative filtering algorithms and chose the three algorithms which gave best results for implementation. The algorithms are Pearson coefficient algorithm and SVD algorithm. Further implementation of modules is under work. Future works area unit fascinating so as to stay examination the advice algorithms implementations obtainable within the newer releases of Apache Spark and R language, since each engines for large-scale processing area unit quickly evolving. It will facilitate to introduce new cluster formula victimization the Scala. Spark is currently at version 2.0.0, discharged on Gregorian calendar month 2016. Since unharness one.3 a brand new Data-Frames API was introduced, that gives powerful and convenient operators once operating with structure datasets. Since unharness one.4 they supply the SparkR, AN R binding for Spark supported Spark's new knowledge FrameAPI [12]. SparkR provides R users access to Spark's scale-out parallel runtime in conjunction with all of Spark's input and output formats [12]. It additionally supports career directly into Spark SQL. Finally, a right away thanks to improve our work is by validation the algorithms on larger datasets, with millions or billions of ratings, and if attainable from completely different recommendation domains like music, movie, product and news.

References

1. Kulkarni, Swapna, "A Recommendation Engine Using Apache Spark" (2015). Master's Project, 456
2. Jiawei Han, "Data Mining: Concepts And Techniques", 2005 ISBN-1558609016
3. Sasmita Panigrahi, Rakesh Ku. Lenka And Ananya Stitipragyan, "A Hybrid Distributed Collaborative Filtering Recommender Engine Using Apache Spark" Procedia Computer Science 1000–1016, 2016
4. Burke Robin, "Hybrid Web Recommender Systems" In The adaptive web pages 377–408 Springer Berlin Heidelberg, 2007
5. Ungar LH, Foster DP. "Clustering Methods For Collaborative Filtering". In AAAI Workshop On recommendations systems (Vol. 1, pp 114–129) July 26 1998

6. Qun Liu, Xiaobing Li* "A New Parallel Item-Based Collaborative Filtering Algorithm Based On Hadoop" doi:10.17706/jsw.10.4.416-426, 2014
7. Pagare Reena, Patil Shalmali A. "Study of Collaborative Filtering Recommendation Algorithm-Scalability Issue" International Journal of Computer Applications, Volume 67-Number 25, 2013
8. Zhcng Wen "Recommendation System Based On Collaborative Filtering" Dec 12, 2008
9. A.H.M. Ragab, A.F.S. Mashat and A.M. Khedra, "HRSPCA: Hybrid Recommender System For Predicting College Admission," doi:10.1109/ISDA.2012.6416521 pp 107–113, 2012
10. Francesceo Ricci, Lior Rokach and Bracha Shapira "Introduction To Recommender System Handbook" DOI 10.1007/978-0-387-85820-3_1, @ Springer Science+Business Media, LLC 2011
11. Jianwen Chen, Ling Feng, "Efficient Pruning Algorithm For Top-K Ranking On Database With Value Uncertainty" CIKM-13 Pages, 2231–2236, 2013, ISBN-978-1-4503-2263-8
12. "Big Data Product Watch 8/28/15: Streaming Analytics high Performance Computing And More." ICT Monitor Worldwide, August 29 2015 Issue

Small Effort to Build Pune as a Smart City: Smart Real-Time Road Condition Detection and Efficient Management System

Suresh Limkar, Omkar Rajmane, Aishwarya Bhosale and Vidya Rane

Abstract Detecting the road condition is a very important task nowadays. There is an alarming increase in the number of vehicles so a number of accidents also have increased in turn. This paper shows a unique way to detect the potholes using an Arduino-based sensing module and android smartphone. It also does an important task of finding the appropriate ways of handling the potholes which are detected like notifying the appropriate time of repairing the pothole, which potholes must be repaired first, etc. This paper also proposes an additional functionality of detecting the skidding of vehicles and location of inappropriate speed breakers. This all mined data will be pinned on to the Google maps and accordingly, the users can change their driving patterns so they can reach the destination safely. The data obtained can be helpful to the governments for the improvement of the road conditions.

1 Introduction

Roads are the basic way of transportation used by citizens. So there must be a deployed method to ensure the safety of the road users. For providing this basic safety of the drivers and for living comfort the bad conditions such as potholes, bump, steep, skidding, etc., must be detected. As the number of people using the smartphone is increasing and becoming an integral part of the people's life, we can

S. Limkar (✉) · O. Rajmane · A. Bhosale · V. Rane
Department of Computer Engineering, AISSMS IOIT, Pune 411001, India
e-mail: sureshlimkar@gmail.com

O. Rajmane
e-mail: mr.omkarrajmane@gmail.com

A. Bhosale
e-mail: aishwaryabhosle438@gmail.com

V. Rane
e-mail: vidyarane111@gmail.com

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_63

merge it to provide them safety at fingertips. In road condition, detection the bad condition of roads is been detected at runtime and the users are given an update of the same for providing them extra comfort.

There are various ways for detecting the road condition like using various dedicated sensors or by using sensors of the smartphone. We can detect condition using dedicated sensors [1] embedded in the vehicles and the data collected is been shown on the dashboard respectively. The detection has also been done using sensors like accelerometer, G-sensor [2] for finding the g-values and using GPS (Global Positioning System) has for finding the position of the bad condition and giving the collected information to the users. There are sensors in your smartphone which can also be used for detection of the potholes and other abnormalities and as the sensors on the smartphone [3] are used there is no extra GUI used for showing the collected information. The sensors like accelerometer, GPS, magnetometer, GSM is been used [4–6]. Figure 1 shows the simple working of the system.

Also machine-learning algorithms [7] can be used for better detection of the road conditions so it can lead to increase of accuracy.

The road conditions of India is deteriorating day by the very simple and efficient way must be deployed for the betterment of the road condition. The system thus created will be used by the government for improving the condition of the road in India. India is looking forward for turning into a Smart Nation. The implementation of the idea as Smart City project will lead to the maximum comfort to the citizen with placing very less amount of effort. The system if deployed on each and every vehicle will lead to large amount of data available which will be useful for finding the faults on roads and repairing them as required. It will lead to overall development.

In the proposed system, the road conditions are been detected using accelerometer mounted on the Arduino-based sensing module and the data so processed by the Arduino is been sent to the Android-based smartphone which will pin all the abnormalities on Google Maps [8] so that a great overview is been given to the user for changing their driving behavior for acquiring maximum comfort for

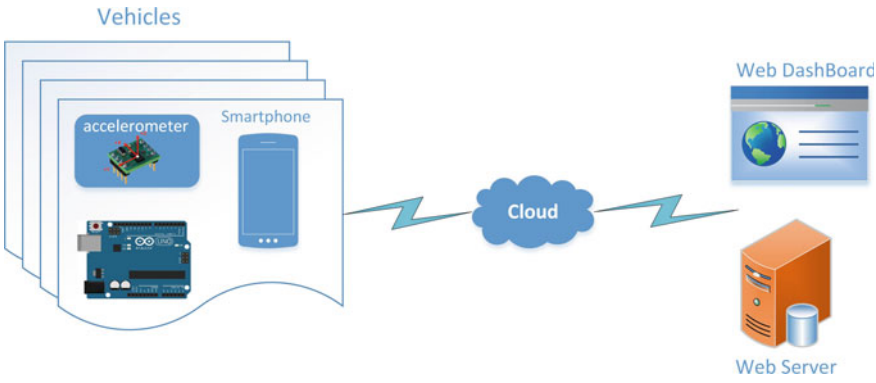


Fig. 1 System overview

reaching to the destination. The data collected by the Android smartphone will be mined so that we can get various functionalities like finding the position of potholes, the appropriate time for repairing them, the degree to which condition of roads are damaged, the skidding detection and also finding the position of inappropriate and unnecessary speed breakers. All this mined data will be very much useful for the administrator to look upon the various ways of using this data for the improving the condition of the roads interns.

The rest of the paper is organized as follows. Section 2 gives brief literature survey, Sect. 3 explains the proposed system architecture, Sect. 4 discusses the various scenarios for road condition anomalies and results, and finally we conclude in Sect. 6 followed by references.

2 Related Work

Hull et al. [1] proposed a CarTel system used form collecting various information from the sensors fitted on mobile systems like automobiles and this data obtained from the sensors is delivered to central portal. The advantage of the system thus proposed is it provides a simple programming interface, easily handles large amount of data obtained, intermittent connectivity is handled well. The various cons of the system are that it does not take proper care of the privacy of the users and the past data obtained is also not used for further usage for map based route finding system. This paper is helping for taking a leap toward developing world's largest and most dynamic sensor networks.

Eriksson et al. [2] proposed an application of mobile sensing and reporting of the condition of surface of roads using signal processing and machine learning. The paper explores the P^2 system and algorithms to monitor the important civil infrastructure. They deployed seven such P^2 systems on taxis in Boston area.

Bhoraskar et al. [3] proposed Wolverine which uses the sensors from smartphones for traffic monitoring. The data received by the mobile can be sent to a central server, which can use the information received. This received data can contain a lot of data like traffic, shoulder off, or bumpy nature of the road, etc. Machine-learning techniques were applied to classify the data that can detect the nature of the road and user's use.

Chen et al. [4] proposed a low-cost solution for vehicles, Road Condition Monitoring with Three-axis Accelerometers, and GPS Sensors which uses a low-cost three-axis accelerometer and a GPS sensor embedded in the vehicle to evaluate the road condition. The paper analyzed the Power Spectral Density (PSD) of the pavement roughness, and classified the pavement roughness level into four levels. The total cost in each vehicle is not greater than $50 USD, which is very less as compared to existing systems.

Mohan et al. [5] proposed a system Nericell which makes use of the sensing components present in user's smartphones, i.e., accelerometer, G-sensor, GPS, and GSM to detect various conditions like honking, traffic, potholes, and bump on the

road. The advantage of the system is that it uses inbuilt sensors present in the smartphone which is easily deployed. The energy cost of Nericell is less impact on the user's smartphone. The accuracy of the system can be increased by machine learning.

Mednis et al. [6] proposed an accelerometer data-based pothole detection and four algorithms with their analysis. Deployment is done on devices with limited hardware and software resources and then compared with data collected various Android OS-based smartphones. Their reports contain test drives and their evaluation and analysis and the overall analysis shows a true positive rate of 90%.

Kulkarni et al. [7] proposed a Pothole Detection System that can supply users with better information about their routes of their transportation. Taking into consideration low GPS accuracy, accelerometer sampling rate and noise they stress on the fact that that accurate pothole detection is possible. They have created an Android application to collect the data from sensors by recording a journey, and display the acquired data using graphs using A Chart Engine, and run that data through neural network.

Bansal et al. [9] proposed various methods for detecting road condition. They have also concluded from their survey that the accelerometer and GPS sensors are used more often in this field of detecting road conditions. Smartphone sensors are becoming popular choice due to cost effectiveness and scalability that they offer.

Ghose et al. [10] proposed a Smartphone-based road conditioning monitoring and alert system. Prototype is developed using low-cost hardware and open source packages thus reducing the cost of the system. This system is not developed for an app on popular platforms such as like Apple and Android.

Douangphachanh and Oneyama [11] executed various experiments to collect data from various sensors like accelerometer and gyroscope on vehicles to measure the roughness of the roads. The collected information can be used for increasing the security. They still have to integrate the model so formed into the smartphone app. The study uses both gyroscopes and accelerometer for estimating the condition of the roads.

Sen et al. [12] composed a method which detects the road traffic condition based on the acoustic sensing based technique to give comfort to the drivers. The disadvantage of the system is that the data center will receive large amount of information though it requires only honk related information. It is a very easy model which can be deployed very easily.

Faiz et al. [13] proposed a system for alarming about the accidents which have occurred. It uses GPS sensor, Accelerometer for change of tilt, pressure sensor to see if there are any sudden changes or not. The disadvantage is that it requires continuous internet access which is difficult to maintain. The accidents are detected and an emergency message is been sent to the nearby hospital and police station so and help can be provided in minimum amount of time.

Fu et al. [14] gave a study for using Google API for development of the web apps and easy usage of the Google Maps. It is used for embedding web pages easily in high resolution and user friendly interface. Google maps are easy to operate and support free scaling. As this technology is in the state of development and all the

data is taken from Google Maps, only there are some technical risks included in it. With the use of Google API is very flexible and simple to use Maps.

Singh et al. [15] proposed a system which will be useful for detection of bad driving behavior by making use of sensors present in our smartphone. An advancement is been made in this system over others is the use of audio processing and use of inbuilt sensors instead of a separate module. The proper classification of the data is not done and extra effort has to be taken so that data so obtained can be used for further enhancement. In future work, machine learning can be deployed so that the circumstances can be taken into account as when person drives rashly.

3 System Architecture

In this section, we describe the software architecture of the road condition detection and along with the sensors used to capture data and working of each module.

System consists of sensor-equipped vehicles and a central server, as illustrated in figure. Raw data is collected by Arduino according to the algorithm, and it is received by the Android device time to time. Position with the abnormal road is marked on Google maps using GPS of the smartphone. The following information can be collected with the help of the accelerometer and GPS.

<Location, time, speed, 3-axis acceleration>

The first two parameters can be obtained from the GPS of smartphone and the three-axis acceleration vector comes from the three-axis accelerometer. Onboard processing algorithmic filters combine data to produce high-probability pothole detections. Simultaneously, the time at which the pothole is detected is also reported. When network connectivity is available, the vehicles automatically upload their detections to a central server, which maintains a good database of detections. The end system will result in the final output of the system. Figure 2 shows the whole system architecture.

3.1 System Description

(a) **System Components**

The system describes the Arduino-based sensing module and android smartphone-based user interface. These low-cost modules are mounted on the vehicles so it's efficient for users as they do not have to have an external sensing function when they are driving their vehicles. The system also has Bluetooth

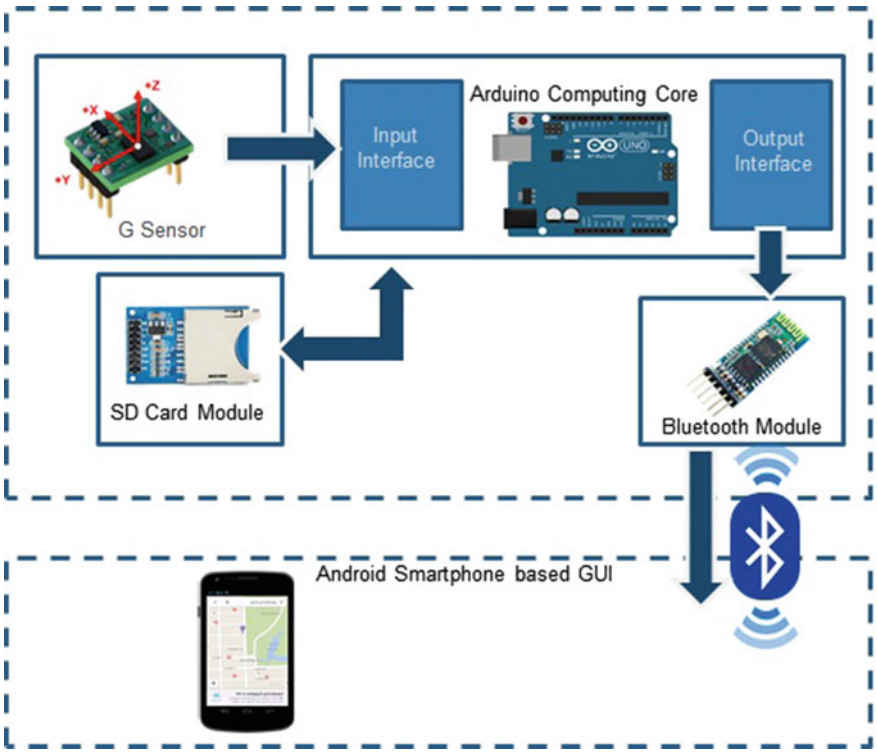


Fig. 2 System architecture

module so that the data taken from the accelerometer sensor is passed on to the android-based smart phone. The accelerometer is with ±2 to 8 g and baud rate of the Bluetooth is 57.6 kHz. The various values of the different three-axis value noted by the accelerometer are detected and the initial data collected for various road conditions is been send to the android-based smart phone with help of the Bluetooth module. These data sent to smartphone on regular time interval. Then the smart phone detects the vehicles position on GPS with information including latitude and longitude data if the vibration level is greater than the predesigned threshold. With the help of GPS coordinators, this position is marked as abnormal one on the Google maps with various markers satisfying the algorithm.

System can be divided into two parts as the Arduino part and the android part.

The Arduino part is to take the raw data form the accelerometer and pass this information to the smart phone using the Bluetooth module. The android part consists of getting the data from the Arduino, processing it and locating the position on the Google Maps. With the help of real-time updates, drivers can change their driving patterns accordingly and can reach to their destination safely.

4 Data Acquisitions

The system depends on the consistent data collected and analyzed by the accelerometer and Arduino, for a given road condition producing the correct localization of anomaly from the onboard-GPS of smartphone. We also discuss here how our training data is gathered.

4.1 Position of Accelerometer

Position of accelerometers inside the vehicle affects the quality of the signal coming from it. We placed accelerometer in the center of vehicle.

It is observed that the strength of the signal is most accurate when the accelerometer is kept at the center. From this data, we can perform various operations to detect the event.

Therefore, we attached the accelerometer to the center of car chassis. This also keeps device out of the way of the passengers.

4.2 Checking of GPS Accuracy

GPS accuracy in deployment is important if various events are to be located accurately. If the multiple detections combined report says the same event at the same place, then the GPS coordinates are accurate.

But the standard difference of about 4.5 m is observed, while combining the reports with modern GPS.

4.3 Detections of False Events

Certain types of road conditions can produce pothole-like events, like off shoulder event, though they do not actually represent a road surface with abnormality. This may include manholes, rail-road crossings, unusually shaped speed bumps, presence of rocks.

For this, we describe the system to automatically remove such false events from the final result.

5 Scenarios for Various Anomalies on the Road

1. Detection of bad roads

The road can be said to be in bad condition if it has potholes, shoulder drop-off, or made up of poor material that wearied off or due to weather conditions. We can

detect these types of road conditions with the help of accelerometer's *Z* axis. If we get continuous fluctuations in *Z* axis value which are over some threshold, and then the road can be detected as bad road.

Algorithm: Detecting bad roads

Input: Average of z values in 10 seconds
Output: Classification of road in smooth and rough road

```
1. Calculate avgRoad = average of z values in 10 seconds
2. Compare avgRoad with predefined values of smooth and rough road
3.          if (avgRoad > smooth_road)
4.              road_condition  = rough
5.          else road_condition  = smooth
6. end
```

2. Skid detection

The vehicle can skid if the road is wet, snowy/icy or because of oil and chip.

The person with skidding vehicle might suffer from injuries but the person followed by him can avoid skidding by real-time update.

Here if the *X*-value is constant and *Y*-value of accelerometer is increasing rapidly, skid can be detected.

Algorithm: Skid detection

Input: X and Y axis values
Output: Detection if vehicle is skidding

```
1. function skidDetection(x_val , y_val)
2.      if (x_val > x_threshold  && y_val < y_threshold)
3.           skid_detected = true
4.      else
5.           skid_detected =  false
6.     return skid_detected
7.  end function
```

3. Rating the potholes

Rating of the pothole is important to identify,

(1) Repair priority: We should provide priority to potholes so that high priority potholes gets repaired first.
The priority depends on,
Number of detections: Higher the number of detections, higher will be the priority.
Traffic: More the traffic, the more will be the priority.

(2) Intensity: Intensity measures the value of *Z* axis. Higher the difference between detected value and threshold, higher will be the intensity.
High intensity potholes should be repaired first.

Algorithm: Rating the potholes

Input: Z axis value
Output: Repair priority and intensity of potholes

```
1.  function repairPriority(detected_hole)
2.  n = detected_hole.num_detections
3.  m = avg_detections - n;
4.  rating_for_detection = (m ÷ avg_detections) // range ±100
5.  a = detected_hole.traffic
6.  b = avg_traffic - a;
7.  rating_for_traffic = (a ÷ avg_traffic) // range ±100
8.  return pothole_rating = ( (rating_for_detection + rating_for_traffic ) ÷ 2 )
9.  end function
```

Algorithm: Intensity the potholes

Input: Z axis value and Z axis threshold
Output: Intensity of potholes

```
1.  function potholeIntensity(z_val, z_threshold)
2.  diff = z_threshold - z_val;
3.  base = z_max –  z_threshold;
4.  return intensity_rating = (diff  ÷  base ) × 100
5.  end function
```

4. Accident detection/urgent brake detection

In accident detection, the *X*-value of accelerometer will be observed. If the *X*-value increases rapidly, keeping *y*-value constant, then the vehicle might have met with an accident or there is an urgent application of brakes.

Algorithm: Accident detection/Urgent brake detection

Input: X axis value and X axis threshold
Output: Accident detection/Urgent brake detection

```
1.  function breakIntensity(x_val, x_threshold)
2.  diff = x_threshold – x_val
3.  base = x_max –  x_threshold
4.  brake_intensity_rating = (diff  ÷  base ) × 100
5.  return brake_intensity_rating
6.  end function
```

5. Abnormal speed breakers detection

Z-axis value is obtained for the ideal speed breaker. All other speed breakers are compared with ideal values. If the difference is more than predefined value, the speed breaker can be marked as abnormal.

Algorithm: Abnormal speed-breakers detection	
Input: Z axis value	
Output: Abnormal speed breaker detection	
1.	function detectSpeedBreaker(z_val, sb_threshold)
2.	if (z_val < 0 && z_val >sb_threshold)
3.	abnormal_speedBreaker = true
4.	return abnormal_speedBreaker
5.	end function

6 Results

We tested out system on roads of Pune and successfully detected potholes on that road. Figure 3 shows the detected potholes and also the condition of the road which is rough by highlighting it in red.

Figure 4 represents the working of the detection of potholes and the *X* axis graph. Figure 5 represents the working of skidding detection and the *y* axis graph. Figure 6 represents the working of and accidental braking. The threshold is predefined and any value above it is marked and saved for further processing.

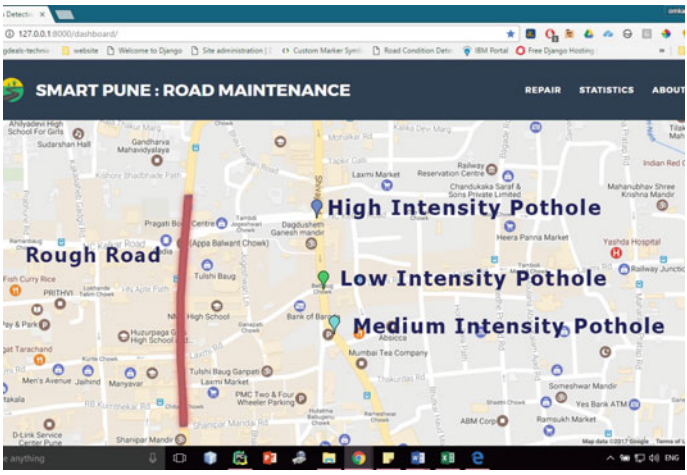


Fig. 3 System dashboard

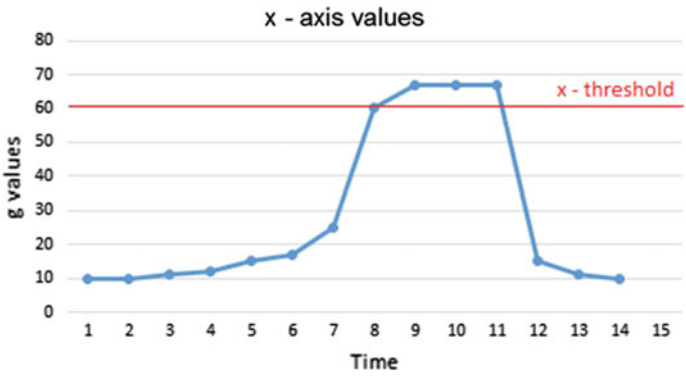


Fig. 4 *x*-axis graph

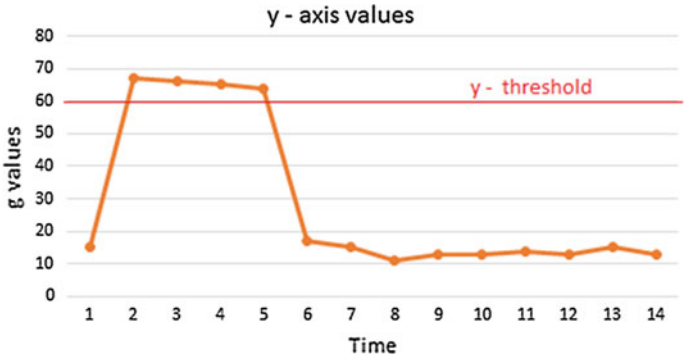


Fig. 5 *y*-axis graph

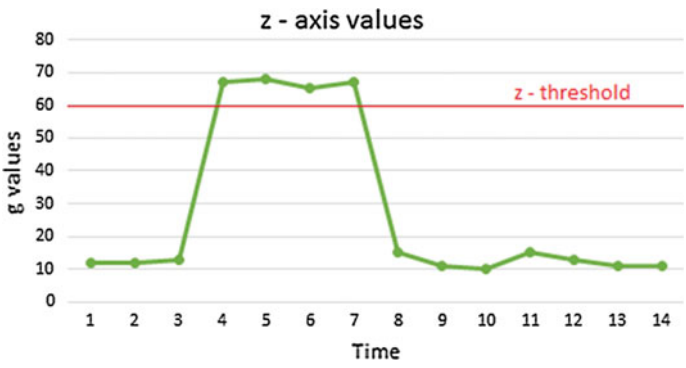


Fig. 6 *z*-axis graph

7 Conclusion

In this paper, we presented a simple and cost-effective system to track the potholes in road and to determine the overall quality of the road by making use of accelerometer values and GPS co-ordinates. In addition to detecting potholes and road conditions we also give statistics such as Rating of pothole based on the traffic and intensity of the pothole. All this is done when the data is sent to the central server for processing. For GPS value calculation and showing real-time data updates of the route, we make use of an Android smartphone which runs an app created by us.

We have also successfully tested skid detection and accident detection or harsh braking by making the use of all three-axis values of the accelerometer. The results that we calculated show accurate plotting of potholes on map and also the plotting of rough versus smooth roads.

The future work includes eliminating the Android smartphone by thus reducing the cost and makes it just a passive data collector device for users who only want to report data (buses) by adding a GPS module and GPRS module. We could also add another GPS module to increase the accuracy of GPS values.

References

1. Bychkovsky, V., Chen, K., Goraczko, H., Hu, H., Hull, B., Miu, A., Shih, E., Zhang, Y., Madden S., and Balakrishnan, H; The cartel: a distributed mobile sensor computing system. In: 4th international conference on Embedded networked sensor systems, SenSys '06, pp. 125–138. ACM, Boulder, Colorado, USA (November 2006).
2. Eriksson J., Girod, L., Hull, B., Newton, R., Madden, S., and Balakrishnan H.; The pothole patrol: Using a mobile sensor network for road surface monitoring. In: Sixth Annual International conference on Mobile Systems, Applications and Services (MobiSys 2008). IEEE, Breckenridge, USA (June 2008).
3. Ravi Bhoraskar, Nagamanoj Vankadhara, Bhaskaran Raman, Purushottam Kulkarni, "Wolverine: Traffc and Road Condition Estimation using Smartphone Sensors", Indian Institute of Technology, Bombay.
4. Chen, K., Lu, M., Fan, X., Wei, M. and Wu, J.; Road Condition Monitoring Using On-board Three-axis Accelerometer and GPS Sensor. In: sixth International ICST Conference on Communications and Networking. China (2011).
5. Mohan P., Padmanabhan, V. N. and Ramjee R.; Nericell: rich monitoring of road and traffic conditions using mobile smartphones. In: 6th ACM conference on Embedded network sensor systems, SenSys '08, pp. 323–336. ACM, New York, NY, USA (2008).
6. Mednis, A., Strazdin, G., Zviedris, R., Kanonirs, G., and Selavo, L.; Real time photole detection using android smartphone with accelerometers. In: International Conference on Distributed Computing in Sensor Systems and Workshop IEEE (June 2011).
7. Aniket Kulkarni, Nitish Mhalgi, Sagar Gurnani, Dr. Nupur Giri, "Pothole Detection System using Machine Learning on Android, 2015", V.E.S. Institute of Technology, Mumbai-74.
8. Syuan-Yi Chen, Annie Shih and Chun-Yi Hsiao, "Road condition Detection Device Using Arduino Sensing Module and Android Smartphone", 2015 International Conference on Consumer Electronics-Taiwan (ICCE-TW).

9. Gunjan Chugh, Divya Bansal, Sanjeev Sofat, "Road Condition Detection Using Smartphone Sensors: A Survey," International Journal of Electronic and Electrical Engineering. ISSN 0974-2174, Volume 7, Number 6 (2014), pp. 595–602.
10. Avik Ghose, Chirabrata Bhaumik, Chirabrata Bhaumik, Monika Sharma, Abhinav Jha, "Road Condition Monitoring and Alert Application Using In-Vehicle Smartphone as Internet-Connected Sensor," PerCom Demos 2012, Lugano (20 March 2012).
11. Viengnam Douangphachanh and Hiroyuki Oneyama, "Exploring the Use of Smartphone Accelerometer and Gyroscope to Study on the Estimation of Road Surface Roughness Condition" 2014.
12. Rijurekha Sen, Pankaj Siriah, Bhaskaran Raman, "RoadSoundSense: Acoustic Sensing based Road Congestion Monitoring in Developing Regions," 2011 8th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks.
13. Adnan Bin Faiz, Ahmed Imteaj, Mahfuzulhoq Chowdhury, "Smart Vehicle Accident Detection and Alarming System Using a Smartphone," 1st International Conference on Computer & Information Engineering, 26–27 November, 2015 Organizer.
14. Cong Fu, Yan Wang, Yanqing Xu, Qingquan Li, "The Logistics Network System Based on the Google Maps API", 978-1-4244-7330-4/10/$26.00 ©2010 IEEE.
15. Pushpendra Singh, Nikita Juneja, Shruti Kapoor, "Using Mobile Phone Sensors to Detect Driving Behavior", Copyright 2013 ACM 978-1-4503-1856-3/13/01.

Penetration Testing as a Test Phase in Web Service Testing a Black Box Pen Testing Approach

Shivam Mehta, Gaurav Raj and Dheerendra Singh

Abstract The study involves the implementation of the black box penetration testing approach; it deals with the step by step idea to conduct a penetration testing on web services as a user not as a developer. In this, we study about top vulnerabilities that are found in SOAP web services and how to exploit them to get confidential information which an attacker can regenerate and gain access to and what countermeasures the developer can take to prevent such vulnerabilities. So to prevent such malicious attack we should test them beforehand and fix the vulnerabilities before deploying web services over the network. We discussed about SOA architecture and black box penetration testing as a part of development lifecycle. We used SOAP UI and Burp Suite to test Web Services for security vulnerabilities.

1 Introduction

Web Services are used to implement platform independence and allowing our application to communicate with other applications over the internet using simple language rather than exposing the code or logic of the application. For example, we have created a Java currency converter Application and we want an C# application to call its code and make use of the logic, to achieve that some approach can be that we serialize the Java Objects and send it over the stub but, the problem with this approach will be that serialization and deserialization of Java will be different than that of the C#.

S. Mehta (✉) · G. Raj
Amity Univeristy, Noida, Uttar Pradesh, India
e-mail: shivam.mehta007@gmail.com

G. Raj
Punjab Technical University, Kapurthala, India

D. Singh
Chandigarh College of Engineering & Technology, Sector-26, Chandigarh, India

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_64

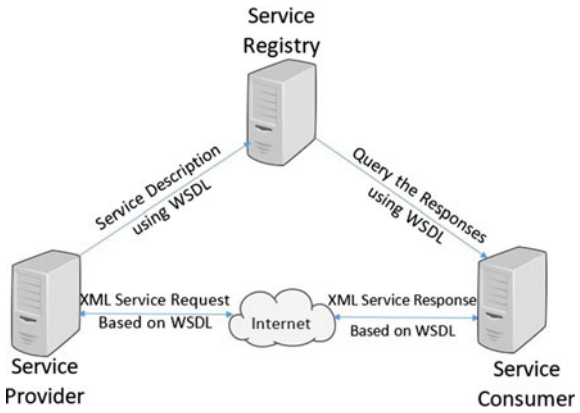


Fig. 1 Components of web services

To prevent such issues, Web Services were developed which use a standard format of XML messages to communicate between different applications, all of them uses a specific format which is described by WSDL (Web Service Definition Language). WSDL is an XML format which specifies the document and procedure of the application for other individuals or applications to access the service over the internet. Service Discovery of web services is done using the UDDI (Universal Description Discovery and Integration), it is specific for distributed registry of web services, UDDI uses WSDL to describe the interfaces to be used by Web Services.

Web Services Uses the SOA architecture that is they are highly Service-Oriented. Figure 1 shows the SOA architecture of SOAP Web Services. The model of Web Services is described by three elements [1]:

1. Service Provider
2. Service Requester
3. Service Registry.

Service Provider implements the service and is responsible for its availability over the internet. Service Registry is centralized registry of services, it provides a place where developers can publish the service or can find an existing service; and last Service Requester is the consumer of the Web Service, it sends an access request which is then responded by the service requester based on WSDL in form of XML SOAP.

Web Services are transferred over the Network using HTTP (Hyper Text Transfer Protocol), the advantage of using that it is simple, stable and reliable also most firewalls allows the HTTP traffic thus resulting in better availability of SOAP messages.

1.1 Testing of Web Services

- Penetration Testing and Static Code Development are two well-known techniques used by developers to test web services [2]. In this paper, we will talk about Penetration Testing Methodology and Approaches.

In the present scenario, the web services and developed and tested mainly for load, stress, and structural, according the empirical survey done over professional developers less than 25% of developers bother to implement security testing as a process in their development lifecycle, mainly to speed up the development for faster product delivery, also development company lacks the resources to perform a good penetration testing.

So the main focus of this paper is to implement Penetration testing as a part of SDLC (Software Development Life Cycle).

1.2 Why Black Box Penetration Testing

As we all know testing can be done as White Box Testing and Black Box testing, this study focuses on Black Box testing because it is rarely that a malicious attacker knows about the code of the program. Also a Black Box penetration testing approach requires no knowledge or previous information and takes the approach of uninformed attacker; thereby the attacker has no previous information about the attacking environment and system. Thus a Black Box Approach simulates a very realistic attack scenario which is ideal while testing any application.

2 Web Service Development Life Cycle

A Web Service Development Life Cycle is similar to an SDLC along with one extra penetration testing stage. Figure 2 describes the SDLC proposed by this research.

2.1 Planning Phase

This is the beginning of the development life cycle where we plan and look about the business model of the lifecycle. Requirements are gathered and documented.

2.2 Analysis and Design

This is the phase where requirements are analysed and Designing Documentation is done.

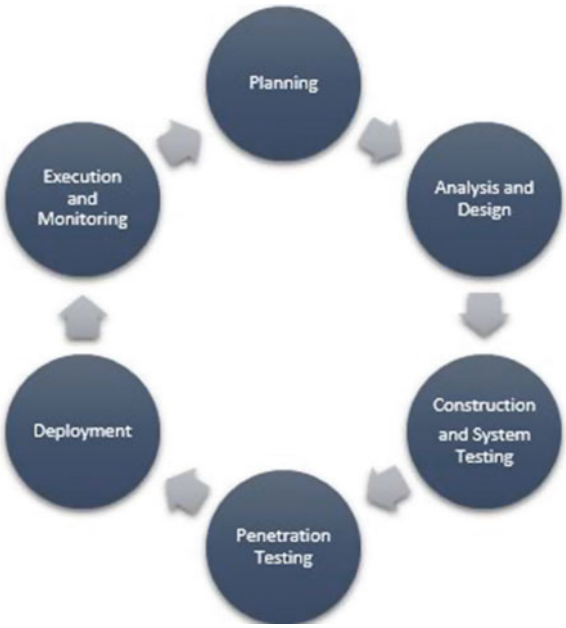


Fig. 2 Proposed web service development cycle

2.3 Construction and System Testing

This is the actual development phase where we develop the business logic of the application and do various systems testing on it.

2.4 Penetration Testing

This is an additional development phase to implement security features in Web Service Development Lifecycle.

2.5 Deployment

Once the Web Service is properly testing and is free from all known flaws and vulnerabilities, we deploy it over the network to be used by Service Requesters.

2.6 Execution and Monitoring

In the end Monitoring about the execution of web services is the maintenance phase of it where we monitor the service and keep on maintaining it.

3 Top Vulnerabilities in SOAP Web Services

The web application-specific vulnerabilities are identified in OWASP top 10 for web application, top 5 of those are:

1. Injection
2. Cross Site Scripting (XSS)
3. Broken Authentication and Session Management
4. Insecure Direct Object References
5. Cross Site Request Forgery (CSRF) [3].

Most of the Vulnerabilities for Web Application also exist on Web Services except for few like, cross site scripting in XML.

In this paper, we will discuss about the most found and most critical vulnerabilities found in Web Services.

4 Methodology

We will use two tools mainly to Pen-Test Web Services for Various Vulnerabilities, SOAP UI and Burp Suite.

SOAP UI: SoapUI is an open-source web service testing application it is used to test SOAP (Simple Object Access Protocol) and REST (REpresentation State Transfer), it is used to invoker various Web Services and do functional Service and other System Testing on them [4].

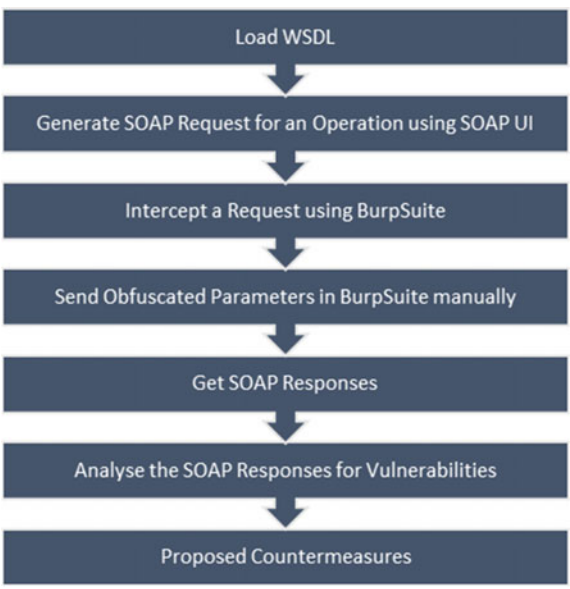


Fig. 3 Penetration testing process

Burp Suite: Burp Suite is an integrated platform for performing security testing of web applications. It acts as an interceptor and Intercepting every requests that goes through its proxy address. Giving us various features such as intruder, repeater, spider, sequencer, decoder, comparer, extender, etc., which can be used to penetration testing of web applications as well as web services [5].

At the time of this study, SOAP UI 5.2.1 and Burp Suite 1.7 version is used. Soap UI is used to generate a SOAP Request which is captured by Burp as an intercepting proxy and then Pen testing is done using burp. We Parse the WSDL file using SOAP UI and use the parse WSDL and its methods to send SOAP Requests to the web service. In SOAP UI and Web Browser set the proxy to manual and point it to 127.0.0.1 port 8080 for the burp to intercept it.

The process can be described by this process diagram represented in Fig. 3.

5 Analysis for Vulnerabilities

5.1 Injection

Injection is one of the most critical vulnerability that occurs in any web application or web service it may be in form of a command line injection or a SQL injection depending on the type of function backend is using. SQL injection is generally found in the places where the developer is directly putting the input string into an SQL query and fetching the results without any parsing or checking. In order to exploit this, a Black Box tester just needs to balance the query. For command line injection instead of a database the query must be fetching from a shell.

We tested a Web Service where the request is generated to check the username and print out its signature. The Query that runs in the backend is

Select * from username where username = “<the input parameter>”;

```
<...>
        <...>
<accounts message="Results for admin ">
<account>
<username>Guest</username>
<signature>Welcome Guest</signature>
</account>
</accounts>
</...>
</...>
```

Supposing this is the soap request that is generated to which the SOAP reply is

```
<…>
<…>
<urn:getUser
soapenv:encodingStyle="http://schemas.xmls
oap.org/soap/encoding/">
<username xsi:type="xsd:string"> Guest
</username>
</urn:getUser>
</…>
</…>
```

We can analyze the logic of this approach and can conclude that this application is getting user input from the SOAP request in XPath = //urn:getUser/username

This username is then looked in the database and if found it is reflected back in the SOAP response under XPath = //ns1:getUserResponse/return/accounts/account

So just putting an injection parameter in Request simple 'will give me the backend logic of an SQL. So now if we send the parameter as Guest 'we will get MySQLHandler → doExecuteQuery('SELECT username…')

#1 /classes/SQLQueryHandler.php(297): MySQLHandler → executeQuery ('SELECT username…')

Resulting in an SQL injection.

Now since we know that there is SQL Injection we can get useful information from there after balancing the SQL query. After few hit and trials admin' or 1='1 – balanced the SQL query resulting in disclosure of all the values in the database.

The SOAP Request

```
<…>
<…>
<urn:getUser
soapenv:encodingStyle="http://schemas.x
mlsoap.org/soap/encoding/">
<username xsi:type="xsd:string">admin' or
1='1 -- </username>
</urn:getUser>
</…>
</…>
```

Yielded the results which showed our database results,

```
<...>
<...>
<ns1:getUserResponse xmlns:ns1="urn:ws-user-account">
<return xsi:type="xsd:xml">
<accounts message="Results for admin' or 1='1 --  ">
<account>
<username>admin</username>
<signature>test@123</signature>
</account>
<account>
<username>adrian</username>
<signature>user1@321 </signature>
</account>
<account>
<username>john</username>
<signature>user2@123</signature>
</account>
</return>
</ns1:getUserResponse>
</...>
</...>
```

5.2 Command Injection

Command Injection is caused when the Web Service uses shell prompt to fetch the result and return it back to the Response. Command Injection can be achieved by appending a shell command with the normal request. Ways to achieve shell injection.

```
<...>
<soapenv:Body>
<urn:lookupDNS
soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
>
<targetHost xsi:type="xsd:string">anywebsite.com</targetHost>
</urn:lookupDNS>
</soapenv:Body>
</...>
</...>
```

There is a web service to lookup the DNS records of a website using the command nslookup in the bash shell.

In this the value of Xpath = //urn:lookupDNS/targetHost will fetch the nslookup from a command line, if we append the parameter; uname, therefore the SOAP Request now will be

```
<…>
<…>
<urn:lookupDNS
soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
<targetHost xsi:type="xsd:string">anywebsite.com; uname -a </targetHost>
</urn:lookupDNS>
</…>
```

This will result in response like

```
<…>
<…>
<ns1:lookupDNSResponse xmlns:ns1="urn:commandinjwsdl">
<Answer xsi:type="xsd:xml">
<results host="anywebsite.com; uname -a ">Server:          192.168.137.2
Address:192.168.137.2#53
Non-authoritative answer:
Name:   google.com
Address: 216.58.220.206
Linux ubuntu 2.6.32-25-generic-pae #44-Ubuntu SMP Fri Sep 17 21:57:48 UTC
2010 i686 GNU/Linux</results>
</Answer>
</ns1:lookupDNSResponse>
</…>
<…>
```

Thereby, we saw that we can pass any shell arguments in the web service, which may even result in passing a Netcat request and receiving a shell of that host remotely.

Countermeasures Injections attacks can be countered by determining the application's entry points and validating the input at each location that is in front end, middleware, and backend all. There should also be Input Validation Strategy like encoding, sanitization, etc.

5.3 Broken Authentication and Session Management and Insecure Direct Object References

These vulnerability are found when there is lack of session management in the code and there is no or lack of AAA implementation that is Authorisation, Authentication and Accounting. Authorisation means what a user can access; Authentication means who can access and Accounting means how much can a user access. For IDOR vulnerabilities the web service when sends a SOAP Request there is no token or a unique identifier, thereby an attacker can easily fabricate a web service Request by simply changing the parameter or using the recovery methods available in a web application.

We took a web service that sent the name of the user and fetched the signature of it from the SOAP Requests parameters.

```
<...>
<...>
<username xsi:type="xsd:string">admin </username>
</...>
</...>
```

As we can see there is no session management, post-capturing the request into the burb suite and changing the parameter of //urn:getUser/username we can get details of users for whom we are not authenticated and authorized to have access to.

```
<...>
<...>
<urn:getUser
soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
<username xsi:type="xsd:string">bobby </username>
</urn:getUser>
<...>
</...>
```

Now the response will become

```
<…>
<…>
<ns1:getUserResponse xmlns:ns1="urn:ws-user-account">
<return xsi:type="xsd:xml">
<accounts message="Results for bobby">
<account>
<username>bobby</username>
<signature>Hank is my dad</signature>
</account>
</accounts>
</return>
</…>
</…>
```

Countermeasures Strong Authentication mechanism like password digests, Kerberos tickets, SSL, and payload encryption or even digital signatures to prevent data tempering should be implemented.

5.4 Malformed XML

This type of attack can be made possible by inputting XML inputs in the parameters of web services that they are parsed by the XML parser without any fault yet yield with results which are not authorized to the user.

A Web Service that changes the username and password of

```
<…>
<…>
<ns :login>
<username> admin</ns:username>
<ns:password> testingsoap </ns:password>
<ns:/login>
</…>
</  >
```

If the parameter //ns:login/username and /password is changed to

```
<...>
<...>
<ns :updatePass>
<username> admin < - - </ns:username>
<ns:password> testingsoap - - ><ns:password>soapnewpass </ns:password>
<ns:/updatePass>
<...>
</...>
```

This SOAP Request will be parsed perfectly by an XML parser and will yield in XML Malformed attack vector.

Countermeasures To prevent malformed XML attacks we can specify the size and schema via DTD or XSD, or simply Validation and Encoding all the inputs and outputs.

6 Conclusion and Future Work

At present, penetration testing is not being considered as a testing phase in development lifecycle but as the awareness toward attackers is increasing, industries are implementing penetration testing specially as a Black Box testing methodology or hiring third party companies to do it for them. In this study, top SOAP vulnerabilities have been discussed and methodologies on how to exploit them has been explained with the help of Open-source/freeware tools which can be implemented by an individual or a company with very minimal cost. The advantage of Black Box approach is that it provides a real-life scenario of an attacker with malicious intent and provides dynamic vulnerabilities. Even though there is WS-Security standards of OWASP but even encrypting and adding security tokens like those in WS-Security cannot prevent from attacks like Injections.

Table 1 Countermeasures of web service attacks

Attack vector	Vulnerable point	Countermeasures
SQL injection	SQL parameter	Login validation
Command line injection	XML parameter	Response validation
Broken authentication and IDOR	Parameter	Strong authentication mechanisms
XML malformed	Parameters	Size, schema validation and encoding

Therefore, Black Box penetration Testing should also be considered in Web Service Development Life cycle before deploying any web service, since web services are pokes in your firewall to allow data transfer to any third party, therefore security measures must be taken before deploying such a crucial service over the network as shown in Table 1.

Future work may be extended toward the vulnerabilities of REST or JSON API'S in Web Service Penetration Testing.

Refrences

1. Ashish Kumar Dwivedi, Santanu Kumar Rath "Incorporating Security Features in Service-Oriented Architecture" in ACM SIGSOFT Software Engineering Notes January 2015 Volume.
2. Nuno Antunes, and Marco Vieira "Comparing the Effectiveness of Penetration Testing and Static Code Analysis on the Detection of SQL Injection Vulnerabilities in Web Services" in Dependable Computing, 2009. PRDC '09. 15th IEEE Pacific Rim International Symposium on 2009.
3. Adnan Massod, Jim Java "Static Analysis of Web Service Security—Tools and Techniques for a Secure Development Life Cycle" in Technologies for Homeland Security (HST), 2015 IEEE International Symposium on 2015.
4. SOAP UI Wiki [Online] Available: https://en.wikipedia.org/wiki/SoapUI.
5. Portswigger Web Security [Online] Available: https://portswigger.net/burp/.
6. OWASPTesting Guide v4 Available: https://www.owasp.org/images/1/19/OTGv4.pdf.
7. OASIS Web Service Security SOAP Message Security 1.1, OASIS Standard Specification 2006.
8. Nuno Antunes, Marco Vieira, "Enhancing Penetration Testing with Attack Signatures and Interface Monitoring for the Detection of Injection Vulnerabilities in Web Services" in IEEE International Conference on Services Computing, 2011.
9. Christian Mainka, Juraj Somorovsky and Jörg Schwenk, "Penetration Testing Tool for Web Services Security", IEEE Eighth World Congress on Services 2012.
10. Alex Stamos, "Attacking Web Services", OWASP APPSEC DC 2005.

Analysis of Software Repositories Using Process Mining

Roohi Arora and Anchal Garg

Abstract Software repositories such as Issue Tracking Systems (ITS) log bug history that contains important information about the activities followed during bug resolution. Mining of ITS can provide useful insights of such processes. This study uses process mining to extract knowledge from the event logs recorded in bug history report of ITS Monorail to determine the as-is process model. This study will help in identifying the kind and source of inefficiencies and inconsistencies and eventually help improving the software bug resolution process.

1 Introduction

Software repositories such as Issue Tracking Systems (ITS), peer code review systems, and version control subsystems store trails of different software development activities. The bug history of the ITS database includes unique identification number of the bug, its publisher, priority, status, state, different dates, summary and labels, programmers working on a bug and operating system in which it occurs. ITS follows a defined sequence of activities through its lifecycle from the time it is first reported to when it is closed, viz. unconfirmed, untriaged, assigned, started, fixed, reopened, and verified. Mining ITS will help us identify the sequence of activities actually followed by programmers while resolving a bug and thus help us in identifying the lacunas and improve the process of resolving the issue. Such study can be a step to improve the overall process quality for best software engineering practices. Process Mining is one of the techniques that can provide useful insights into the quality of the process and aid as an assessment tool of ITS process.

R. Arora (✉)
Accenture Solutions Private Limited, Pune, Maharashtra, India
e-mail: roohi9arora@gmail.com

A. Garg
Department of Computer Science & Engineering, Amity School of Engineering & Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: agarg@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_65

The interest in the area of Mining Software Repositories (MSR) has gained significant importance by researchers over past few years. Poncin [1] first used process mining to discover process map by combining events from different repositories. Sunindyo [2] analyzed bug reporting system of Red Hat Enterprise limited and performed conformance checking for process improvement. Gupta and Surekha [3] mined the bug report history of open source project such as Firefox and Mozilla to study process inefficiencies. Gupta et al. [4] analyzed multiple repositories such as ITS, peer code review subsystem and version control subsystem to improve software defect resolution process. Similarly, a study was conducted by Zimmermann et al. [5] on Windows operating system to categorize probable causes of reopened bugs.

Lately, a lot of work had been done by researchers to process mine software configuration management activities [6, 7] but no work has been performed on the ITS of Google Chromium. Hence, it is worthwhile to study the process from this repository and derive useful insights. One of the widely accepted web browser viz Google Chrome, derives its source code from Chromium. This work conducts in depth analysis of the event logs of ITS repository of Google Chromium.

The motivation behind this study is to mine the bug history of ITS to identify the bug resolution process. This study will help us provide useful insights into the process which can aid in identifying whether the sequence of activities is performed as desired or are there any inefficiencies and inconsistencies. In case of lacunas, the study will help us determine the kind and source of inefficiencies, thus providing us a roadmap on resolving such concerns in future. The kind of analysis will might help in improving the efficiency and productivity of the process.

This paper is structured as follows: Sect. 2 gives the details of the dataset adapted for conducting the study, Sect. 3 discusses the details of the work done, Sect. 4 presents and discusses the results of the experiment.

2 Experimental Dataset Adapted

This paper uses Google Chromium's Monorail Issue Tracker for the study. The details of experimental dataset used for the study are given in Table 1.

Table 1 Details of the dataset used for experiment

Attribute	Value
First issue creation date	8 April 2015
Last issue creation date	18 February 2016
Date of extraction	28 February 2016
Total issues extracted	23,826
Range of issues	475,000–525,000
Total number of events	77,752

3 Simulation Model

This research framework has four different stages Data Extraction, Data Cleaning, Process Mining and Process Analysis.

Data Extraction: Python script was used to extract trails from the ITS of Google Chromium. Details of issues extracted are given in Table 1. A trail contains all the information associated to a particular issue. Open and closed issues are considered for analysis in this study.

Data Cleaning: Only relevant attributes such as issue ID, status, updated time, closed date, and actors (resources) were selected for analysis. The comments that depicted the progress of the work done on the issues were extracted and appended. Missing values (NULL) and inconsistencies if any were removed. An initial state *REPORTED* was created for all the issues based on attributes such as Published Time and Owner. Finally, the final event log was obtained with attributes such as timestamp, issue id, activity and resource associated with that issue.

Process Mining: Process Mining was performed for analyzing the event logs of ITS using DISCO tool. Generated event log were mined from multiple perspectives to derive insightful process maps of the ITS process Discovered process maps were further analyzed to scrutinize the performance of the developers, productivity of the process and list the shortcoming so that its overall performance and efficiency could be enhanced. Process Mining ITS of Google Chromium will assists developers to become familiar with the development process, its progress, obstacles and challenges. It will also reveal what developers are actually doing in contrast to what they claim they have been doing.

Process Discovery: The discovered process map is presented in Fig. 1. Edges between the activities represent transition between the activities in a process. Frequency of transition is indicated on the edge. Darker edge corresponds to more frequent transition in contrast to lighter edge signifying less frequent transition.

4 Results and Analysis

The process map generated for the ITS repository was analyzed, initially to determine the frequency of each activity. Table 2 present the results of activity frequency analysis.

Activity Frequency Analysis: For all 23,826 issues *Reported* is the initial activity. A significant number of bugs have been fixed as reported by *Fixed* activity. However, the frequency of issues being *Verified* is apparently low indicating that issues are being fixed but are not being *Verified* either by the tester or by the person who initially *Reported* that issue. This probably indicates a loophole in the system. Thus, once the issue is *Fixed*, it should prompt its owner or the tester to verify the resolved issue and assign *Verified* status, if it works well or *ReAssigned* if it is unresolved. The frequency of *Wontfix* is comparatively high which is undesirable.

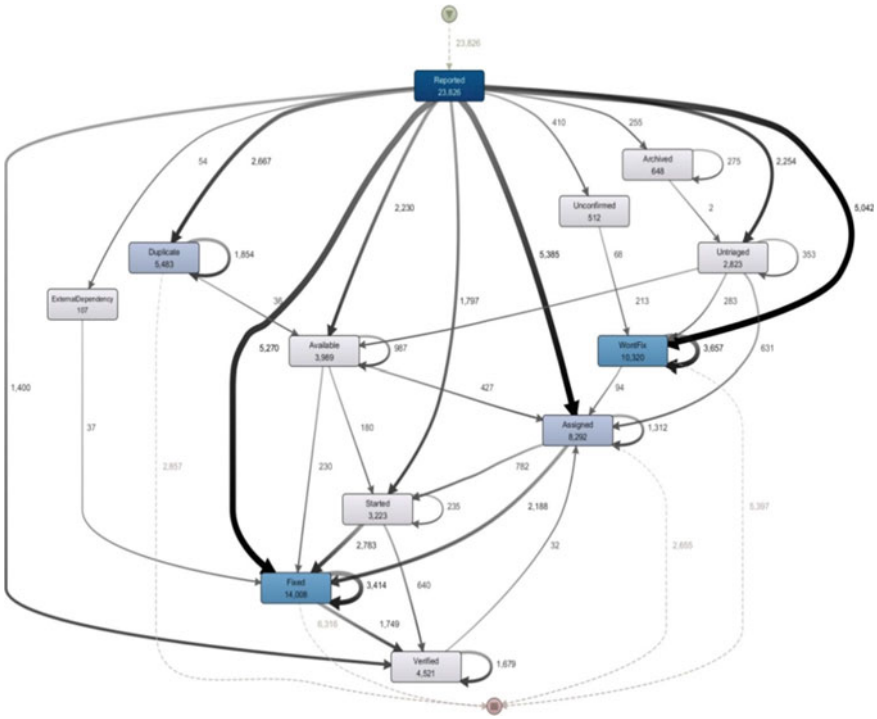


Fig. 1 Process map of ITS of Google Chromium with labeled absolute frequency

Table 2 Activities and their relative frequency

Activity	Relative frequency (%)	Frequency
Reported	30.64	23,826
Fixed	18.01	14,008
Wontfix	13.27	10,320
Assigned	10.67	8,294
Duplicate	7.05	5,483
Verified	5.81	4,521
Available	5.13	3,991
Started	4.14	3,223
Untriaged	3.63	2,824
Archived	0.83	648
Unconfirmed	0.66	512
Ext. dependency	0.14	107

A detailed analysis revealed that the programmers are reworking on the issues that cannot be *Fixed*. Further, many activities developers are reworking on the issues that have been resolved earlier as indicated by *Duplicate* status. Thus, during assignment additional information should be provided for issues already marked

Duplicate. This would save the efforts of developers and thus reduce organizational cost. Many issues are still *Available* after being assigned priority and being *Confirmed* which is again not an efficient practice. *Untriaged* status of the issues is a matter of concern as the developers may be fixing issues having low priority when there high priority issues lined up. Few issues have *Unconfirmed* status, but this can be mended if it is *Confirmed* as soon as an issue is *Reported*, sooner it is *Confirmed* and *Triaged* sooner it is in the hands of developer. Very few issues have *External Dependency* as their status which is good for our process.

Event Frequency Analysis: An analysis of event frequency revealed various loopholes. First, 3/23826 events have frequency 1, indicating that the issue is *Reported* but no further event/activity is performed on it and that is a matter of concern. Although the number is too low but such a practice should be avoided as the issue may be of high priority and severity which might reduce the quality of the product or may appear in later stages of development and cost huge to the development team and organization. Second, in few cases *Fixed* issues are being reassigned. Such issues are reopened several times as the root cause of the issues might not be clear. This has caused delay of 273 days. If we analyze the event frequency of closed issues which have been *Fixed* and *Verified* there do 8714 cases with 30,668 events constitute 36% of the total cases and 42% of the total events. However, many of these issues are restarted and reassigned and do not adhere to the process but they are eventually *Fixed* and *Verified*. Numbers of events range from 3 to 16.

Variant Analysis: For 23,826 cases, 757 unique variants were obtained. Most frequent variants are listed in Table 3.

Top 4 variants cover 38% of the total cases and 33% of the total events. Majority of the variants have self loop, i.e., the activity is repeated twice. It may be assumed that the developers might not be sure of their decision that is delaying the final issue resolution. Variant analyses reveal that many issues are being reassigned status (*Fixed*/*Wontfix*/*Duplicate*) after 300 or more days.

Analysis of Issues with Different Priority: Issues in chromium ITS needs to triage with different priorities depending upon their effect the software evolution process. Issues can be assigned one of the following priorities:

Priority 0: Requires Quick resolution
Priority 1: High impact issues
Priority 2: Low impact issues
Priority 3: Can be resolved anytime

Table 3 Most frequent variants in the process

S. No.	Variant	Percentage (%)
1.	*Reported→Wontfix→Wontfix*	37.78
2.	*Reported→Fixed→Fixed*	28.24
3.	*Reported→Duplicate→Duplicate*	19.19
4.	*Reported→Assigned*	14.79

Further analysis was conducted to identify how the developers handled the issues with different priorities. We looked for the answers to following questions: (i) Are the issues served on the basis of their priority? (ii) Do developers fix problems as per their importance? (iii) To what extent the process followed comply with the specified process.

An analysis indicates that the issues are resolved as per their priority levels. Priority 0 and Priority 1 issues are resolved quickly. However, it is also observed that though the issues are assigned *Fixed* status after resolution, not all of them are *Verified.* Mean case duration of such cases is 67.1 that are undesirable. On the other hand, issues at Priority 2 and Priority 3 have a delayed response from the resolvers. Although these issues are not of much importance to the current release but they can affect functionality in the upcoming releases. Mean case duration of issues with Priority 2 was 64.9 days and that with Priority 3 is 84.7 days. Analysis also reveals that 23 issues were assigned invalid priority such as 4, 21, etc. This indicates that there should be a check while setting the priority of the issue.

The analysis provides vital insights into the bug resolution process. This study has falsified our conception that the process followed during bug resolution is satisfactory. As-is process model revealed that the sequence of activities followed is not as assumed. The developers either skip or duplicate some of the activities. The issues once *Fixed* were again *Assigned* thus wasting efforts of the software developers and adding to the organizational cost. Few cases were trapped in between causing delays in resolving the issue. Some cases were *Reported* but not *Assigned* to anyone. Few issues were not assigned priorities causing a risk of an important and severe issue not being resolved on time. The analysis indicates inefficiencies and inconsistencies in the process thus adding to the expenses of the organization. Such analysis may be used by Chromium team to remove the inefficiencies and improve the process. This will both save the efforts of the development team and help manage the organizational cost and reputation.

5 Conclusion

In this paper, detailed analysis has been performed on the ITS of Chromium. The paper provides insights on how process mining of software repositories can help unveil useful insights into the software development activities. If the organizations adopt an approach to continuously monitor their software repositories, they can gain useful insights of their processes. Such practice would improve the quality of the processes thereby reducing overall operational cost of the software development that is incurred by the organizations.

References

1. Poncin, W., Serebrenik, A., Brand, M.V.D.: Process Mining Software Repositories. In: 15th European Conference on Software Maintenance and Reengineering, pp. 5–14. IEEE, Germany (2011).
2. Sunindyo, W. Moser, T. Winkler, D., Dhungana, D.: Improving Open Source Software Process Quality Based on Defect Data Mining. In: Biffl, S. Winkler, D. and Bergsmann, J. (eds.) LNBIP, vol. 94, pp. 84–102. Springer Berlin Heidelberg (2012).
3. Gupta, M., Surekha, A.: Nirikshan: Mining Bug History For Discovering Process Maps, Inconsistencies and Inefficiencies. In: International Conference on Software Engineering, pp. 1. ACM, Chennai (2014).
4. Gupta, M. Surekha, A., Padmanabhuni, S.: Process Mining Multiple Repositories for Software Defect Resolution from Control and Organizational Perspective. In: Proceedings of the 11th Working Conference on Mining Software Repositories, pp. 122–131. ACM, Hyderabad (2014).
5. Zimmermann, T. Nagappan, N. Guo, P.J., Murphy, B.: Characterizing and Predicting which Bugs Get Reopened. In: Proceedings of the 34th International Conference on Software Engineering, pp. 1074–1083, IEEE, Zurcih (2012).
6. Kagdi, H., Collard, M. L., Maletic, J. I.: A survey and taxonomy of approaches for mining software repositories in the context of software evolution. Journal of software maintenance and evolution: Research and practice. 19(2), 77–131 (2007).
7. Chen, T. H., Thomas, S. W., Hassan, A. E.: A survey on the use of topic models when mining software repositories. Empirical Software Engineering, 21(5), 1843–1919 (2016).

Predictive Analytics for LAMA and Absconding Behaviour of Patient

Roopal Chaudhary, Anchal Garg and Madhulika Bhadauria

Abstract The absconding behaviour of a patient or leaving the hospital against medical advice is a matter of concern as in the both situations it might create risk for the patients, the people around them and for the hospital. This study predicts various factors responsible for absconding and LAMA cases with purpose to reduce the chances of their occurrence. Various classification techniques were used for the prediction and the comparison of classifier is done on the basis of their performance. Age, gender, sponsored category, ward and doctor were observed as significant factors associated with such cases. This study will help the hospital in early detection of such patients and reduce the occurrence of these events. Thus, it will help the hospital in improving the health and saving the life of patients of such cases.

1 Introduction

Every hospital aims to provide the best quality treatment to their patients but they have to face challenges where the patients either leave the hospital against medical advice or abscond. Though the rates for LAMA and absconding are infrequent but they affect the well-being of patients as well as the reputation of the hospital. Leave Against Medical Advice (LAMA) means when a patient leaves the hospital premises against medical advice but with the official permission for discharge. The patient is referred as absconding when he/she escapes from the hospital without

R. Chaudhary (✉) · A. Garg · M. Bhadauria
Department of Computer Science & Engineering, Amity School of Engineering & Technology, Amity University Uttar Pradesh, Noida, Uttar Pradesh, India
e-mail: roopal1@amity.edu

A. Garg
e-mail: agarg@amity.edu

M. Bhadauria
e-mail: mbhadhauria@amity.edu

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8_66

taking any official permission from the hospital staff [1, 2]. Therefore, there is a need of to reduce such cases for well-being of the patients and benefit of the hospitals.

Various studies have been conducted to determine the factors responsible for LAMA and absconding behaviour of patients. Previous studies are mostly targeted towards the detention cases for mental illness and substance abuse [1–8]. For mental illness, drug abuse and alcohol the rate of LAMA and absconding were comparatively high (approx. 12–20%) [5, 9–11]. Different studies have identified diverse factors such as demographics [4, 10], duration of stay [1, 4], type of wards [12], time [7] and psychological issues [12–15], treatment cost [16–18] to be responsible for such behaviour [4, 10]. It is found that young males are most likely to demonstrate such behaviour [12, 19, 20]. It is observed that patient showing absconding behaviour tend to harm self or others around them [16–18].

Existing studies are mostly limited to mental illness [1, 4, 10, 21, 22]. Also, such studies are conducted in countries such as Australia, Canada and UK but there is hardly any study performed on Indian hospitals. The researches in India are again focused on mental hospitals. Furthermore, previous studies are majorly targeted towards identifying the factors affecting LAMA and absconding behaviour of patients but none have developed the predictive model for early detection of such cases. This paper provides a predictive model for determining the patients with potential to demonstrate such behaviour.

The paper is structured as follows: Sect. 2 discusses the research methodology adopted for the study, Sect. 3 presented the results of the analysis and Sect. 4 gives the detailed discussion.

2 Research Methodology

This study was conducted on a multi-speciality hospital located in Delhi-NCR. 5,223 detention cases were recorded between January 2013 and July 2016. Of those, there were 257 cases (4.92%) of LAMA and 18 cases (0.34%) of absconding. This study uses predictive analytics modelling to predict the variables responsible for LAMA and absconding. Logistic regression, decision tree and neural network models were used and compared to find suitable model.

Data Pre-Processing: No missing and inconsistent values were recorded in the dataset. Irrelevant attributes such as patient name and bed number were omitted.

Predictive Variables for Modelling: Chi-square test confirmed that all the attributes were significant for the analysis (Table 1).

Defining Target Variables: LAMA/absconding status was taken as a target variable for classification.

Predictive Modelling and Evaluation: For this research, the predictive modelling is done using: (a) Logistic Regression: For the prediction, the probability of occurrence of an event is calculated using previous information. In this study, the null hypothesis is an attribute is not associated with LAMA and absconding event

Table 1 List of variables used for predictive modelling with their description

#	Variable name	Type	Description
1	Admission date	Date and time	Admission date and time
2	Discharge date	Date and time	Discharge date and time
3	Age	Numeric	Age of the patients
4	Gender	Nominal	Gender of patient: male, female
5	Doctor name	Text	The doctor who treated the patient (name kept anonymous)
6	Specialization name	Text	Specialization is an area under which patient diagnosis falls
7	Sponsor	Text	Sponsorship provided to patient for treatment
8	Ward	Text	Patient stay during the detention period
9	LAMA status	Nominal	Status of a patient: if it was a LAMA case or not (values: yes, no)
10	Absconding status	Nominal	Status of a patient: If it was an absconding case or not (values: yes, no)
11	IP days	Numeric	Total number of days of detention period

and alternate hypothesis is an attribute is significant and associated with such cases. Higher p-value are not significant as they shows respective variables are not associated with dependent variable so the p-value < 0.05 are only considered as they shows significant relationships which depicts the alternate hypothesis is true. (b) Decision Tree: A decision tree is a model with tree or a graph like structure which is used to represent solutions based on the decision. It is a flowchart kind of decision support tool which uses classification rules, in which the internal nodes tests on the variables and further branches represent the solutions of the test after computing for the variables. Leaf node is the end node which represents the decision generally represented by the triangle. (c) Neural Network: Neural networks is also the one of the predicting modelling approach which can easily learns from the example set. It can easily find out the hidden dependencies even if there is presence of noise in the training set. The neural network can be easily trained with the historical data and based on that the nonlinear dependencies can be easily discovered unlike in regression. And these dependencies are used for the prediction in future.

The most important thing in modelling is to evaluate the performance of these models as it helps to decide which model is best. There are different measures which shows the performance of the model such precision, recall, accuracy and the area under ROC curve.

3 Results

Analysis of classifiers: The comparison of the three models viz. logistic regression, decision tree and neural network) revealed that the logistic regression model is more accurate with higher value of AUC for both LAMA and absconding as shown in Tables 2 and 3.

Demographic features of patients and hospital (Predicted by Logistic Regression):

(a) Age: For both cases, patients in the age group of early 20–30 s are more likely to show such behaviour. 36.18% of LAMA and 38.88% of absconding cases are in this age group.
(b) Gender: Female patients were predicted as significant feature associated with LAMA (p-value = 0.015) and absconding cases (p-value = 0.02). Therefore, female patients are more likely to be associated with risk factor.
(c) Ward: Ward NICU (p-value = 0.002) for LAMA and Ward Deluxe general ward 205 (p-value = 0.04) for absconding were found to be strongly related.
(d) Sponsor: For LAMA cases, sponsored patients were most likely to leave in comparison to non-sponsor patients (p-value = 0.01).
(e) Doctor Name: The logistic regression model shows this variable significant only with the occurrence of absconding events but not for the LAMA cases. The model predicted three doctors which are associated with absconding events: Doctor A (p-value = 0.007), Doctor B (p-value = 0.02) and Doctor C (p-value = 0.04) with respective specialization: gynaecology, paediatric and general medicine (Doctor name is kept anonymous).

Table 2 Comparison of classifiers for LAMA

Classifier	Precision (%)	Recall (%)	Accuracy (%)	Area under ROC (AUC)
Logistic regression	17.45	26.07	90.20	0.757
Decision tree	7.69	7.79	90.01	0.672
Neural network	10	2.50	89.85	0.621

Table 3 Comparison of classifiers for absconding

Classifier	Precision (%)	Recall (%)	Accuracy (%)	Area under ROC (AUC)
Logistic regression	0.40	0.20	99.40	0.756
Decision tree	0.26	0.54	90.06	0.653
Neural network	0.40	0.05	99.31	0.656

4 Discussion

This study is based on multi-speciality hospital having comparatively higher cases of LAMA (4.92%) and lower cases of absconding (0.34%). Previous studies have reported lower cases for LAMA (1–2%) [10, 11, 19], while higher for absconding (11–13%) [9, 16, 20, 23, 24]. For age group, the results match the previous studies [10, 12, 24]. Previous studies show that the male patients are at higher risk of showing such behaviour [12, 18–20, 24] but logistic regression model predicted female patients are more likely to demonstrate these behaviours. The sponsored and non-sponsored results indicate that probably patients with sponsored category are less concerned about money. More cases might have been reported for NICU (Neonatal Intensive Care Unit) might be similar to as reported in earlier study [25]. Ward deluxe general ward 205 which is predicted for Absconding events may have the possible reasons such as not liking the surrounding, feeling isolated and bored as reported in earlier study [12]. Many times, patient abscond as they do not like the treatment style, lack of communication, fear for surgical operation so the doctors cannot be assumed directly responsible for such cases as predicted by the model in this study under another demographic variable doctor.

5 Conclusion

This study determines various factors responsible for LAMA or absconding behaviour of the patients. The predictive model provided in this study could be used by the hospital for early detection of such cases. Such a model will help the hospital reduce or totally avoid such cases for both the benefit to the patient and the hospital.

Acknowledgements Authors would like to thank the hospital for providing the data and helping out with the queries.

References

1. Lal, Narottam, Sethi, B. B., Manchanda, R., Sinha, P. K. A Study of personality and related factors in absconders in a psychiatric hospital. Ind. J. Psychiat. 1977; 19, 51.
2. Jones AA, Himmelstein DU. Leaving a county hospital against medical advice. JAMA 1979; 242: 2758.
3. R. Antebi. Some Characteristics of Mental Hospital Absconders. The British Journal of Psychiatry 1967; 113 (503) 1087–1090.
4. C. J. John, B. N. Gangadhar, S. M. Channabasavanna. Phenomenology of Escape from Mental Hospital in India. Indian J. Psychiat. 1980; 22, 247–250.
5. Jeffer EK. Against medical advice: Part I, A Review of the Literature. Mil Med 1993; 158: 69–73.

6. Muir-Cochrane, E. & Mosel, K. Absconding: A review of the literature 1996–2008. International Journal of Mental Health Nursing 2008; 17, 370–378.
7. Muir-Cochrane, E. & Mosel, K. Research in brief: A retrospective analysis of absconding behaviour by psychiatric inpatients in one psychiatric hospital campus in Australia. Journal of Psychiatric and Mental Health Nursing 2010; 16, 211–213.
8. Moyse HS. Discharges against medical advice: a community hospital's experience. Can J Rural Med 2004; 9: 148–153 Franks P, Meldrum S, and Fiscella K. Discharges against medical advice: Are race/ethnicity predictors? J Gen Intern Med 2006; 21: 955–960.
9. Bowers, L., Jarrett, M. & Clark, N. Absconding: A literature review. Journal of Psychiatric & Mental Health Nursing 1998; 5, 343–353.
10. Smith DB, Telles JL. Discharges against medical advice at regional acute care hospitals. Am J Public Health 1991; 81:212–215.
11. Franks P, Meldrum S, and Fiscella K. Discharges against medical advice: Are race/ethnicity predictors? J Gen Intern Med 2006; 21: 955–960.
12. Bowers, L., Jarrett, M., Clark, N., Kiyimba, F. & McFarlane, L. Absconding: How and when patients leave the ward part 2. Journal of Psychiatric and Mental Health Nursing 1999a; 6, 207–211.
13. Brook M, Hilty DM, Liu W, Hu R, Frye MA. Discharge against medical advice from inpatient psychiatric treatment: A literature review. Psychiatric Services 2006; 57: 1192–1198.
14. Saitz R. Discharges against medical advice: Time to address the causes. CMAJ 2002; 167: 647.
15. Dickens, G. L. & Campbell. Absconding of patients from an independent UK psychiatric hospital: A 3-year retrospective analysis of events and characteristics of absconders. Journal of Psychiatric and Mental Health Nursing 2001; 8, 543–550.
16. Bowers, L., Jarrett, M., Clark, N., Kiyimba, F. & McFarlane, L. Absconding: Outcome and risk part3. Journal of Psychiatric and Mental Health Nursing 1999c; 6, 213–218.
17. Meehan, T., Morrison, P. & McDougall, S. Absconding behaviour: An exploratory investigation in an acute inpatient unit. Australian and New Zealand Journal of Psychiatry 1999; 33, 533–537.
18. Kraut et al. A population-based analysis of leaving the hospital against medical advice: incidence and associated variables. BMC Health Services Research 2013; 13:415.
19. Bowers, L., Jarrett, M., Clark, N., Kiyimba, F. & McFarlane, L. Determinants of absconding by patients on acute psychiatric wards. Journal of Advanced Nursing 2000; 32(3), 644–649.
20. Saitz R, Ghali WA and Moskowitz MA. Characteristics of patients with pneumonia who are discharged from hospitals against medical advice. American Journal of Medicine 1999; 107; 507–509.
21. Tawk R, Freels S, Mullner R. Associations of mental, and medical illnesses with against medical advice discharges: the national hospital discharge survey, 1988–2006. Adm Policy Ment Health 2013; 40:124–132.
22. Carr, V.J., Lewin, T.J., Sly, K.A.et al. Adverse incidents in acute psychiatric inpatient units: Rates, correlates and pressures. Australian and New Zealand Journal of Psychiatry 2008; 42 (4), 267–282.
23. Khisty, N., Raval, N., Dhadphale, M., Kale, K. & Javadekar. A prospective study of patients absconding from a general hospital psychiatry unit in a developing country. Journal of Psychiatric and Mental Health Nursing 2008; 15, 458–464.
24. Farragher, B., Gannon, M. & Ahmad. Absent without leave: Can we predict those who go AWOL? Irish Journal of Psychological Medicine 1996; 13, 28–30.
25. Al Jurayyan NM, Al Nasser MNS. Children's discharge against medical advice: Is it a problem? Saudi Medical Journal 1995; 16: 391–39.

Author Index

S.C. Satapathy et al. (eds.), *Smart Computing and Informatics*, Smart Innovation, Systems and Technologies 78, https://doi.org/10.1007/978-981-10-5547-8