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Amit Kumar
Stefan Mozar *Editors*

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About This Book

This book comprises selected articles from the 2nd International Conference on Communications and Cyber-Physical Engineering (ICCCE) 2019, held in Pune, India, in 2019. It offers papers and cutting-edge research results related to machine learning/AI and its networked applications, wireless/mobile networks (WBAN/WPAN/WLAN/WMAN/WWAN), 5G/6G cellular systems and heterogeneous networks, future Internet and future networks, ad hoc and sensor networks, autonomous networking, big data/cloud computing and networks, cognitive radio, cooperative communication and networking, content distribution network (CDN), cyber-physical system (CPS), delay-/disruption-tolerant network (DTN), device-to-device communications, distributed database, and data mining. The content includes contributions from both academia and industry.

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About the Editors

Amit Kumar is a forensic scientist, entrepreneur, engineer, bioinformatician, and an IEEE volunteer. In 2005, he founded first private DNA testing company BioAxis DNA Research Centre (P) Ltd in Hyderabad, India, with a US collaborator. He has a vast experience of training 1000+ crime investigation officers and helped 750+ criminal and non-criminal cases to reach justice by offering analytical services in his laboratory. His group also works extensively on biomedical engineering and genetic predisposition risk studies of cancers and has been helping many cancer patients from 2012 to fight and win the battle against cancer. He was a member of IEEE Strategy Development and Environmental Assessment (SDEA) committee of IEEE MGA. He is a senior member of IEEE and has been a very active IEEE volunteer at section, council, region, technical societies of computational intelligence and engineering in medicine and biology and at IEEE MGA levels in several capacities. He has driven a number of IEEE conferences, conference leadership programs, entrepreneurship development workshops, and innovation- and internship-related events. Currently, he is also a visiting professor at SJB Research Foundation and vice chairman of IEEE India Council and IEEE Hyderabad Section.

Stefan Mozar obtained his engineering degrees from the University of New South Wales in Sydney, Australia, and his MBA from the University of Technology Sydney. He is a fellow of the IEEE and of the Institution of Engineers, Australia. He is a chartered professional engineer and has extensive experience in industry and academia. He has held senior leadership roles in various technology companies and has taught at a number of Australian, Asian, and British universities. His work has resulted in inventions, patents, and publications. He has lived and worked in Australia, China, Hong Kong, Singapore and worked on projects in India, Indonesia, Malaysia, Thailand, and Vietnam and has made contributions to the advancement of the IEEE in R-10 and globally. He is the editor of the 6th edition of the McGraw-Hill Electronics Engineering Handbook, released in 2017.

Internet of Everything (IoE): A New Era of IoT

Dipesh Vaya and Teena Hadpawat

Abstract After the inception of Internet of Things (IoT) a very new term is get into existence i.e. Internet of Everything (IoE). Before discussing on Internet of Everything one must know the meaning of it. In Internet of Everything process, people, data, and things are connected intelligently. Internet of Everything is a platform which makes the connection among process, people, data, and things more valuable and relevant. IoE generates new capabilities for businesses, individuals and countries by converting information into actions. Internet of Everything is based on Internet of Things with the inclusion of intelligence in the network. By intelligence in network we mean that a network of various things must possess visibility across earlier different systems along with the orchestration and convergence properties. Today's IP-Enabled modern devices and easy availability of broadband and internet services along with the advantages of IPV6 has made it possible to create new connections joining the Internet of Everything. IoE has significance over IoT in terms of security, network congestion, privacy and consumption of energy. IoE comprises of network of context aware devices which plays an important role. This secure infrastructure of IoE can be scaled up without compromising with intelligence and security.

Keywords Internet of Things · Internet of Everything · Sensor fusion · Remote Emotive Computing

1 Essentials of IoE

Essential parts of IoE [1] are shown in pictorial form in Fig. 1 [2]. And in following section each part is explained in brief.

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Fig. 1 Major components of IoE [2]

1.1 People

LinkedIn and Facebook like social networking platforms are available for People to connect through tablets, PC's and Smartphones. And due to progress in internet facilities people now has become more interactive with the helping hand of IoE. For example, we can see many people wearing digital jewelry on skin. Some very common example of such digital jewelry is smart watches, by which one can measure his/her daily workouts along with diet plans. Various sensors are available that can be wear with cloths. In IoE people may act as nodes. And these nodes of people are the source of constant static data stream [1].

1.2 Data

In present scenario data is gathered and sent to central repository by the devices through internet. Once all the data reach at central source, analysis and processing is done over the data. In all cases the data has short-lived value. The value of data becomes almost equivalent to zero as fast as it is generated [1]. So, it is not necessary to store all data.

1.3 Things

Things in IoE comprises of various physical objects or things like sensors, actuators, meters and more devices which have the capability to interact with other devices and networks for information sharing. Things/devices share their sensed data, provide proper responses for control inputs and also helps in decision making processes.

Example of Things in IoE consists of production line robots that automate factory production planning, smart electricity metering devices that shares consumed energy etc.

1.4 Process

Another essential part of IoE is process. Evolution of technology is required in explosively scalable large extent, automated businesses and organizations. Process is the important aspect of IoE as it is responsible for interaction among data, people and things in order to provide economic value and benefits to the society.

2 Major Difference Between IoT and IoE

In IoT 'T' stands for physical or virtual things that can be made addressable and have the capability to send the data or information without the need of human being. Autonomous interaction among various things is the central part of IoT. On the other hand, IoE includes accepting communications initiated by users and interactions allied with the global entirety of networked devices. Conceptualization of IoE is done at Cisco. According to Cisco, IoE is a communication and connection among data, things, process and people, but in an intelligent way. Interactions among IoT, machines and M2M are occasionally considered identical. The more liberal IoE theory includes, besides M2M [3] communications, machine-to-people (M2P) and technology-assisted people-to-people (P2P) [4] communications. Figure 2 [4] depicts major contents of Internet of Everything.

3 Importance of Sensors Fusion in IoE

Sensors has become the essential part of any IoT and IoE based devices and applications. With the use of appropriate sensors now humans can make ultimate sensing machines which can mimic like humans or can be said more intelligent than humans in various cases. Now a day's use of sensors has become very common. We can find various sensors in automatic systems, health care, climate monitoring, oil searching and smart computing and mobile devices. Sensor fusion is an important aspect of IoE. It can be understood easily by taking example of human body (refer Fig. 3 [5]). A human body is the live example of sensors fusion.

At a time, many sensors work simultaneously e.g. when humans eat something there are a lot of sensors working together to support the action 'eating'. For example, while eating, eyes works as visionary sensor, nose smells the food, hands works as actuators, and finally the test buds are used to know about the taste of food [6].

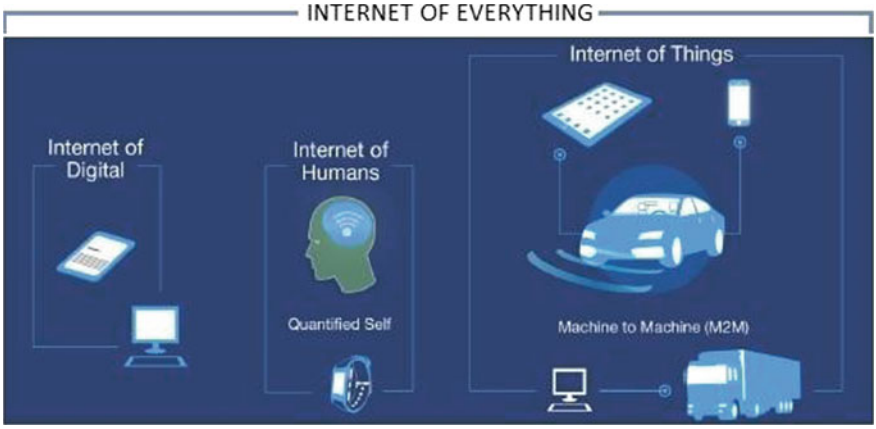

Fig. 2 IoE consists of IoT, IoH and IoD [4]

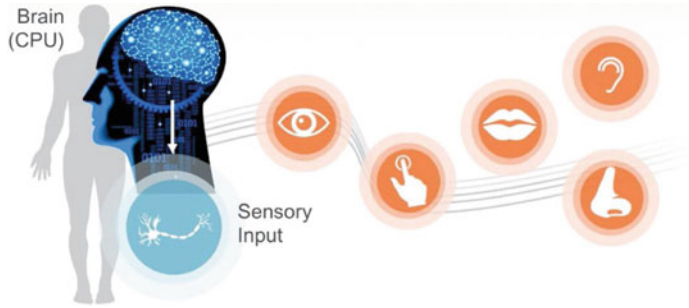

Fig. 3 Fusion of sensors in humans [5]

So, it can be said that it's a combination or fusion of various sensors. And at the mainstream human brain takes inputs from all sensors of the body and according to the input accurate decision is taken. So, fusion of sensors makes the tedious task very easy. Figure 4 [6] denoting versatility of sensors whereas Fig. 5 [7] showing various context awareness due to sensor fusion.

One more very popular example of health apps can be found these days e.g. Pedometer. These health-based apps measure the number of steps you have taken in whole day along with the quantity of calories burned while making these steps. Day by day advancement in technology making these apps now even smarter. Revolutionary improvements came after the use of MEMS-based inertial sensors [7]. And now the next generation of pedometer apps makes use of Altimeter, which is used to determine and account for the altitude changes while a person is walking, from a fixed reference point (elevation). Fusion of sensors along with embedded connectivity and processing enables context awareness and it tends to a new world of services.

Fig. 4 Various sensors for many tasks [6]

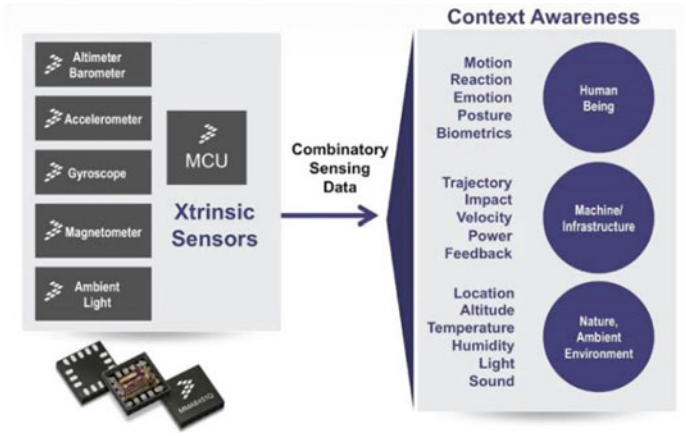

Fig. 5 Context awareness due to sensor fusion [7]

4 Conclusion

People lives can be made easier with the help of information collected through sensors. Further with the use of data mining people can feel more secure and can ensure privacy for their secret data and information. With the sensor fusion and Remote Emotive Computing (REC) technology one can generate more capable IoE devices. It can be said without any doubt that Internet of Everything (IoE) will be a masterstroke and will touch all the important details of life in coming one or two decades. Are you ready to be a part of it?

References

1. Miraz MH, Ali M, Excell P, Picking R (2015) A review on internet of things (IoT), internet of everything (IoE) and internet of nano things (IoNT). In: Proceedings of the fifth international IEEE conference on internet technologies and applications (ITA 15), Wrexham, UK, pp 219–224
2. Evans D, How the internet of everything will change the world. Cisco Blog, http://blogs.cisco.com/news/how-the-internet-of-everything-will-change-the-worldfor-the-better-infographic/. Last accessed on 2018/12/27
3. Kalyani VL, Sharma D (2015) IoT: machine to machine (M2M), device to device (D2D) internet of everything (IoE) and human to human (H2H): future of communication. J Manag Eng Inf Technol 2:17–23
4. Bradley J, Loucks J, Macaulay J, Noronha A, Internet of everything (IoE) value index: how much value are private-sector firms capturing from IoE in 2013? White Paper 2013; Cisco Internet Business Solutions Group (IBSG), Cisco Systems, Inc.: San Jose, CA, USA. https://www.cisco.com/c/dam/en_us/about/business-insights/docs/ioe-value-index-whitepaper.pdf. Last accessed on 2018/12/27
5. Balasubramaniam S, Kangasharju J (2013) Realizing the internet of nano things: challenges, solutions, and applications. Computer 46:62–68
6. Alansari Z, Anuar NB, Kamsin A, Belgaum MR, Alshaer J, Soomro S, Miraz MH (2018) Internet of things: infrastructure, architecture, security and privacy. In: Proceedings of the IEEE international conference on computing, electronics & communications engineering 2018 (IEEE iCCECE '18), Southend, UK
7. Teich P (2014) Segmenting the internet of things (IoT); White Paper 2014; Moor Insights & Strategy: USA. http://www.moorinsightsstrategy.com/wp-content/uploads/2014/05/Segmenting-the-Internet-of-Things-IoT-by-Moor-Insights-and-Strategy.pdf. Last accessed on 2018/12/27

Evaluation of Trends and Techniques of Flexible, Wearable and Waterproof Antenna for Wireless Communication: A Survey

Rameez Shamalik and Sanjay Koli

Abstract Our day-to-day life is surrounded by electronic equipments, which, if designed with flexible material, would provide new ease and comfort for the end user. This paper reviews the emergence of flexible technology with respect to wireless communication. The materials as well as processes to produce flexible antennas are discussed. Antenna fabrication methods are presented and compared. Novel designs in the field are highlighted and the pros and cons of Flexible Antenna Arrays are evaluated.

Keywords Flexible antenna · Array · Wearable and waterproof technology

1 Introduction

The topic of flexible electronics is gaining enormous popularity due to recent breakthroughs in electronics industry with respect to materials, production and packaging process. Lightweight flexible electronics that are potentially foldable, bendable and portable would substantially diversify the usage of state-of-the-art electronic devices. This technology is identified as one of the fastest growing technologies in today's world. The recent modernization in miniaturized and printable energy storage, and flexible photovoltaic have contributed to the rise of this technology. Increasingly, wearable and flexible devices require the inclusion of antennas to provide wireless connectivity [1]. Applications of Flexible Antenna Technology can be in the fields of personal communication, biomedical, military, industry and aeronautics [2]. Flexible antennas are robust, lightweight and can withstand mechanical tensions to a reasonable extent. The basic idea is to lay a thin metal strip on top of a flexible substrate. This metal must maintain their conductivity even when it is stretched.

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This paper is subdivided into five sections. Section 1 is an introduction to the importance of and opportunities in the topic. Section 2 is a literature survey that deals with the selection of material for Flexible Antenna. Section 3 contains suggestions for improvement and simplification of the process and a prototype design. Section 4 states the results and discusses their implications. The paper ends with Sect. 5 containing concluding remarks and suggestions for future work.

2 Literature Survey

2.1 Selection of Substrate

Substrate plays a crucial role for the antenna to work with satisfactory and expected results. Basically, there are two types of substrates, namely conductive and dielectric. Different factors including conductivity, resistivity, permittivity and loss tangent of the material dominate its selection. Figure 1 shows a flowchart of the design procedure [1] of a flexible antenna. It starts from selection of material.

Films having lower loss tangent and thickness, textile materials such as cotton, silk, wool etc., where constituent materials and thickness are the key factors, and thin sheets of solid foams and polycarbonates such as Polydimethylsiloxane (PDMS) are also widely used [3]. PDMS substrates are water-resistant and strong under high temperatures, and can be modified to have higher permittivity. The drawbacks of PDMS include complexity in manufacturing and hence, a high cost.

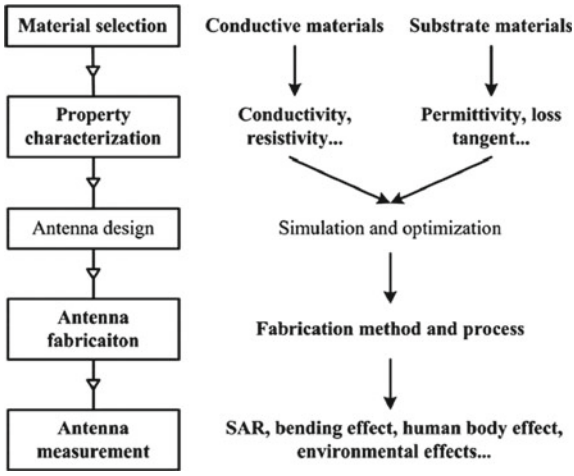

Fig. 1 Design procedure [1]

2.2 Novel Designs in Flexible Antennas

Wireless communication, which is replacing age-old wired connectivity in almost all fields, is not possible without antennas. Antennas acquire different shapes and sizes based on their application and frequency range. A variety of flexible antennas, right from two-dimensional to three-dimensional, are now feasible due to upgrading of the fabrication processes as discussed in last section. In this section, some of the latest designs in flexible antennas are presented.

Three-Dimensional (3D) Miniaturized Inverted F Antenna (IFA). A 3D flexible antenna came to exist in the reality owing to the liquid metal and additive printing technologies. Its operating frequency is 885 MHz. Different types of 3D printing technologies have been proposed during the last decade: Stereo Lithography (SLA), Selective Laser Sintering (SLS), and Fused Deposition Modeling (FDM) are developed [4].

This antenna, as shown in Fig. 2, includes NinjaFlex flexible plastic for FDM technology to fabricate a dielectric radome. Micro-channels are used in the fabrication process, limiting the shape of the conductive part of the antenna. Later, the micro-channels are filled with liquid metal making the antenna flexible.

Wearable Antenna. Ultra-wideband (UWB) antenna has picked up momentum since the US Federal Communications Commission (FCC) authority announced free usage of bandwidth of 7.5 GHz, which ranges from 3.1 to 10.6 GHz.

The above antenna has been built on flexible and very thin Kapton material, suitable for limited-space, wrist-worn applications. It is specially designed for the fourth generation (4G) communication system i.e., LTE band for Europe and USA. Its bandwidth is up to 2700 MHz and Return loss −6 dB [5]. Figure 3 shows its simulated version in CST and then the fabricated version wrapped around a synthetic material. Ultra-wideband can be effectively used for Wireless Body Area Network (WBAN) due to its ultra-low power consumption. Acceptable Surface Aperture Rate (SAR)

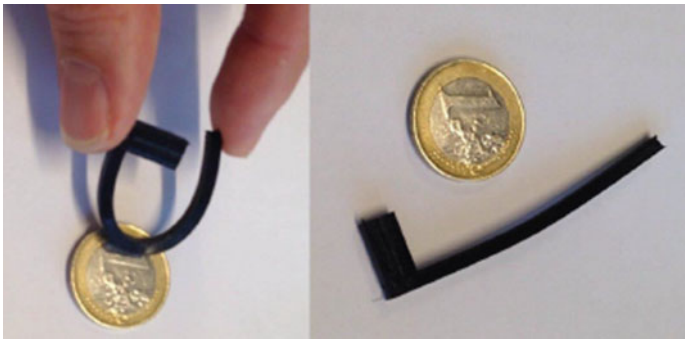

Fig. 2 IFA antenna [4]

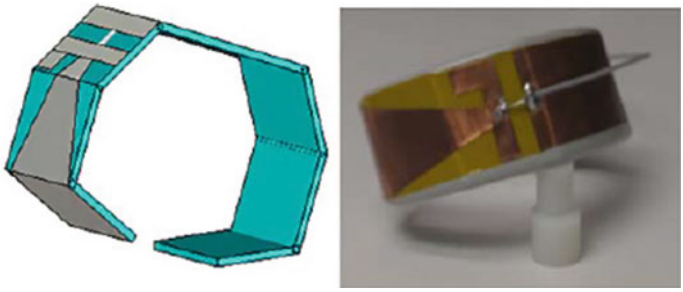

Fig. 3 Compact UWB wearable antenna [5]

values need to be considered due to constant connection of human body with the antenna.

Flexible Waterproof Antenna. As water is a lossy dielectric and it easily affects the performance of any electronic circuits, majority of electronics industries stay away from waterproof equipments. However, due to increasing customer requirements in this section, we often see waterproof electronics such as mobile phones, and fitness bands. Flexible antennas usually experience degradation in their performance due to water absorption. Therefore, in order to minimize water absorption and maintain performance under water, a super hydrophobic paint is used to cover these circuits [6]. This paint can easily be applied to paper and textile with advantages of low cost and low RF Loss.

2.3 Flexible Array Antennas

A four-element UWB textile cross array. As the name suggests, it contains four antennas positioned in a cross-section stationed on a textile substrate. This antenna is most suitable for spying or tracking purposes as it goes easily with any kind of garment. It provides dual-spatial and dual-polarization diversity. It provides a good impedance bandwidth of 1.4 GHZ in UWB. Mutual coupling between its elements is below −25 dB and diversity gain is phenomenal at 24.81 dB [7]. Additional throughput gain is possible due to adaptive subcarrier modulation.

Uniform Linear Arrays (ULA). Several shapes of arrays are made using 24 half-wave dipole elements. An efficient global hybrid optimization method is put forward by coupling the Central Force Optimization (CFO) as a global optimizer and Hill Climbing (HC) algorithm as a local optimizer [8]. Uniform circular, hexagonal and octagonal arrays are compared in terms of amplitude and phase angle per each element. Half dipoles kept in a circular array show greater directivity than octagonal or hexagonal array, while hexagonal array gives slightly deeper nulls and a higher gain as compared to the other two arrays.

A multi-beam phased array. This design offers more than one beam to increase the capacity of the channel and is also used to increase the number of users. It is very much useful if the target is on the move. Due to the narrow bandwidth offered, it provides high radiation gain, and in turn, better directivity using the Butler matrix through Discrete Fourier Transform (DFT) [9]. Such a design on a flexible substrate allows for adjustment of array to gain not only overall efficiency but radiation efficiency as well.

Beam-reconfigurable superstrate antenna. This array is generated by capturing liquid metal crystals in channels of polymer flexible substrate [10]. Its working is completely based on stretching and bending of the flexible substrate in order to achieve the required beam. It serves as an economical counterpart to switches and varactors for electronic tuning.

3 Proposed Design

Based on the survey, authors would like to propose a design that attempts to synthesize the uniqueness of several designs discussed and at the same time tries to provide solutions to shortcomings, if any.

3.1 To start with the substrate, where flexibility is an important criterion, polyamide stands apart from others in terms of its availability and economic value. Its dielectric constant is equivalent to FR4, which is exclusively used for many rigid microstrip antenna designs.

3.2 In fabrication process, Photolithography is the most tried, tested and recommended method. Author suggests a sheet of polyamide covered with a copper layer, which can be etched precisely as per the required design.

3.3 When it comes to the shape of the patch, there are all kinds of options available, especially triangular and rectangular ones. We opt for a hexagonal shape since it is a mixture of both of these shapes and also has a good surface area value in terms of radiation [11].

3.4 Array is the new frontier in any antenna design research due to its superior results in terms of gain and efficiency, but simplicity is a major criterion worth considering while finalizing the design.

3.5 Equipments need to be waterproof since the recent technological advancement and consumer demands require them to work around or inside water bodies. Superhydrophobic paint cover serves this purpose after the antenna is fabricated conventionally.

We put forward a two-element hexagonal patch array working on the frequency range of 3.5 GHz UWB. The design is simulated in High Frequency Simulation Software (HFSS). As shown in Fig. 4, two hexagonal patches forming an array are uniformly placed on a polyamide substrate.

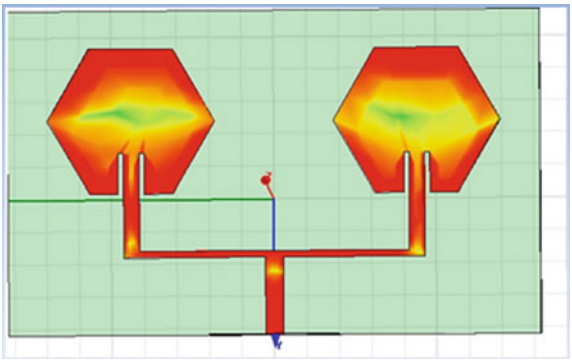

Fig. 4 Two element hexagonal patch array

4 Results and Discussions

Figure 5a shows the gain of the two-element hexagonal array, which is 7.7 dB, better than the other UWB or ISM band flexible antennas designed. Typical values of gains of flexible antenna designs are Sighted in the range of 2–6 dB [1].

Figure 5b shows the radiation pattern of the designed antenna. The radiation pattern of an antenna provides the information that describes how the antenna directs the energy that it radiates. As seen above, it is a unidirectional radiation pattern, as the other side of the array is completely grounded. It is useful for a direct line of communication.

The VSWR acts as an indicator for degree of closeness between the impedance of an antenna and the impedance of the connecting transmission line. If an impedance mismatch exists, a reflected wave will be created towards the energy source. Figure 5c shows its VSWR of 1.04, which is better than the cited work of authors in this paper for UWB band and is impressively close to ideal value of 1.

The return loss is a complementary parameter for VSWR, highlighting loss of power in the signal reflected by a discontinuity in a transmission line. Figure 5d shows return loss of −33.77 dB, which is extremely better compared to the required minimum value of −10 db. It is also better than the UWB band wrist antenna return loss of −18 dB [8].

5 Conclusion

The journey of flexible antennas from P band to UHF band was reviewed. Starting from the design procedure, material selection, novel designs and flexible arrays were studied with their advantages and drawbacks. A 2×1 hexagonal patch array has been proposed that works on 3.5 GHz, which comes under UWB. Polyamide was preferred as a substrate due to its ease of availability, lower cost and its dielectric constant 4.3, which is close to the famous Fire Resistant 4 substrate. Radiation pattern of the

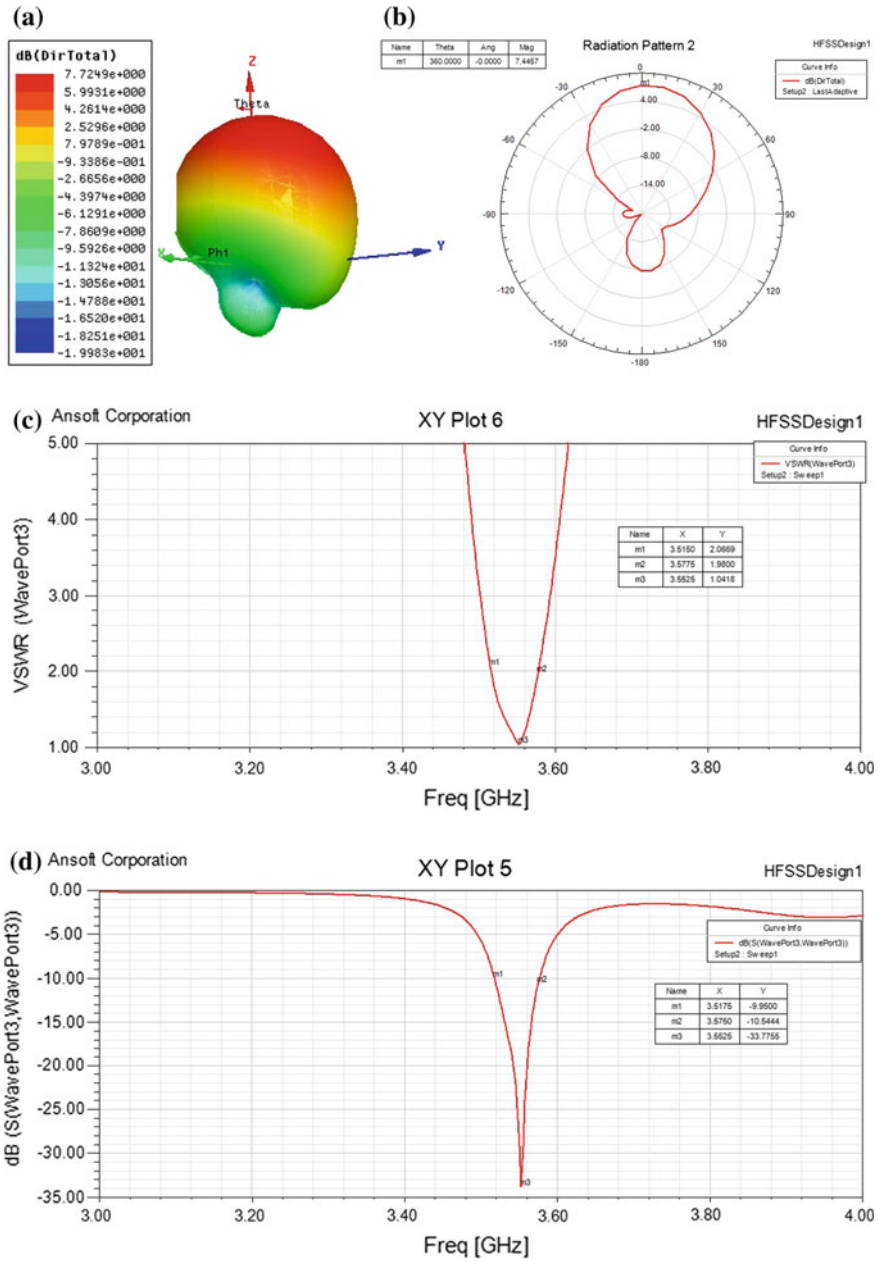

Fig. 5 **a** Gain, **b** radiation pattern, **c** voltage standing wave ratio (VSWR), **d** return loss (s11)

antenna is highly directional, which supports Line of Sight communication. Gain, VSWR and return loss were measured and compared with those of other flexible antennas and found to be better than most of them.

For future work, waterproof antennas can prove effective in underwater or extreme environments. Longevity of the antenna in terms of its resistance to bending, dust, heating and damp surroundings need to be worked upon.

References

1. Khaleel H (2015) Innovation in wearable and flexible antenna. WIT Press
2. Shamalik R, Shelke S (2012) Design and simulation of flexible antenna for ISM band. Int J Eng Res Appl (IJERA) 2(3):2168–2170. ISSN: 2248-9622. www.ijera.com
3. Rahman HA et al (2016) Design of a flexible antenna using printed silver loaded epoxy on PDMS/plastic substrate for wearable applications. In: 10th European conference on antennas and propagation (EUCAP). IEEE
4. Cosker M et al (2016) Realization of 3D flexible antennas using liquid metal and additive printing technologies. J Latex Files 14(8)
5. Flores-Cuadras JR et al (2016) Novel UWB flexible antenna for wearable wrist worn devices. Centro de Investigaci on Cientıficay de Educacion Superior de Ensenada (CICESE) Mexico, Sept 2016
6. Foroughian F et al (2016) Flexible RF-antennas coated by a super hydrophobic paint for minimal water absorption. IEEE. ISBN: 978-1-5090-2886-3/16
7. Castel T et al (2017) Four-element ultrawideband textile cross array for dual-spatial and dual-polarization diversity. IEEE Antennas Wirel Propag Lett 16
8. Montaser AM et al (2012) Circular, octagonal and hexagonal array geometry for smart antenna systems using hybrid CFO-FC algorithm. J Eng Sci Assiut University 40(6):1715–1732
9. Chou H-T (2017) Design methodology for the multi-beam phased array of antennas with relatively arbitrary coverage sector. In: 11th European conference on antennas and propagation (EUCAP). ISBN: 978-88-907018-7-0
10. Moghadas H et al (2017) Beam-reconfigurable aperture antenna by stretching or reshaping of a flexible surface. IEEE Antennas Wirel Propag Lett 16:1337–1340
11. Rakhshani MR et al (2018) Engineering hexagonal array of nanoholes for high sensitivity biosensor and application for human blood group detection. IEEE Trans Nanotechnol. https://doi.org/10.1109/tnano.2018.2811800

Virtual Personal Assistant and Improve Education System

Poonam Desale, Priyanka Mane, Kunal Bhutawani, Bhagyashri A. Shetage, Manju Vyankatesh Dalai and Kunika Ramchandra Gulave

Abstract The main aim of research is to improve quality education using digital tools like ICT tools with the combination of dialog system. By using digital tools create a more interactive and interesting environment for teachers and student. To improve performance of education used dialog system it takes input in the form of speech is natural dialog rather than text means natural dialog between humans and machines. This process is done by using artificial intelligence. Now days Virtual Personal Assistants (VPAs) used by many companies for their own proposed application like Google Assistant etc. The process of proposed digital education system first step is used natural dialog as input to dialog system and in second step it gives output in the form of animated graph like When user call 'A for apple' then on projector show the Drawing of 'letter A' and retrieve 'picture of apple' from highly secure database. And second example is when user say "two friends walking on road" then dialog manager show "relationship between two animated persons" and show "running status of them." Means this particular dialog system has a total knowledge of alphabets and numbers with grammar. As well as relations, different position and behavior of human. Means indirectly this dialog system work as well educated person. This application is more use full in primary education system at primary level there is

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required practice of student in good observation. When teacher say ‘A for Apple’ then dialog manager do its work means it Draw ‘letter A’ and retrieve ‘picture of apple’ from respective database. And when user say “two friends walking on road” then dialog manager show “relationship between two animated persons” and show “running status of them.” Means student virtually imagine the each statement of story is show on projector board with the help of dialog manager. This time of teacher is utilized for give more attention on student and make student perfect. Means indirectly reduced the effort of teacher and improve accuracy of education. This application also used in many area such as write any letter, speech, sentence. Indirectly reduced the effort of user and improve accuracy by reducing grammatical mistake.

Keywords Dialogue systems · Virtual personal assistants · Digital education tools · Mobile learning · e-learning · Web learning

1 Introduction

Digital device are more user friendly for teachers and students to learn according to their own space and environment. By using computer based training system enhance the learning to wide audience at low cost by printing learning materials and using animation at vision. By using ICTs its time to adapt students with interactive learning system so that they can improve catching learning and memorizing capability. Visual learning can be easier to understand and increase the interest of students. Traditional teaching and learning method is based on reading and memorizing its hard and boring to learn. This problem is resolved by visual learning concept it is based on listen, seen and memorizing. It increases the interest of students but it make lazy to learner. Proposed system use the Intelligent Personal Assistant to increase the interest in learning by making good practice of student and minimize the efforts of teachers this process goes through listen, seen, practice and memorizing. In practice model the dialog system takes input as a speech of teachers and gives output as in the form of drawing those particular things. For example When user call ‘A for apple’ then on projector show the drawing of ‘letter A’ and retrieve ‘picture of apple’, from its respective highly secure database. And second way is when teacher say “two friends walk on road” in story then dialog manager show “relationship between two animated persons” and show “running status of them.” Means student virtually imagine the each statement of story is show on projector board with the help of dialog manager. It help the to understand the each statement of story in accurate way in minimum time.

Virtual personal assistant (VPA) is “a software agent that assists people to perform basic tasks or services for an individual, usually providing information via natural language”. Means virtual personal assistants (VPAs) as “systems that are capable of learning the interests and behavior of the user and respond accordingly”. Virtual personal assistant perform its function in five number of tasks first one is speech recognition, second is language understanding, third is dialog management, language

creation, and last one is give the response to user query in user understandable form. In today's market virtual personal assistants are available reactively for many application such as hotel reservation, weather forecasting, etc. Because VPSs provide the right information at the right time to users.

A. **Objective**:

The main objective is using dialog system to improve quality of primary education. Education is based through listen, seen, practice and memorizing. Student can do practice by seen the output of dialog system in the form of animated graph. It is more understandable and accurate to students as compare to traditional teaching approach.

2 The Structure of General Dialog System

A dialog system is nothing but complex software component it effectively and efficiently communicates with a human in natural language. Indirectly dialog system is one kind of interface computer based hardware and user. A spoken dialogue a system is defined as computer systems that human interact in which spoken natural language interface plays an important part in the communication. Different virtual personal assistances have different architectures but basic architecture of dialog system is same.

2.1 Components of Dialogue System

A Dialogue system has mainly seven components. These components are following:

- Speech Recognition (Input Decoder)
- Natural Language Understanding
- Dialogue Manager
- Language Creation
- Response Generator (Fig. 1).

2.1.1 Speech Recognition (Input Decoder)

Speech Recognition takes input in the form of a human speech and converts it to in simple text. Means it convert spoken sound into a string of words. For that purposed there is required the knowledge of phonology and phonetics.

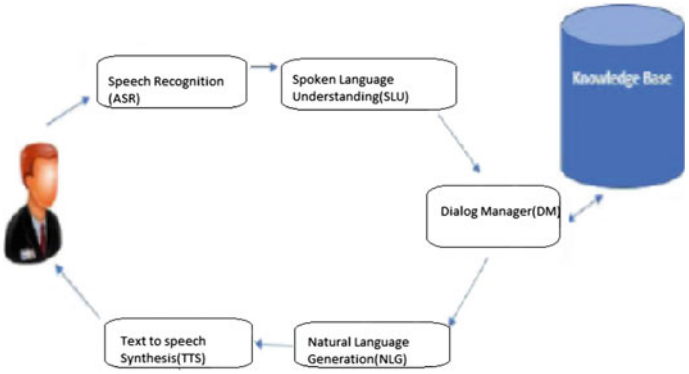

Fig. 1 General structure of dialogue system

2.1.2 Natural Language Understanding

Speech recognizer convert input user speech data to text form, by using different computed (automatic) speech recognition it also called as simple speech to text converter. Then output text is input of Natural language understand it represent that speech into semantic order means represent in semantic and systematic order. For that purposed that required Study of morphology it included study of the structure and content of word forms.

2.1.3 Dialogue Manager

After converting user speech in systematic and well understandable form means in correct text data. Then dialog manager do its operation by understanding the need of user reading that particular text output of Natural Language Understander. And then retrieve the content stored in different files in databases by deciding best response for user. Dialogue manager has different components such as User Model, Knowledge Base, Grounding Module, Discourse Manager Dialog Model, Reference Resolver, etc.

2.1.4 Language Creation

For processing purposed language creator required the interface with some external software such as a database or an expert system. Means it convert text data into used language. This can be handled by Natural Language Query Processing system. This system generate SQL query from natural language.

2.1.5 Response Generator

Current virtual personal assistant use simple way such as used predefines templates to insertion of retrieved data. Means output given template is fix dialog manager insert its resulted record in that particular template space.

2.2 Classification of Dialogue System

Classification of Dialogue system into three types, First one is graph based systems in with user takes its input through a predefine dialogue it consisting of a sequence of predetermined steps or stages. The flow of dialogue is specified as a set of dialogue.

Second one is frame based dialog systems in this dialog system predefine template is there user is asked questions in way of order to perform tasks.

Third type is agent based system it allow complex communication between the system and user in order to solved some complex problem or tasks. It show the interaction between two agents, each of which is capable of reasoning about its own actions and beliefs.

3 The Proposed VPAS System

In current education system both teachers and students use ICT rule to improve education quality. To extend these ICT rule to become more attractive and user friendly for both teachers and students use dialog system (virtual personal assistant) in such way that it takes input as the user speech (as natural language English) and produced output in the form of animated graph and retrieved the data from highly secure database as per requirement of output screen.

The main aim of virtual personal assistants is to increase efficiency as well as productivity of the user. VPS is specific software that perform particular functionality using "desktop" computing environment, and support to user in the learning and using specific software package.

Proposed virtual personal assistant is used in education system to increased quality of education system by following advanced communication technology.

Advanced Communication Technology:

In advance communication technology includes several factors that contribute towards the success of learning communication at each level. At the level of transmission, factors such as media distribution, media capacity and media accessibility used in message transmission are crucial.

M-Learning:

M-learning denotes all the forms of portable technologies like handheld computers, Web 2.0 tools, technologies. A good learning tool has to ensure a very important factor called learner motivation. So many researches are available in the field of motivation and learning process.

Multimedia for Computer Based Programs:

In education, multimedia is used for computer-based training programs CBT lets the user go through a series of computer-generated learning material, explanations about a particular topic and associated illustrations in various information formats, such as documents containing text and graphics and video. Here in proposed system output is only in the form of graph or repeated graph. It helps to student to do practice because practice is more important thing in education (Fig. 2).

The Proposed virtual assistant have two main part in first part VPAS takes input from user in the form of speech then decode that input and understand the language of user. Then according to user requirement VPAS draw the respective graph and retrieve particular image from highly secure respective database. For drawing purposed dialog manger have knowledge of phonology and phonetics as well as study of morphology it included study of the structure and content of word forms. Means indirectly required the knowledge of grammar in well form.

Respective database is highly secure means no other user can't change that data means only authorized user can change data of respective database. Provide the security to it by highly secure algorithm such as AES algorithm (Fig. 3).

Output of proposed system is very very important part of application software. Dialog manager draw the animated graph such as first case is when user say 'A for Apple' that time VPS draw the 'letter A' and retrieve the 'picture of apple' from database. And second case is convert each statement of story into animated graph These both process is done based on own knowledge of dialog manager. For implementation process of developed knowledge dialog manager used different fuggy logic algorithms.

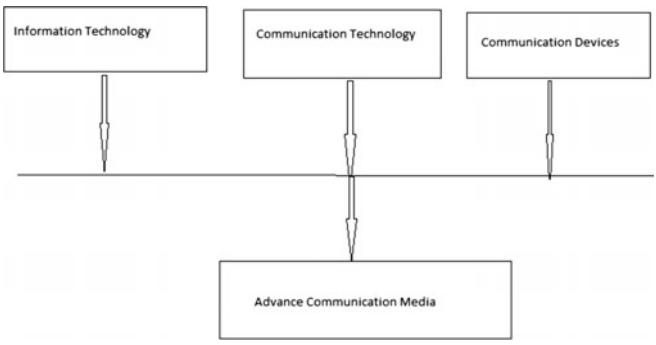

Fig. 2 Advanced communication media

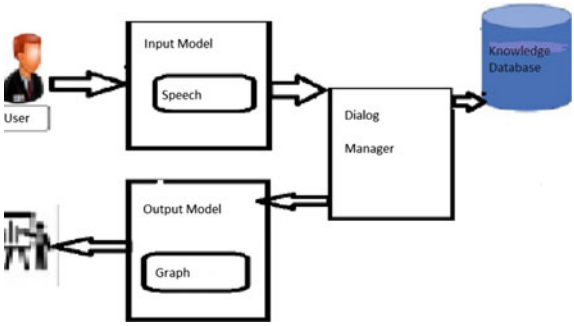

Fig. 3 The structure of proposed virtual personal assistants

Algorithm Required:

1. AES algorithm: to provide security to respective database.
2. Automatic speech recognizer: to understand the user query in the form of speech. It also called as Natural language under stander.
3. Highly accurate and efficient Knowledge database it act as training database to teach dialog system, some part of that data is used for validation purpose. Prepared the VPAS in such a way that it gives minimum testing error. Indirectly it has low biased and low variance because it not weak learner. Then By using it own knowledge VPAS draw the graph of any letter or sentence as well as retrieve picture of respective image from database.
4. Fuggy Logic algorithm: There are required some line of code to developed different fuggy logic algorithm that are required for these application. (i) Converted natural dialog of human into text data. (ii) Identify letters, number, images. (iii) Also identifies actor, relationship, activity done by particular actors etc.

4 Conclusion

The digital technologies perform fundamental roles in education system by changing the way of teaching and learning. Digital devices have produced significant transformations in the educational field. Mobile devices are also decrease limitation of learning location. They should be incorporated in the educational industry and curriculum. Developments, researchers are conducting investigations and experiments to integrate digital ICTs into the curricula. Thus, digital tools enhance the communication process in the teaching-learning process by using dialog system (virtual personal assistant) taking the input in the form of speech and produce output in the form of graph. It is effective way of learning. In these application output is in the form of animated graph of any sentence (speech) of human in English which is related to primary education. These output animated graph is very effective and attractive for student to learn basic and important thinks in childhood age. It is step by step

learning processes as compared to animated videos. So, it is very effective to both students as well as teachers.

References

1. Kepuska V, Bohouta G (2018) Next-generation of virtual personal assistants. In: IEEE. 978-1-5386-4649-6/18/$31.00 ©2018
2. Mead R (2017) Semio: developing a cloud-based platform for multimodal conversational AI in social robotics. In: 2017 IEEE international conference on consumer electronics (ICCE)
3. Bohouta G, Këpuska VZ (2017) Comparing speech recognition systems (Microsoft API, Google API And CMU Sphinx). Int J Eng Res Appl
4. Bohouta G, Këpuska VZ (2017) Improving wake-up-word and general speech recognition systems. In: 2017 IEEE 15th international conference on dependable, autonomic and secure computing
5. McTear M (2016) The dawn of the conversational interface. Springer International Publishing Switzerland
6. Arora S, Batra K, Singh S, Dialogue system: a brief review

Literature Survey—Food Recognition and Calorie Measurement Using Image Processing and Machine Learning Techniques

V. Hemalatha Reddy, Soumya Kumari, Vinitha Muralidharan, Karan Gigoo and Bhushan S. Thakare

Abstract Nowadays, with easy access to internet, food is delivered at our doorsteps just on the click of a button due to which people have started to consume higher amount of fast food. This has accelerated the chances of suffering from a chronic disease known as obesity. Since obesity has become such a widespread disease, various mobile e-health applications have been developed for assistive calorie measurement to help people fight against health-related problems. In this paper, we have surveyed different methods for food recognition and calorie measurement using various methods and compared their performances based on several factors.

Keywords Convolutional neural network (CNN) · Deep learning · Food recognition · Machine learning (ML)

1 Introduction

In early 2000s, it had been observed that people have become more health conscious due to the outbreak of a chronic disease called obesity. According to the Institute of Heath Metrics and Evaluation, it was found that adults crossing the number of 603 million and children crossing the number of 107 million (where 7.5 is the population

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considered globally) are obese (http://www.healthdata.org) [1]. That represents 5% of all children and 12% of all adults.

We often make a record every day to know what we eat. Such recordings were done manually before the use of the gadgets such smartphones, but manual recordings are tedious and prone to errors. To overcome this difficulty, various techniques were developed to record the daily food intake using latest technologies where taking a picture of the food was enough for food recording.

Nowadays, being fit has become the most important agenda of human beings and to help them out in this journey, various e-health applications have been developed. These applications use image processing methods to detect calories present in a particular cuisine. Therefore, to overcome this, various algorithms were implemented for food image recognition to calculate the calorie intake by a particular user. The analysts made use of algorithms like Convolutional Neural Network (CNN), Gabor filter, Support Vector Machine (SVM), Selective Search, K-means Clustering etc. and came up with an easy and intelligent solution for measuring the intake of food and collecting their dietary information.

To recognize multiple food items in one picture and calculating its calorie count, it requires high skills and sound knowledge of pros and cons of every method tried by different researchers. It is indeed a difficult task as it includes collection of huge datasets for training the system. It was also observed that there were significant intra-class variations in the captured images of the food items that were observed [2]. This paper consists of the comparisons between various algorithms to understand merits and demerits of each and develop an application providing higher accuracy in results. The survey done in this paper consists of the researches done by various analysts, their methodologies, theoretical formulae and the conclusions they have arrived at.

2 Literature Survey

For recognizing multiple items of food in the images captured using mobile devices, Parisa et al. [2] proposed a Deep Learning method in which experiments were conducted on FooDD dataset and it 90.98% of average recall rate was shown. An algorithm called stochastic gradient was also implemented. A set of images for training of a food image in which it was needed to classify the food type (for example, an Apple) was achieved by tweaking the weights and biases values and this was done using Stochastic Gradient. Stochastic gradient is generally used to minimize the error of a model on the training data. To minimize the quadratic cost function, neural network is trained to find the weight (w) and bias (b). This was achieved by defining the cost function as

$$\text{Cost}(\text{w}, \text{b}) \equiv 1/2 \sum \|y(x) - a\|^2 \tag{1}$$

where, w → collection of all the weights in the network, b → biases, a → vector of outputs from the network, x → input.

By using this function, cost function is improved by making it easier to make minor changes in the weights (w) and biases (b).

Deep learning is a growing method which helps a computer model learn in performing classification task directly from images. It's an approach of machine learning and has been executed towards the discovery of multiple levels of representation including (Fig. 1).

For improving the correctness of classification of food and calorie measurement systems, Deep Learning has been used. CNN is the first ever successful learning algorithm of training multiple layer network structure and is responsible for handling the training and testing of the upper layers in the neural networks [3]. Training algorithm of neural network is divided into two phases: forward propagation and backward propagation. Forward propagation deals with training the machine by taking sample inputs and corresponding outputs. Backward propagation is calculation of difference between actual output and corresponding desired output.

An algorithm, well known as K-means algorithm is used to solving the problems on clusters. It divides the image into n number of segmentations based on their colour variation information. After that identification and removal of uniform colour segments from being used for adjusting the colour constancy. The main aim of the system is to provide an optimal constancy of colour. The working of the algorithm is such that it helps in the refining the image. The input is then converted using the algorithm which is an RGB format into a L * a * b format where L* → is lightness of the image a* and b* → are components of the image. Pouladzadeh et al. [4] surveyed for Calorie Measurement Approaches and categorized them into Traditional Clinical Methods, Smartphone Based Systems, Smart Environments and Dedicated Portable Systems.

Turmchokksam et al. [5] put forward a method wherein the nutrition knowledge is used along with the fusion of heat and brightness information for recognition of food. This method uses both software and hardware to achieve the goal.

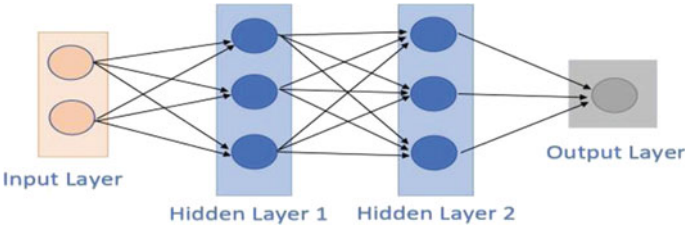

Fig. 1 Structure of neural network

Software includes:			
1.	Database Preparation	3.	Food Type Classification
2.	Ingredient Boundary Detection	4.	Ingredient Temperature-range classification
Ingredient Consideration—Calorie Calculations			
Hardware Includes:			
1.	Food Type Classification	3.	Channel Selector
2.	Ingredient temperature-range classification	4.	Boundary Detection—Ingredient Selector

Testing of the system was done in their labs and the dataset used were the images captured by the CCD (Charged-couple device) and thermal cameras. Results showed that the system gave more accurate output when compared to other average statistical data of food calories. Ciocca et al. [6] works on a new dataset consisting of canteen trays with food items belonging to 73 food classes arranged on those trays in sequence for food recognition purpose. They have used CNN based features for food and tray recognition as well and achieved an accuracy of 79%. The regions of interests that are generated are further processed by food class predictor (global approach-visual features are extracted from the whole considered region, local approach-visual features are extracted from local patches of considered region), whose output is a list of food that are recognized (Fig. 2).

He et al. [7] used ingredient-based food recognition method. An automatic food classification method, DietCam was designed which specifically addressed the variation in the food appearances and to address this variation problem in the appearances, a detector for ingredient detection and a multi-view multi-kernel based Support Vector Machine (SVM) was developed for the classification food items. DietCam's performance was better as when compared with other classification methods. Author made a combined use of texture models and applied a multi-view multi-kernel SVM for the classification of the food ingredients. Herranz et al. [8] uses a geo-localized system which means that the photos which are taken by the customers and then that image is then located using the SIFT. The visual classification is done using neural networks. The entire system is based upon the accuracy of how the dish recognition

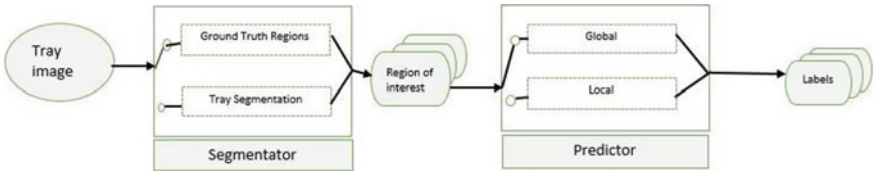

Fig. 2 Tray analysis pipeline [6]

and restaurant recognition with the help of location identification. With the help of this, the author can achieve an accuracy between 54 and 70%.

In the paper [9] the author elucidated on the need for a food recognition algorithm as he talks about the different variety of food and the calories in them which differ from region to region depending upon its preparation. The author says that the detection algorithm will be completely dependent on very large CNN. The use of CNN is such that, it provides higher accuracy when considering large scale image data. GoogleNet, ResNet and AlexNet are the three different networks of Convolutional Neural Network (CNN). Features extraction and training of linear Support Vector Machine (SVM) kernel are the two process for which these two models were used. During experimental process the author takes into consideration of 10 sample of Indian foods which gave an experimental result with an accuracy of 95.95%.

Aizawa et al. [10] investigated a FoodLog multimedia food recording tool wherein the food images were uploaded by the users of their daily food and then using Image Processing, a diary was constructed. Image processing included detection of food image and estimating food-balance. So, to improve this process, the author proposed a Bayesian framework which used personal dietary tendencies. Images outperformed textual descriptions for gaining richer and better information. Image processing was used to determine the food diet composition and further recorded information for viewing in figure or graphical representation.

Bayesian model possess a property of updating with personal tendencies and hence the result showed that after updating the model in accordance with personal data, an improvement in accuracy was seen from 89 to 92% The method shown in [10] was based on a traditional framework: extraction of features the classifier approach. Another method was K-nearest neighbour method (matching-based image classification) (Fig. 3).

One more very famous method, Gabor Filter, used for Texture segmentation. Henriksen [11] stated that one of the most important issues which occur during the detection of images is the understanding of the various textures which are differenti-

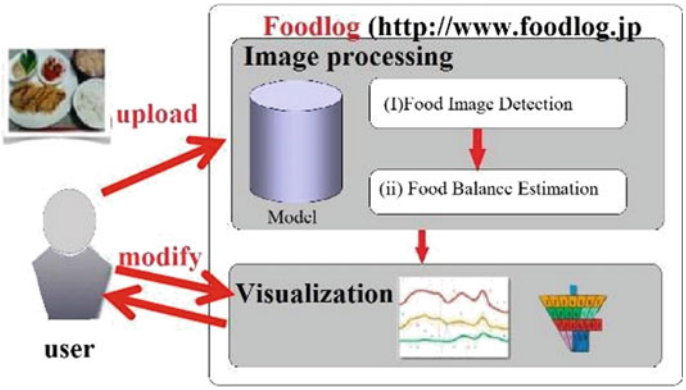

Fig. 3 Functional overview of FoodLog [10]

ating the various parts of the image. These segments and textural differences can be found out using the Gabor filter. The output obtained after the various identifications and segmentation are stored in a 2-dimensional array and then sent for further processes. Since the detection of different type of food requires segmentation as food of different variety has different types of colour [2].

Martin et al. [12] proposed a system in which a system will capture the images of food plate and other wastes and upload it to a research center where actual analysis will take place. They used a reference card system which is helpful in the analysis of true food portion in a plate. Since it involves sending of pictures to research center for offline analysis, this incurs delay in result which is not feasible in this fast paced world.

Numerous studies have been conducted on food recognition and calorie estimation. In this paper [13] different combination of segmentation method, like colour, texture, graph cut segmentation and deep-learning neural network combinations has shown 99% accuracy of food recognition. The model integrates the calorie measurement application and the Deep Neural Network (DNN) where CNN serves as the backbone of the system. It unfolds into 3 major stages:

1. Graph-cut Segmentation
2. Deep-Learning Neural Network (DNN)
3. Calorie Measurement

With more than 25,000 images of 360 categories of food they have created a dataset, and applied deep convolutional neural network in paper [14]. The result generated consequently outperformed the traditional Support Vector Machines (SVMs) method. Classification rate of 69.50% was achieved by the system in cooking method recognition task, and in the food ingredient detection task, 60.74% precision was achieved.

In [15], real time mobile food recognition system is developed, which uses colour-histogram features and a linear SVM with bag-of-SURF.

This model works on 50-category food dataset and achieves 81.55% accuracy. Detailed description for Food Recognition is as follows:

1. GrabCut
2. Food Recognition
3. Image Features
4. Classification
5. Experiments on accuracy

Aizawa et al. [16] confirmed that CNN performed better than conventional baseline method for food detection. Ordinary meals were taken for evaluation of food image recognition. Region selection method was used for the food identification purpose and were isolated for the dataset. Smartphones were meant to be of great use here for the food logging apps and produced very good data. The app named Food Logs (FL) was developed for this purpose. Two months of data were recorded i.e., approximately 170,000 images. The diversity on the types of food items were large and hence showed heavy bias towards some items.

Fig. 4 Food with fixed size reference with its corresponding subsampled 3D model [19]

One more feature, which is size of food, is added by Pouladzadeh et al. [17] other than colour, texture and shape used by most of the proposed systems.

Texture segmentation of food images for better classification has been done by the implementation of the Gabor filter.

In [18] for food category representation, data collection for similar meal name is done using k-nearest neighbour search and then constructing a relationship between the meal names and the datasets to build a word graph for minimal path identification and obtaining categorical information of original meal name. The final output of the system is the short representation of meal names.

In [19], author has used methods of computer-vision for estimation of volume of food which can be calculated from the 3D models obtained by using multi-view geometry. Joutou et al. has used 50 kinds of food items and came up with a method to recognize food images by the fusing several image features include Gabor, SIFT-based bag-of-features, and colour histograms using multiple kernel learning (MKL), and classification rate of 61.34% was achieved (Fig. 4).

In [20] the author majorly talks about the problems which have been caused by obesity and talks about how to develop a model which is used to measure the calorie intake of the person. The author talks about how the user would be able to calculate, his or her calorie intake before and after each meal (if any left overs, by subtraction the calories in the respective meals).

Author of [21] has proposed a food recognition using local textural patterns and global structure with the help of Local Binary Pattern (LBP) and Scale Invariant Feature Transformation (SIFT) detector and achieved a lower rates of classification for food items as compared to Yang el al.'s [22] outcome on same dataset. But both of these papers mainly focus on American fast foods rather than various other cuisines. SIFT and LBP is used in [17] to locate as well as encode local textural structures of food objects. In their training procedures, they have created a codebook of local textural and studied their spatial relationship by using shape context. The method proposed by the author accommodated different types of shapes and sizes of food objects. This proposed method has shown better performances than other two baseline methods (Colour Histogram + Support Vector Model (SVM) Classifier and Bag of SIFT Features + SVM Classifier).

Paper [22] also works on spatial relationships where vectors has been assigned to each and every pixel in a particular food image. These vectors represent probability of occurrence of pixel which belongs to each of the 9-categories of food ingredients. This process is done using Semantic Texton Forests (STF). STF is a method of categorization and segmentation of image to generate soft labels for pixels. This takes place on the basis of local, low-level characteristics, like colour of nearby pixels of that image. Thus, this paper focus on exploiting spatial relationship between different ingredients, example a burger consisting of meat and vegetables. Shimoda el at. [23] proposes segmentation of food images using CNN without any pixel-wise annotation. The author build the proposed system using the strategy as the selective search, bounding box clustering, back propagation-based saliency map with the Convolution Neural Network (CNN) model calibrated with the UECFOOD100 dataset, Grabcut method guided by the evaluated saliency maps and region integration by non max suppression. Regarding the food region detection and the PASCAL VOC detection task, it was hence seen that the proposed model worked much better than the RCNN.

Sun et al. [24] has proposed a system where dimension of the food can be determined for calculation of calorie. Results of their experiments have shown that method proposed by them produces decent accuracy level including measurement error consisting between 5 and 8%. Solving this problem was done by collecting the food dimensions based on image data collected through following methods (Table 1):

- Pin hole model
- Intrinsic and extrinsic parameters
- Focal length estimation
- Size estimation.

3 Conclusion

In this paper, we have discussed about various techniques proposed by different authors to detect and recognize multiple food items placed in a plate. We saw how each method work, how much accuracy these methods give and concluded that Convolutional Neural Network shows greater accuracy than any other base methods for food detection, SVM for food recognition. In our future work, we will develop an application to detect and recognize food and calculate total calorie counts present in that dish.

Table 1 Tabular representation of the survey

R. No., year	Approach	Feature used	Accuracy	Merits	Demerits	Data set used
[2] (2017)	Stochastic gradient and region selection	BoF-bag of features, HOG-a histogram of oriented gradient, Gabor texture features	94.11%	Minimum cost, minimum errors and faster compared to older models	Too much variance in food appearance	FooDD dataset
[4] (2016)	K-mean clustering, and segmentation based on GraphCut	Colour and Texture	–	–	– Multiple food detection in composite meals – Users acceptance studies	–
[5] (2018)	Fuzzy C-means, weighted FCM, SVM	Brightness of food image, temperature	2.21% error in software and 2.28% error in hardware	Results are better than other average statistical data	– Component cost (thermal cameras) are highly expensive – Bulkiness of the system	–
[6] (2016)	Convolutional neural network, JPEG algorithm	Colour, texture, PRI probabilistic rand index, variation of information (VI), unique dataset	79% accuracy achieved for recognition of food items	– Used large food categories for better prediction – Implemented segmentation pipeline for proper segmentation of food items and tray images	– Manually segmentation of food images, therefore time consumed will be more – Could not achieve accuracy as high as other methods studied in this paper	UNIMIB 2016

(continued)

Table 1 (continued)

[7] (2015)	Food recognition, multi-view recognition, multi kernel SVM	Semantic texton forest (STF), colour histogram, texture verification, food ingredient features	90% precision for general food items 85% for difficult categories (DCs)	DietCam presented reliability and outperformance in recognition of food with complex ingredients, realtime performance	The food categories with small and vague ingredients were not covered, some ingredients (or food and ingredients) were not visually separable in the image	PFID
[8] (2016)	SIFT, Geolocalization of restraints using GPS	Type of dishes eaten	54–70%	Helps the tracking of food items ordered by customers using the internet and measure the calorie intake	The images of all the food items available won't necessarily be uploaded	–
[9] (2017)	CNN: AlexNet, GoggleNet, ResNet	Texture, colour and shape of the food item	95.95% for 10 Indian food dishes and 97.6% for ETH food 101-database	High accuracy when consider a large database of food	–	
[10] (2013)	SVM, Bayesian framework for food balance estimation, AdaBoost for colour and frequency detection	Colour features, circle features, BoF, Block features	92%	Performance on food-balance estimation as well by using the Bayesian framework to reflect correction from the users and improve in the estimations	Recall rate needed to be used incase of dataset which has less data, the no. of estimations can result in 0 for some class, thus the precisions were not defined	FoodLog

(continued)

Table 1 (continued)

[11] (2007)	2D-3D conversions, gabor filters, Kalman filters, particle filter, 2D, 3D hypothesis	–	–	Accurate results for surface approximation	– Time consuming – Space consuming	
[12] (2009)	Gabor filter, SVM	RGB colour data (values of red, green, and blue), Gabor texture features	–	Does not require any manual labour as in previous food related experiments	The algorithms do not utilized 3D images to give an optimal output, also the detection of food item when considering low quality images has not been implied	
[25] (2018)	Two-step K-means clustering algo, CNN model (rooted from GoogLe Net model), softmax classifier	Edge pixels, texture, colour, grayscale	– Top-5 accuracy on UEC-100 dataset = 95.2% – Top-5 accuracy on Food-101 dataset = 94%	– Takes care of blurred images – Less energy consumed by system – Minimum response time	Network connection (cellular or WiFi connection) required	UEC-256, UEC100 and Food101
[13] (2016)	Gabor filter, colour texture, Graphcut segmentation, SVM as classifier, CNN	Colour, texture	99%	Much-improved food recognition and image segmentation technique when compared to previous models giving a high segmentation result	Like all Deep learning algorithms and models, it takes time for the user to understand how to implement the application	Web service called FoodLog

(continued)

Table 1 (continued)

[14] (2016)	Convolutional neural network	Local colour and texture features	81.55%	Higher accuracy compared to the previous models	As shown by experimental results the output is not always as optimal as desired	ILSVRC dataset
[15] (2013)	Bounding image with box adjustment: GrabCut, food recognition: linear SVM (classifier), uses linear support vector machine	Colour histogram, HoG, gabor texture feature, PHoG and bag-of-SURF	81.55%	As it dedicated to a mobile system it requires fast and accurate recognition which is achieved using the SVM	The only issue with the image recognition is that the GrubCut algorithm has a high computation cost	Kaggle dataset
[16] (2014)	Convolutional neural	Colour features	93.8%	Very high accuracy when considering image recognition, ability to detect vast categories of food which was difficult with traditional recognition models	–	FoodLog (FL)
[17] (2014)	SVM based food recognition model, Gabor filter	Colour and texture	92.21%	Better detect of food items with the help of image recognition, improvise the ability to detect various colours	– Inaccuracy for mixed food and liquid diet – Food classification categories are less	Own dataset

(continued)

Table 1 (continued)

[18] (2015)	K-nearest neighbour search algorithm, word graph	Textual input	82.5%	– Better statistical investigation of this huge dataset - Works for two different datasets	The system built was limited to Japanese language	FoodLog, Rakuten recipe database
[19] (2013)	Shape reconstruction: Kinect fusion algorithm, volume est.	Shape and colour	61.34%	– Low failure rates – Computation time is less than 15 s	Complexity of surface causes error values	USDA food and nutrient database
[1] (2012)	Felzenszwalb's DPM (deformable part model, JSEG region segmentation, circle detector	Bounding box of candidate regions including bag-of-features based on SIFT, (HoG), Gabor texture features and CSIFT with spatial pyramid (SP-BoF)	55.8%	To reduce computational cost	Low recognition accuracy	Own dataset
[21] (2010)	Invariant feature transformation (SIFT) detector, local binary pattern (LBP)	Local texture, shape	78%	Robust, simple for computation, better accuracy achieved for some categories of food	Low recognition performance	Pittsburgh fast food image (PFI) dataset
[22] (2010)	PFID: colour histogram + SVM and bag of SIFT features + SVM	Descriptive pairwise, low level, statistical features	80%	Outperforms baseline model of bag-of-features based on SIFT/colour histograms	Techniques used globally for identifying the objects are not suitable for such a problem	Pittsburgh food image dataset (PFID)

References

1. Matsuda Y, Hoashi H, Yanai K (2012) Recognition of multiple-food images by detecting candidate regions. In: IEEE international conference on multimedia and Expo. Department of Informatics
2. Pouladzadeh P, Shirmohammadi S (2017) Mobile multi-food recognition using deep learning. ACM Trans Multimedia Comput Commun Appl
3. Kuang P, Cao W-N, Wu Q (2014) Preview on structures and algorithms of deep learning. In: 11th international computer conference on wavelet active media technology and information processing (ICCWAMTIP)
4. Pouladzadeh P, Shirmohammadi S, Yassine A (2016) You are what you eat: so measure what you eat! IEEE Instrum Meas Mag
5. Turmchokksam S, Chamnongthai K (2018) The design and implementation of an ingredient-based food calorie measurement system using nutrition knowledge and fusion of brightness and heat information. IEEE
6. Ciocca G, Napoletano P, Schettini R (2016) Food recognition: a new dataset, experiments and results. IEEE J Biomed Health Inform
7. He H, Kong F, Tan J (2015) DietCam: multi-view food recognition using a multi-kernel SVM. IEEE J Biomed Health Inform
8. Herranz L, Xu R, Jiang S (2016) Modeling restaurant context for food recognition. IEEE Trans Multimedia
9. Pandey P, Deepthi A, Mandal B, Puhan NB (2017) FoodNet: recognizing foods using ensemble of deep networks. IEEE Signal Process Lett
10. Aizawa K, Maruyama Y, Li H, Morikawa C (2013) Food balance estimation by using personal dietary tendencies in a multimedia food log. IEEE Trans Multimedia
11. Henriksen JJ (2007) 3D surface tracking and approximation using Gabor filters. South Denmark University
12. Martin CK, Kaya S, Gunturk BK (2009) Quantification of food intake using food image analysis. In: Conference proceedings of the international conference of IEEE engineering in medicine and biology society
13. Pouladzadeh P, Kuhad P, Peddi SVB, Yassine A, Shirmohammadi S (2016) Food calorie measurement using deep neural network. In: IEEE international instrumentation and measurement technology conference proceedings
14. Zhang XJ, Lu YF, Zhang SH (2016) Multi-task learning for food identification and analysis with deep convolutional neural networks. J Comput Sci Technol
15. Kawano Y, Yanai K (2013) Real-time mobile food recognition system. In: IEEE conference on computer vision and pattern recognition workshops (CVPRW)
16. Aizawa K, Kagaya H, Ogawa M (2014) Food detection and recognition using convolutional neural network. In: '14 Proceedings of the 22nd ACM international conference on multimedia
17. Pouladzadeh P, Shirmohammadi S, Al-Maghrabi R (2014) Measuring calorie and nutrition from food image. IEEE Trans Instrum Meas
18. Amano S, Aizawa K, Ogawa M (2015) Food category representatives: extracting categories from meal names in food recordings and recipe data. In: IEEE international conference on multimedia big data
19. Dehais J, Shevchik S, Diem P, Mougiakakou SG (2013) Food volume computation for self dietary assessment applications. In: IEEE 13th international conference on bioinformatics and bioengineering (BIBE)
20. Villalobos G, Almaghrabi R, Pouladzadeh P, Shirmohammadi S (2012) An image processing approach for calorie intake measurement. In: IEEE international symposium on medical measurements and applications proceedings
21. Zong Z, Nguyen DT, Ogunbona P, Li W (2010) On the combination of local texture and global structure for food classification. In: International symposium on multimedia
22. Yang S, Chen M, Pomerleau D, Sukthankar R (2010) Food recognition using statistics of pairwise local features. In: IEEE computer vision and pattern recognition

23. Shimoda W, Yanai K (2015) CNN-based food image segmentation without pixel-wise annotation. In: International conference on image analysis and processing—ICIAP 2015 workshops. Springer
24. Sun M, Liu Q, Schmidt K, Yang L, Yao N, Fernstrom JD, Fernstrom MH, DeLany JP, Sclabassi RJ (2008) Determination of food portion size by image processing. In: 30th annual international conference of the IEEE engineering in medicine and biology society
25. Liu C, Cao Y, Luo Y, Chen G, Vokkarane V, Ma Y, Hou P (2018) A new deep learning-based food recognition system for dietary assessment on an edge computing service infrastructure. IEEE Trans Serv Comput
26. Chi P-YP, Chen J-H, Chu H-H, Lo J-L (2008) Enabling calorie-aware cooking in a smart kitchen. In: PERSUASIVE '08 Proceedings of the 3rd international conference on Persuasive Technology

Real Object Detection Using TensorFlow

Milind Rane, Aseem Patil and Bhushan Barse

Abstract Distinguishing and perceiving objects in unstructured and in addition organized situations is a standout amongst the most difficult undertakings in computer vision and man-made reasoning exploration. This paper presents another computer-based vision hindrance recognition technique for versatile innovation and its applications. Every individual picture pixel is delegated having a place either with an impediment dependent on its appearance. The technique utilizes a solitary focal point webcam camera that performs progressively, and furthermore gives a twofold hindrance picture at high goals. In the versatile mode, the framework continues taking in the presence of the snag amid activity. The framework has been tried effectively in an assortment of situations, inside and outside, making it reasonable for a wide range of obstacles. It likewise reveals to us the kind of impediment which has been distinguished by the framework.

Keywords Object detection · Image edge detection · Image segmentation · Object recognition · Computer vision

1 Introduction

Obstacle detection is an important task for many mobile technological applications. Most mobile applications rely on range data for obstacle detection. Zhang, Forshaw [1] Popular sensors for range-based obstacle detection systems include ultrasonic sensors, lasers, radar, stereo vision, optical flow, etc. Because these sensors measure the distances from obstacles to the robot, they are unavoidably suited for the tasks of obstacle detection and obstacle avoidance. But, none of these sensors are perfect. Ultrasonic sensors are cheap but suffer from optical and spectral reflections and usually from poor angular resolution. Ren, He, Girshick et al [2] Lasers and radars provide better resolution but are more complex and more expensive. Moreover, stereo vision and optical flow are nearly computationally expensive. In addition

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to their individual deficiency, all range based obstacle detection systems have difficulty detecting small or flat objects on the ground. Accurate and reliable detection of these objects require high measurement accuracy and hence precise calibration. Range Sensors have a difficult time in detecting obstacles on the ground surface. He, Zhang, Ren et al [3]This is a problem especially outdoors, where range sensors are usually unable to differentiate between the sidewalks and the adjacent flat grassy areas. While small objects and different types of ground are difficult to detect with range sensors, they can be easily detected with color vision. For this reason, we have developed a new appearance-based obstacle detection system that is based on the technology of artificial intelligence. The heart of the algorithm consists of detecting pixels different in appearance than the ground and classifying them as obstacles. The algorithm performs in real-time, providing a high-resolution of the obstacle image, and operates in a variety of environments. The fundamental difference between the range-based and thee appearance-based obstacle detection systems is the obstacle criterion. In range-based systems, obstacles are objects that bulge out a minimum distance from the ground. In appearance-based systems, obstacles are objects that are distinct in appearance from the ground.

2 Literature Survey

There are two primary critical methods for identifying impediments and entities in a framework. They are namely Pytorch and TensorFlow.

Ren, He, Girshick et al [2] PyTorch is an open source in the machine learning library for Python, in light of the dialect Torch, utilized for applications, for example, normal dialect handling (NLP). It was principally created by Facebook's man-made consciousness look into gathering, and Uber's examination assemble in particular "Pyro" for probabilistic programming. While, TensorFlow is an open-source programming library for dataflow programming over a scope of errands. Malinovskiy, Zheng, Wang [4] It is an agent math library, and is utilized for machine learning applications, for example, convolutional neural systems. TensorFlow pursues the colloquialism 'Information as Code and Code is Data'.

In TensorFlow you define the graph inertly before a model can run. All its communications with the outer world are performed with two sensors namely, `tf.Session` object and `tf.Placeholder`, which are tensors that will be substituted by an external data at its runtime. In PyTorch things are way more essential and dynamic, you can define, change and execute nodes as you edit and process the code, no special session interfaces or placeholders are required. Overall, the framework is slightly more tightly integrated with Python programming language and it feels more native most of the times Ren, He, Girshick et al [2]. When you code in TensorFlow sometimes you feel that your model is behind a brick wall with several tiny apertures to communicate over. From the following points we can conclude that using TensorFlow the process is more efficient and is more reliable than Pytorch. So we shall implement our project using TensorFlow.

3 Appearance-Based Object Detection

Appearance-based entity recognition techniques have as of late exhibited better execution on a variety of issues. The framework shows phenomenally great acknowledgment of an assortment of 3-D objects, going from autos and planes to snakes and reptiles with full orthographic in-variance. It has played out various substantial scale tests, including more than 2000 separate test pictures that assess execution with expanding number of things in the database, within the sight of foundation change and impediment, it is likewise the consequences of some the conventional arrangement tests where the framework is tried on the articles never recently observed or demonstrated.

The fundamental idea is to represent the visual appearance of an entity as the approximately organized blend of various nearby setting districts keyed by unmistakable key highlights, or parts. Presently under the diverse conditions the element extraction process will discover a portion of these unmistakable keys, in any case, by and large not every one of them. Indeed, even with the nearby relevant check, such keys likely could be reliable with various worldwide speculations. In any case, the division that can be found by existing component extraction forms is every now and again adequate to recognize questions in the scene, when the worldwide proof is amassed. Zhang , Forshaw [1] This is one of the rule issues of article acknowledgment, which is that, in any but instead fake conditions, it has so far demonstrated difficult to dependably section entire items on a base up premise. In a present framework, nearby highlights depend on consequently separated limit parts are utilized to speak to various 2-D views (aspects) of inflexible 3-D objects, however the essential thought can be connected to different highlights and different representations.

4 Implementation

4.1 YOLO Weights in Real Object-Detection

You only look once (YOLO) is an object detection system used for real-time image processing (Fig. 1).

YOLOv3-320	COCO trainval	test-dev	51.5	38.97 Bn	45	cfg	weights
YOLOv3-416	COCO trainval	test-dev	55.3	65.86 Bn	35	cfg	weights
YOLOv3-608	COCO trainval	test-dev	57.9	140.69 Bn	20	cfg	weights
YOLOv3-tiny	COCO trainval	test-dev	33.1	5.56 Bn	220	cfg	weights
YOLOv3-spp	COCO trainval	test-dev	60.6	141.45 Bn	20	cfg	weights

Fig. 1 YOLO weights used in the processing

4.2 Advantages of YOLO

1. Speed (45 frames per second), faster than real-time
2. Network understands generalized object representation
3. It is a faster version with a smaller architecture of 155 frames per sec, but is less accurate.

4.3 Limitations of YOLO

YOLO forces solid spatial limitations on the jumping box forecasts since every one of the matrix cells just predicts two boxes and can have just a single class. This spatial limitation at that point confines the quantity of close-by items that our model can anticipate. The model battles with the little items that show up in gatherings. Since the model figures out how to foresee jumping boxes from information, it anyway battles to sum up items in new or abnormal perspective setups.

4.4 Webcam/Camera Installment

We have to call the function cv2.VideoCapture(), and read the approaching frames. The .read() technique is a blocking potency, so the primary string of our Python content is totally obstructed until the point that the edge is perused until the camera gadget comes back to our script (Fig. 2).

This is an issue, as it is basic for our framework to keep running progressively. We can enhance the FPS (frames per second) just by making the new string that does

Fig. 2 Using OpenCV for installing the camera

```
import cv2

video_capture = cv2.VideoCapture(0)
while True:
    # Capture frame-by-frame
    ret, frame = video_capture.read()
    cv2.imshow('Video', frame)

    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

```

only pull the camera for new casings while our principle string handles preparing over the present edge.

4.5 Algorithm of the System with VideoCapture Function

1. Load the required yolo.cfg and yolo.weights depending on its processing speed.
2. Develop the TensorFlow graph and store it locally using TFNet.
3. Capture the Video using OpenCV and break it into frames.
4. While the frame exists predict and perform the suitable triggering actions on it.
5. Once done with all the frames close cv2.VideoCapture().

5 Applications of the System

5.1 Self-driving Cars

Self-driving cars square measure the longer term, there's little question in this.

However the operating behind it's terribly tough because it combines a range of techniques to understand their surroundings, together with radio detection and ranging, optical device lightweight, GPS, odometry, and laptop vision [5].

Advanced management systems interpret sensory info to spot acceptable navigation methods, similarly as obstacles and once the image sensing element detects any sign of a living being in its path, it mechanically stops. This happens at a awfully quick rate and could be a massive step towards Driverless Cars.

5.2 Security

Object Detection plays a awfully vital role in Security. Be it face ID of Apple or the membrane scan employed in all the sci-fi movies. Girshick R [5] It is conjointly employed by the government to access the protection feed and match it with their existing information to search out any criminals or to observe the robbers' vehicle. The applications square measure limitless (Fig. 3).

Fig. 3 Output of the video that was programmed on, before testing it on a live feed

Table 1 Object level versus pixel level w.r.t. the frame of reference

		Pixel level			Object level		
		P	R	F	P	R	F
Overall	Our	76.9	80	77.6	63.5	73.4	68.1
		81.9	73.7	70.9	61.9	66.9	64.3
Dataset1	Our	68.3	73.6	68.3	51.7	56.2	53.8
		69.9	66.9	85.8	46.8	54.9	50.6
Dataset2	Our	85.6	85.9	87	75	92.5	82.8
(P) Precision (%)		(R) Recall (%)			(F) F-measure (%)		

6 Results

See Table 1.

7 Conclusions

TensorFlow has far better and easier support for saving and loading models across totally different environments and even programming languages. If loading and saving models is a priority, then TensorFlow comes in handy. This paper presents a new method for obstacle detection with a single webcam camera. It also presents a new method of vision-based surveillance robot with obstacles avoidance capabilities for general purposes in indoor and outdoor environments. The algorithms of neural

networks for obstacle detection and framing the image has been used. Dai J, Li Y, He K et al [6] The camera used has a very poor resolution because it uses only 5MP. For future work, we will improve this system, to act as a surveillance system in robotic as well as future applications.

References

1. Zhang X, Forshaw MRB (1997) A parallel calculation to extricate data about the movement of street traffic utilizing picture investigation. Transp Res: Part C 5(2):141–152
2. Ren S, He K, Girshick R et al (2015) Faster R-CNN: towards real-time object detection with region proposal networks. IEEE Trans Pattern Anal Mach Intell 39:1137
3. He K, Zhang X, Ren S et al (2016) Deep residual learning for image recognition. In: Computer vision and pattern recognition. IEEE, pp 770–778
4. Malinovskiy Y, Zheng JY, Wang YH (2007) Straightforward and display free calculation for continuous person on foot discovery and following. The 86th annual meeting of the transportation research board, Washington, D.C.
5. Girshick R (2015) Fast R-CNN. Comput Sci
6. Dai J, Li Y, He K et al (2016) R-FCN: object detection by means of region-based fully convolutional networks

BPSO Based Method for Screening of Alcoholism

Sandeep Bavkar, Brijesh Iyer and Shankar Deosarkar

Abstract Selection of optimal channels for alcoholic detection is a major issue in recent year. Advance knowledge of brain region or EEG channels, most affected by alcohol, will reduce the computational complexity and new EEG recording device can be designed using selected channels. In this paper, we propose complexity and nonlinearity features and ensemble subspace K NN classifier to differentiate alcoholics and nonalcohol's from visually evoked potential (VEP). Binary particle swarm optimization (BPSO) is used to select optimum number of channels that minimize classification errors. A novel fitness function is designed to use in optimization technique. Fitness function evaluated using classification error and selected channels. Experimental results show that optimal channel selected have biological significance associated with alcoholic person. Thus, the outcome of the proposed channel selection methodology can be used for the accurate and rapid classification of normal and alcoholic subjects.

Keywords Alcoholic · BPSO · Nonlinear feature

1 Introduction

Brain is the most complex organ in human body. It contains near about 1012 million neurons acting in very complex manner. Excess alcohol consumption damages every organ in body, including brain. Analysis of the effect of alcohol on the human brain is difficult due to chaotic nature of the brain. An EEG is non-invasive method for recording brain signal during which several electrodes are placed on human scalp.

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These signals are used for analyzing different brain diseases like a brain tumor, epilepsy, brain trauma, strokes and alcoholism analysis. According to WHO 2016 report, alcohol consumption is turning fatal for human being irrespective of its socio-economical strata [1].

Henri Begleiter et al. had first reported the analysis of the effect of alcohol on human central nervous system [2]. After this work, many researchers were worked on classification of alcoholic and nonalcoholic persons based on EEG signals and achieved notable classification accuracy [3–12]. Hybrid Feature [3, 9], Computer Aided Diagnostic (CAD) Technique [4], Machine Learning [5], Functional Brain Network [6], Time–frequency Images [7], Empirical Mode Decomposition [8] are proposed in past literatures. However, these results do not contain information regarding the most vulnerable area of the brain (sensitive channels) or different cognitive impairments in the brain due to alcohol. Most vulnerable brain area to alcohol addiction can be identified by comparing alcoholic EEG with normal EEG based on location of channel. EEG channel that contribute more discriminant information between alcoholic and normal EEG were selected as vulnerable channels.

This manuscript is organized as: In Sect. 2, the details of state of art in the proposed area of research. In Sect. 3, the proposed methodology is explained. Section 4, belongs to experimental results and discussion the conclusions are written in Sect. 5.

2 State of the Art Technology

Generally, EEG signals are recorded with the help of 64 channel EEG machine. Increase in the number of channels may increase the spatial resolution but at the cost of huge computational complexity. It is recognized that alcohol disturbs the motor system most prominently and therefore the cerebral motor cortex area is considered to be most susceptible to alcoholism [10]. In the literature, few research papers reported the EEG channel selection, however, there result shows reduction in accuracy when the number of channels are decreased [11]. Few researchers studied the optimal channel selection out of 64 EEG channel for better classification result. R. Palaniappan et al. used genetic algorithm (GA) for optimization of EEG channel to efficiently distinguish alcoholics and controls. This method provided an average classification accuracy of 81.8 and 94.3% by fuzzy art map (FA) classifier and multi-layered perceptron-back propagation (MLP-BP) network respectively. Studies in [11] have revealed that as number of channels reduced using PCA, the classification accuracy also reduced. Classification accuracies obtained on reduced channel 95.83, 94.06, 86.01, and 75.13% for 61, 16, 8, and 4 channels, correspondingly. The correlation between the chosen optimal subset of channels for alcoholics was discovered in a study [12] to choose the channel subset based on the mean gamma band power. However, there is a need to study impact of different optimization algorithm for EEG optimal channel selection. Prior information of the arrangement of these channels will permit a decrease in the essential hardware and computation time. So, methods of detecting these channels must be found.

3 Materials and Methods

3.1 Problem Formulation

EEG data recorded with 64 channels increase the computational complexity during the analysis of the EEG signal. These 64 electrodes cover all locations over the scalp (Brain region). These channels extract signal present at cerebral cortex of brain from different location. All EEG channels may not contribute discriminant information between alcoholic and normal EEG because alcohol may damage particular brain region more as compare to the other. Hence, we need to focus on particular brain region channels or most efficient channels that provides significant variation in EEG signals of alcoholic person. To obtain most affected channels, we proposed to use optimization algorithm that gives few channels (only affected by alcohol). "Decrease the number of channels by keeping accuracy constant" is the optimization problem. For this problem, a fitness/objective function need to be derived by considering the different constraints (Number of channels and Accuracy). In this paper, the novel fitness function defined as:

$$Fitness = \beta_t \times \frac{\#Channels}{\#All\ Channels} + (1 - \beta_t) \times \frac{Error\ Rate}{Error_0} \tag{1}$$

$$\beta_t = \beta\max \times \frac{t}{T}$$

where β_t belongs to [0; 1] and t signifies the tth iteration in the algorithm. T represents the maximum iterations of the BPSO. *#Channels* denotes the number of channels selected. *#All Channels* gives the number of all the available channels. *Error Rate* indicates the classification error rate obtained using the selected channel subset. *Error*0 is the error rate obtained by using all the available channels for classification on the training set. $\beta_{\max}$ is the maximum value of β_t and $\beta_{\max}$ is in between [0; 1].

3.2 Feature Extraction Method

Most important part in classification problem is to extract discriminant information as feature. EEG signals are very complex and chaotic in nature so, initially EEG signal is decomposed in its EEG rhythm delta (0–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–28 Hz), and gamma (28–60 Hz) band using IIR band pass filter as per their frequency range. Out of these rhythm alpha and gamma band further used to extract linear feature and complexity measure.

Sample Entropy, Approximate Entropy, Hjorth Mobility and EEG band power features extracted from alpha and gamma band rhythms as shown in Fig. 1, which plays major role in extracting discriminant features between alcoholic and normal subject.

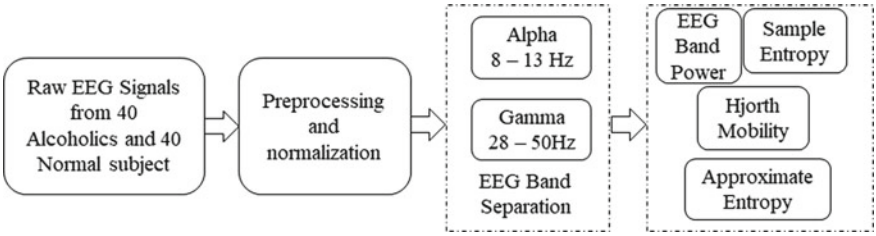

Fig. 1 Block diagram of feature extraction

3.3 Binary Particle Swarm Optimization

In 1995, PSO algorithm was developed by Kennedy and Eberhart which is based on the simulation of social behavior of birds [13]. In PSO each particle has potential solution to search problem. The particles fly over the search space with definite velocity. Each particle gains the knowledge from the discoveries and previous experience of all other particles of the swarm. Every particle searching for best solution for given problem in search space, they consider the present best solution as well as previous best solution. The position and velocity of the particle are updated as follows.

$$v^i_{(k+1)} = wv^i_k + c_1 * r_1(p^i_k - x^i_k) + c_2 * r_2(xgbest - x^i_k) \tag{2}$$

$$x_i(t+1) = x_i(t) + v_i(t+1) \tag{3}$$

where $C1$ is cognitive component and $C2$ is social component; i denotes each particle. $C1$, $C2$ controls the movement of particle in single trial. When $C1 > C2$, more importance given to personal best as compared to global best solution and vice versa. w is inertial weight value which constrains previous velocity. $r1$, $r2$ are arbitrary random values between 0 and 1.

Binary PSO (BPSO) is discrete adaptation of PSO. Velocity update is same as in particle swarm optimization. The only difference is that the particles have either a 0 or 1 value in BPSO, and position revise rule is different. Following equation provides the revise rule for BPSO.

$$s(v) = \left(1 + e^v\right)^{-1} \tag{4}$$

$$\begin{aligned} &\text{If} \quad \emptyset < S\left(v^i_{k+1}\right)\ x^i_{k+1} = 1 \\ &\text{Else if } \emptyset > S\left(v^i_{k+1}\right)\ x^i_{k+1} = 0 \end{aligned}$$

where, Ø is a random value between 0 and 1. Channel space acting as the solution space for searching problem, and each particles location can have a value of either 0 or 1. '0' indicate channel not selected for classification and '1' indicate channel

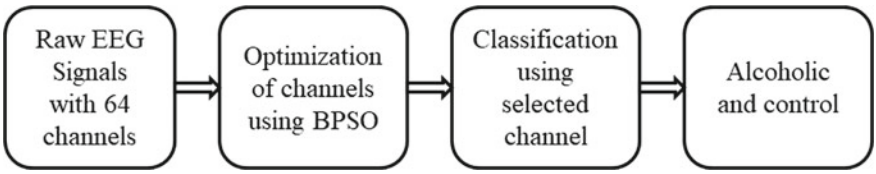

Fig. 2 Block diagram of channel selection

selected for classification. Initially random population is generated as binary string for each particle as shown in below.

Channels	1	2	3	4	…	60	61
Particle 1	1 ✓	0 ✗	0 ✗	1 ✓	…	0 ✗	1 ✓
Particle 2	1 ✓	1 ✓	0 ✗	0 ✗		1 ✓	1 ✓
. . .							
Particle n	0 ✗	1 ✓	1 ✓	1 ✓		0 ✗	0 ✗

Particle having bit '1' means that channel is selected and '0' means channel is not selected for calculating fitness function. Block diagram for channel selection procedure is shown in Fig. 2.

For classification purpose, various methods like Linear Discriminant, QDA (Quadrature Discriminant Analysis), SVM (Support Vector Machine), K NN (K Nearest Neighbor) and Ensemble classifier with different kernel function are used in experimentation and performance is compared with respect to accuracy. Out of theses classifier Ensemble subspace K-NN classifier gives better results.

4 Experimental Design and Result

For experimentation 40 alcoholics and 40 normal persons EEG were used with 10 trails each from Neurodynamics Laboratory, State University of New York Health Center [14]. Total 800 samples were used for training and testing the proposed method performance. Randomly 80% samples used for train set and remaining 20% used for test set. Ensemble Subspace K NN is selected for evaluation of classification performance with BPSO.

The parameters of BPSO are set as follows: inertia weight $w = 0.8$, acceleration constants $c_1 = c_2 = 2$, maximum velocity $v_{max} = 6$, population size $P = 50$, maximum iteration $T = 100$. The fully connected topology is used in BPSO. As the maximum iteration is 100, we have given more importance to accuracy at initial phase therefore, $\beta max = 0.2$ is selected in Eq. 1.

Table 1 Classification results comparison of with and without BPSO

	Linear discriminant (%)	QDA (%)	Quadratic SVM	Fine K NN	Weighted K NN	Ensemble subspace K NN
Accuracy using 61 Channels	76.3	81.8	87.4	91.1	88.9	95.1
Accuracy using selected channels	71.1	65	83.6	91.8	91.5	92.88

Each particle is holding the binary string of length 61. By using each particle classification accuracy and Fitness function was evaluated using Eq. 1. The particle which gives maximum fitness value will be selected as global best particle. Table 1 describes the results obtained from different classifier using all 61 channels and selected channels by BPSO. It gives maximum classification accuracy using Ensemble Subspace K NN classifier.

BPSO is applied iteratively eleven times to select most optimal channels in alcoholic person. Result gives 'FP1', 'FP2', 'FC5', 'T7', 'O2' 'AF7', 'AF8' 'F6', 'FPz', 'TP8', 'TP7', 'PO7', 'PO8' and 'FT7' are the 14 optimal channels. These channels give 92.88% accuracy with Ensemble Subspace K NN which is approximately equal to without selecting optimal channel.

These selected channels belong to prefrontal cortex, temporal region and occipital region. It indicates alcoholics persons have inability in functions of these brain regions. Due to damage in occipital and temporal region, alcoholic person have blurred vision and unable to hair clear speech. A selected channel in our invention maintains overall accuracy as that of using all 64 channels. It indicates other channels (brain region) have minor impact of alcohol as compared to selected brain region channels.

5 Conclusion and Future Scope

The present paper proposes the method for detecting optimal channel that have most impact of alcohol. BPSO Optimization algorithm detects EEG channels that are affected due to large consumption of alcohol. Proposed method detects 'FP1', 'FP2', 'FC5', 'T7', 'O2' 'AF7', 'AF8' 'F6', 'FPz', 'TP8', 'TP7', 'PO7', 'PO8' and 'FT7' channels as most optimal channels. These channels give 92.88% accuracy with Ensemble Subspace K NN which is approximately equal to without selecting

optimal channel. Experimental results show that optimal channel selected have biological significance associated with alcoholic person. Thus, it is projected that for future analysis, these selected channels might be used for application that involves classification of alcoholics and nonalcohol's. A selected channel in our invention maintains overall accuracy as that of using all 64 channels.

References

1. World Health Organization (2016) Global status report on alcohol and health. World Health Organization, Geneva
2. Begleiter H, Platz A (1972) The effects of alcohol on the central nervous system in humans. In: Kissin et al (eds) The biology of alcoholism. Plenum Press, New York
3. Ren W, Han M (2018) Classification of EEG signals using hybrid feature extraction and ensemble extreme learning machine. Neural Process Lett
4. Acharya UR, Sree SV, Chattopadhyay S, Suri JS (2012) Automated diagnosis of control and alcoholic EEG signals. Int J Neural Syst 22(3):1250011
5. Mumtaz W, Vuong PL, Xia L, Malik AS, Rashid RBA (2016) An EEG-based machine learning method to screen alcohol use disorder. Cogn Neurodyn 11(2):161–171
6. Ahmadi N, Pei Y, Pechenizkiy M (2017) Detection of alcoholism based on EEG signals and functional brain network features extraction. In: 2017 IEEE 30th international symposium on computer-based medical systems (CBMS), Thessaloniki, pp 179–184
7. Bajaj V, Guo Y et al (2017) A hybrid method based on time–frequency images for classification of alcohol and control EEG signals. Neural Comput Appl 28:3717
8. Priya A, Yadav P, Jain S, Bajaj V (2018) Efficient method for classification of alcoholic and normal EEG signals using EMD. J Eng 2018(3):166–172
9. Bavkar S, Iyer B, Deosarkar S (2019) Detection of alcoholism: an EEG hybrid features and ensemble subspace K-NN based approach. In: 15th international conference, ICDCIT 2019, Bhubaneswar, India. https://doi.org/10.1007/978-3-030-05366-6_13
10. Daskalakis ZJ et al, The mechanisms of interhemispheric inhibition in the human motor cortex. J Physiol 543:317–326
11. Palaniappan R, Raveendran P, Omatu S (2002) VEP optimal channel selection using genetic algorithm for neural network classification of alcoholics. IEEE Trans Neural Networks 13(2):486–491
12. Ong K-M, Thung KH, Wee C-Y, Paramesran R (2005) Selection of a subset of EEG channels using PCA to classify alcoholics and non-alcoholics. In: 2005 IEEE engineering in medicine and biology 27th annual conference, Shanghai, pp 4195–4198
13. Kennedy J, Eberhart R (1997) A discrete binary version of the particle swarm algorithm. Proc IEEE Int Conf Syst Man Cybern 5:4104–4108
14. https://archive.ics.uci.edu/ml/datasets/eeg+database

Real Time Analysis of Android Applications by Calculating Risk Factor to Identify Botnet Attack

Sonali Kothari

Abstract With the rapidly-growing popularity of smartphones, there has been a drastic increase in downloading and sharing of third-party applications and user-generated content, making smartphones vulnerable to various types of cyber-attacks. Current studies on botnet are mostly discussed on detection of botnet only. Any precautionary model for avoiding propagation is not available to safeguard user's mobile services. The tools available for botnet detection are very limited and mainly focused on identifying either existing attacks or web based attacks. Focusing on these limitations of existing methods, main aim of the proposed research work is to enhance the security of mobile services by analysing several security issues in accessing mobile services. This research work is focused on safeguarding mobile phones from ever growing and varying technologies of botnet attack. To identify malicious applications on user's mobile phone, security application is developed which scans all applications installed and identifies probable harmful applications.

Keywords Online social media · Android OS · Mobile botnet · Malware · C&C server · Smartphone attack

1 Introduction

Smart phones are becoming more common than Desktop PCs as mobile phones continue to acquire many capabilities. Usually smart phones remain online all the time because of their default features and behavior of user. Users must be aware that smart phones are endangered to being affected by malware and thereby can be turned into a client of bot as a botnet part. Mobile users are using various services provided like SMS, MMS, and Bluetooth for data transfer, and OSM access over WiFi/Data Network, Group message broadcasting, downloading various applications free of cost from various online stores etc. Most of these facilities are used without any precaution by end user. From the literature survey, it is clear that mobile botnet

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attacks are increasing day by day. To provide security to smart phones, a model is required which will allow attack-free access of mobile services through a common medium. Number of methods is available to attack mobile phones and that needs to consider while performing research work.

Though technically working of PC and Smart phones is different, methods used for infection, propagation, execution for both are very similar. Early detection of botnet activities is an important issue because its further propagation and damages can be responded and prevented. The first Android bot, Gemini, was discovered in China in December 2010. Android OS attacks can be categorized in four levels that is hardware-based, Linux kernel-based, system core program-based and application-based. Application based attacks are more common than other methods of attacks on Android. Android applications include pre-installed applications and user installed applications. User applications are downloaded from variety of sources making it difficult to identify their reliability. If application is installed from official play store, it doesn't guarantee malicious-content free application every time. Most of the times user ignores security tips provided while downloading/installing applications making device prone for attack.

2 Literature Survey

The increase of botnet attacks in mobiles have made researchers and analysers to focus on the participant components of botnet attacks in mobile phones since it is essential to know about the core process of botnet attacks prior detecting and preventing from the root cause.

2.1 Some Real World Botnet Attacks

Following are some commercial botnet attacks identified by various organizations or researchers.

1. WireX: This Android bot was successful in attacking tens of thousands devices within weeks after its launch in August 2017 [1]. The attack waited patiently before launching itself to avoid detection and hiding itself under system processes. The malware was available in Google Play store, which was removed after detection, and is trying to remove it from infected devices. This "Android Clicker" attack includes devices that are running one of the hundreds of malicious apps installed from Google Play store and launches massive application layer DDoS attack.
2. Mirai: By 2017, there were 8.4 million devices, which were connected in IoT network, and working either with low security or even without security. Mirai took advantage of this [2]. As stated in article, Paras Jha, an undergraduate at Rutgers

and interested in DDoS attacks for money making, developed Mirai under the name "Anna-Senpi" which includes hardcoded passwords. Mirai attack initiated in September 2016 and was used against the French host OVH.

3. Tizi: [3] states that Tizi, detected by Google Research team, is the backdoor malware designed to attack social media. Tizi was available on Google Play store and managed to escape Google's security system for Android devices. Before being detected, Tizi managed to infect 1300 devices mostly in Kenya, Nigeria and Tanzania.
4. HaoBao: McAfee Labs [4] reported resurfacing of Lazarus cybercrime group with new and sophisticated crypto currency attack scheme. McAffee labs reported 16 malwares, 23 incidents and 25 web and network threats during its first quarter threat report of 2018.

2.2 Botnet Detection Method

Amro [5] observed the existing mobile models, OS, Botnet attacks on mobiles and detection techniques. As per his findings, the malware propagation has certain techniques, such as: repackaging, dynamic payloads, drive by download and stealth malware techniques. The authors have also observed the evasion techniques of malwares and argued that: anti-security techniques, anti-analyst techniques and anti-sandbox techniques have been in use by the attackers in mobile phones which bypasses the security and safety measures initiated by application developers. Hence the study offered detection techniques, such as: (a) static techniques: permission based analysis, signature-based approach and virtual machine analysis; (b) dynamic techniques: anomaly based, emulation based and taint analysis. Thus the author explained about the evasion techniques and detection techniques in mobile phones.

Singh et al. [6] evaluate the potential for mobile phone based botnets to communicate and coordinate predominantly via Bluetooth. Authors investigate whether a command and control infrastructure can be maintained in an environment with almost entirely transient links. Authors has contributed in developing the first characterization of Bluetooth based C&C for mobile devices, create a new C&C architecture based on node popularity in which bots selectively communicate with the botmaster based on their popularity. Also authors have developed patching and mitigation strategies that significantly reduce a mobile botnet's ability to defend against countermeasures and remain hidden.

Singh and Chauhan [7] researched about Non-PC botnets and how to detect and prevent from them. Similar to Amro, the authors also stated that, detecting the botnets consists of two categories: static (or code) based approach and dynamic (run-time execution) analysis. Apart from these standard techniques, the authors have also stated that hybrid approach (for example: DroydSeuss) which consists of both static and dynamic would be more effective and faster in detecting the Botnet attacks in mobile phones. These hybrid approaches basically extracts data, stores data, filters data, scans/reads data for malicious residual of virus or malwares, especially Trojans,

botnets, etc. once it detects the malware it immediately cuts off the data access. Thus detecting and preventing malware attacks could be made faster and easier via hybrid approaches.

3 Proposed Methodology, Design and Implementation

Dynamic real-time analysis is performed on user device by calculating risk factor of every application. Permission vector plays vital role in permission analysis of applications as it helps in calculating risk factor and classifying application as trusted or untrusted. There are different permissions available at various levels of Android out of which many are redundant and never used in any of the applications. These permissions are removed during dynamic analysis. Permission vector for dynamic analysis has only those permissions which are harmful for user data. Out of hundreds of different Android permissions, not all the permissions are harmful. For dynamic analysis Android permissions are classified in four categories as most harmful, moderately harmful, and probably harmful and normal. More than 500 applications including benign and malware apk are analysed during this and 200 are selected for preparing self-prepared dataset. Permissions are allotted in respective category after checking access to different permissions by malwares, benign applications and frequently used permissions by all applications.

There are hundreds of Android permissions out of which 135 permissions are commonly used. With careful analysis of existing attacks and permissions used by them, 37 permissions are considered as harmful divided in three categories while remaining are considered as normal and assigned in fourth category. Every category is having a specific weight based on risk proposed by them. For Set A—weight 5, for Set B—weight 4, for Set C—weight 2 and for Set D—1 is assigned. These weights are used to calculate risk factor of every application on user device.

After identification of appropriate permissions for permission vector, user device is scanned and risk factor is calculated for all applications. Application with risk factor more than threshold is considered as dangerous for user device. The proposed system is then tested against detection of existing botnet attacks and preventing new attack from accessing user device data. To make system more compatible with ever growing apps, analyst is allowed to add new application and its permissions with threat level of app using admin panel. This will help user while scanning his device for malicious apps.

3.1 Procedure to Calculate App Risk Factor

Risk factor is average of two different risk scores calculated based on permissions added with third risk factor calculated with C2DM permission count.

1. First part is RF_1 which is calculated by assigning weight to all permissions based on their category. To calculate RF_1 of application, following formula is used. Here summation of permission of different category (P_i) multiplied by its weight (W_i) is calculated. If all permissions of this app are considered as dangerous, all permissions count (P) is multiplied by 5 (weight assigned to dangerous permission). Value of RF_1 will be converted into percentage risk. If RF_1 is above 60%, app is considered as untrusted and notified user without calculating remaining scores.

$$RF_1 = \frac{\sum (P_i \times W_i)}{5 \times P} \times 100$$

2. RF_2 is the second part of risk score calculation. In this total dangerous permissions of all categories (TP) are calculated and percent is calculated against 37 dangerous permission identified during research (P). If RF_2 is above 70%, app is considered as untrusted and notified user without calculating remaining scores.

$$RF_2 = \frac{P}{TP} \times 100$$

3. Besides this, C2DM permission is considered in risk calculation. If C2DM permission count (c), exceeds one, it is counted and multiplied with 5 to calculate RF_3.

$$RF_3 = \begin{cases} 0, & c \leq 1 \\ c \times 10, & c > 1 \end{cases}$$

4. RF is calculated using all these three risk factors. RF_2 is averaged with RF_1 and RF_3 is added in it to calculate Risk Factor of app RF. If RF exceeds 55%, it will be considered as untrusted and user will be notified with alert message.

$$RF = \frac{RF_1 + RF_2}{2} + RF_3$$

4 Sample Results and Discussion

For Android permission, standard datasets are not provided. Considering this, self-prepared dataset is made by carefully analysing benign and malicious applications and a dataset of approximately 200 records with 37 harmful permissions is designed.

4.1 Android Application for User Device

Following section shows results achieved during preventing malicious application based on application permissions on user device (Fig. 1).

1. INTERNET Permission Analysis: INTERNET is a permission which is used by most of the applications (benign and malicious). It is necessary for user to keep monitoring INTERNET permission. For this, list of all applications using this permission is listed.
2. Applications with High Risk Score: On scanning user device, risk score of all applications is calculated. If risk score is above threshold value, it is presented to user for consideration. Also third party applications using SMS service are presented for further action.
3. Category-wise Permission Details: Screenshot 4 shows details of permission used by different applications. Count in "RED" gives number of most harmful permissions, "YELLOW" count is moderately harmful permission category group, "BLUE" colour count is probably harmful permissions while last is count of normal permissions in "WHITE" colour. Clicking on respective application gives details about permission in respective category and check its risk factor calculated using risk factor formula.
4. Trusted-Untrusted Application: "Your Applications" option allows user to mark application as trusted or untrusted by changing its threat level. Based on risk

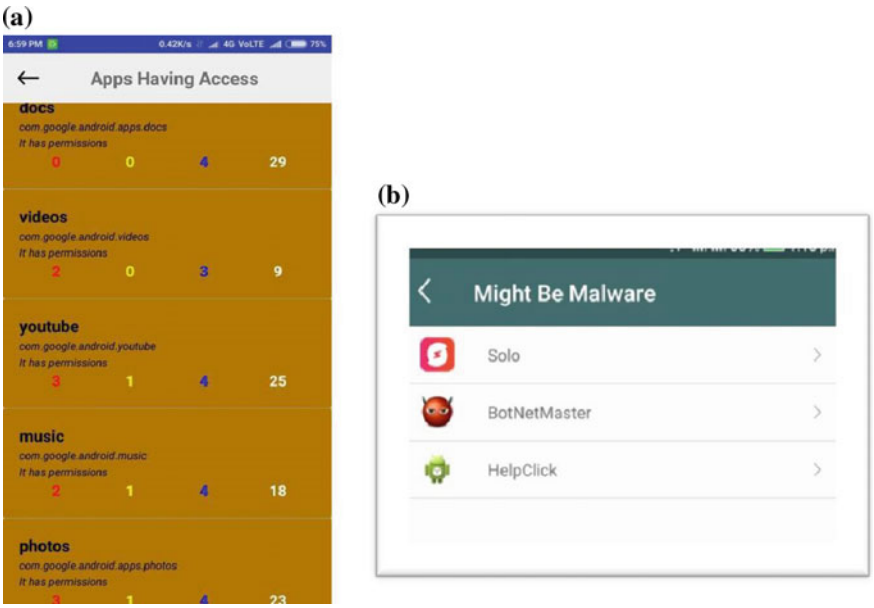

Fig. 1 Category-wise count of permissions and applications with high risk factor

factor, default threat level is shown using "YELLO" colour for mid-level risk and "RED" for application with high level risk (risk factor more than threshold). User is allowed to change threat level of application for his device if required using "Your" threat level button.

5. Adding New Malware Details through Admin Panel: Admin may find some applications which are not currently available in botnet or malware list. Admin Panel allows admin to add new applications with their risk details on server. This will help in detecting new risky applications. If some application needs to be updated by changing its risk level, it can be done using this panel.

5 Conclusion and Future Scope

The novel features of research include:

1. The proposed research work can classify SMS as spam or ham—statically.
2. It takes permissions of an apk as input and marks application as trusted or untrusted based on trained network.
3. It scans user device for installed applications and compares applications with predefined list of harmful permissions and notifies user.
4. Analyst is allowed to change threat level of existing application using server side panel.

Mobile botnets only recently appeared and have not been fully explored yet. Therefore, the main challenge for mobile botnet detection and analysis is the limited understanding of these new emerging cybercrimes due to the lack of sufficient samples and benchmark. The research work has given more emphasis on checking permissions. In future research it is required to consider system calls, different services used in application. Knowingly or unknowingly humans participate in cyber-attacks. Educational campaigns are needed to sensitize users about cybercrimes.

References

1. PentaSecurity Blog (2018) Top 5 botnets of 2017. https://www.pentasecurity.com/blog/top-5-botnets-2017/. Last accessed 14 June 2018
2. Fruhlinger J (2018) The Mirai botnet explained: how teen scammers and CCTV cameras almost brought down the internet. https://www.csoonline.com/article/3258748/security/the-mirai-botnet-explained-how-teen-scammers-and-cctv-cameras-almost-brought-down-the-internet.html. Last accessed 14 June 2018
3. Vigliarolo B (2018) Google stops the spread of Tizi Android malware in the play store. https://www.techrepublic.com/article/google-stops-the-spread-of-tizi-android-malware-in-the-play-store/. Last accessed 14 June 2018
4. McAfee Labs Threats Report, June 2018. https://www.mcafee.com/enterprise/en-us/assets/reports/rp-quarterly-threats-jun-2018.pdf. Last accessed 14 June 2018

5. Amro B (2017) Malware detection techniques for mobile devices. Int J Mobile Netw Commun Telematics (IJMNCT) 7(4/5/6):1–10
6. Singh K et al (2010) Evaluating Bluetooth as a medium for botnet command and control. In: DIMVA 2010, LNCS6201, Springer, Berlin, Heidelberg, pp 61–80
7. Singh JP, Chauhan A (2018) Detection and prevention of non-PC botnets. http://vixra.org/pdf/1709.0402v1.pdf. Last accessed 14 June 2018

Transformation of Video Signal Processing Techniques from 2D to 3D: A Survey

Sanjay Koli and Rameez Shamalik

Abstract This paper presents an advanced depth intra-coding approach for 3D video coding based on the High Efficiency Video Coding (HEVC) standard and the multi-view video plus depth (MVD) representation. This paper is motivated by the fact that depth signals have specific characteristics that differ from those of natural signals, i.e., camera-view video. Our approach replaces conventional intra-picture coding for the depth component, targeting a consistent and efficient support of 3D video applications that utilize depth maps or polygon meshes or both, with a high depth coding efficiency in terms of minimal artifacts in rendered views and meshes with a minimal number of triangles for a given bit rate. For this purpose, we introduce intra-picture prediction modes based on geometric primitives along with a residual coding method in the spatial domain, substituting conventional intra-prediction modes and transform coding, respectively. The results show that our solution achieves the same quality of rendered or synthesized views with about the same bit rate as MVD coding with the 3D video extension of HEVC (3D-HEVC) for high-quality depth maps and with about 8% less overall bit rate as with 3D-HEVC without related depth tools. At the same time, the combination of 3D video with 3D computer graphics content is substantially simplified, as the geometry-based depth intra signals can be represented as a surface mesh with about 85% less triangles, generated directly in the decoding process as an alternative decoder output.

Keywords Video coding · 3D video · Multi view with depth · HEVC

1 Introduction

With the latest breakthroughs and ease of access in Internet technology, an exponential increase in data usage can be seen around the world. Internet is basically

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used for two purposes namely information and communication, majority of which is provided to the end user by the means of either images or videos. Videos have easily overtaken images in information and communication areas due to advent of 4G communication and increasing number of devices with high resolution recording as well as more storage space. We are in the era of never before seen data giving rise to new challenges and opportunities to store, handle and process data especially videos to extract useful information out of it.

Video processing and coding techniques are mostly used for video surveillance right from a Person identification to Traffic monitoring for vehicle tracking, in factories or nuclear plants, for military and spying purposes, Underwater activities and archeological expeditions, Medical diagnosis and agricultural activities. The List goes on. Modern day Cinema is a major contributor to video processing and coding techniques due to huge demand in Special effects as well as animated movies and has played a key role in transformation from 2D to 3D videos. 3D videos are proving out to be a cutting edge technology as new paradigms like depth and geometry are included in them to be worked upon.

In this paper we highlight promising techniques used in development of video processing and coding. This paper is divided into four sections. Section 2 discusses the background of various approaches taken for utilization of this technology and overviews the latest 3D coding Techniques and Sect. 3 provides comparison of the techniques followed by Sect. 4 providing conclusion.

2 Background

2.1 2D Techniques

Video-Based Face Recognition on COX Face Database Face recognition from a given video is the need of an hour as we see number of CCTV user multiplying. It surely is bit complicated as compared to age old image based face recognition. A database was created using combination of still images and videos called COX Face Database whose initials comes from the union of three institutions who worked on this project namely Chinese Academy of Sciences (CAS), OMRON Social Solutions Co. Ltd. (OSS), and Xinjiang University [1]. Based on the experiments done a new method was proposed named Pointto-Set Correlation Learning (PSCL) which takes care of correlation between different data types simultaneously. Still a lot of work remains to be done when it comes to Face recognition from a Real-time video.

Vehicle Detection by Adaboost Algorithm Traffic monitoring is the need of an hour especially in fast growing cities. Vehicle detection plays a key role in it where it is divided into two steps off-line training and on-line identification [2]. Haar feature is used to extract the image from a large pile of vehicle samples for off-line training process. Further processing is done by Adaboost algorithm to recognize the required

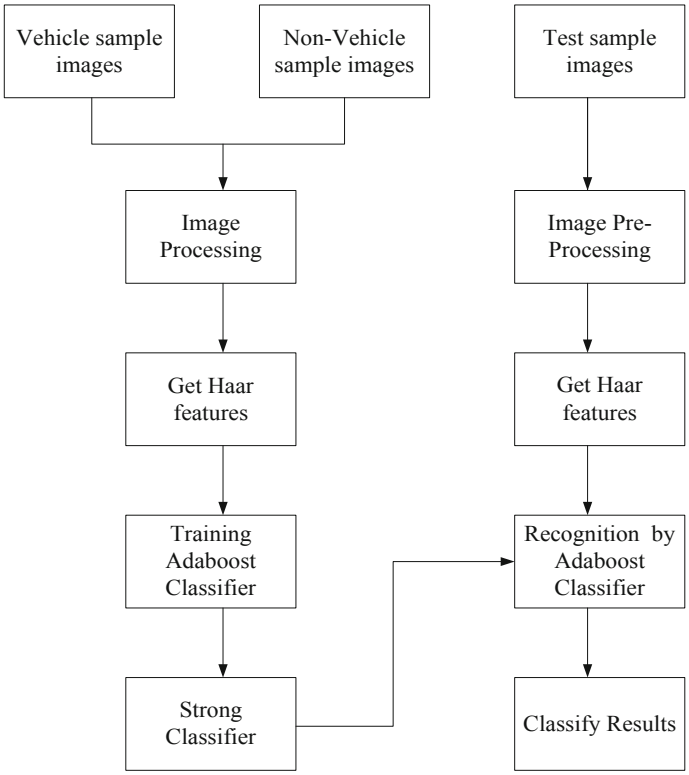

Fig. 1 Adaboost algorithm application [2]

sample given by Haar Classifier as shown in Fig. 1. This technique works only when the data is already saved.

Real-Time Video Processing using Adaptive Edge Detection on FPGAs Edge Detection is most tried and tested algorithm when it comes to Real time video and image processing. It comes really handy when the sample taken from the video is blurred or the video stream itself is anti-aliased. Neoh et al. [3] uses Canny edge detection to serve the above purpose. In Canny algorithm an outline is highlighted between object of interest and background. Thus providing maximum localization and minimum error rate. Although FPGA provides an economical and apt alternative to run the real time video processing giving good enough computational speed for canny algorithm, as the complexity of the algorithm increases computational speed decreases.

Video Surveillance Using Guassian Mixture Modelling (GMM) and Camshift A novel monitoring system to improve safety for personnel in nuclear plant is proposed by Jorge et al. [4]. There is a possible Radiation Hazard in the environment for working personnel. Hence background modeling and subtraction method GMM

is used. Further Camshift technique is used for individual tracking using color histogram. Camshift is an improved version of Mean shift method specially used for video processing. It proves helpful as cumulative tracking of region of interest is done in a distributive manner. Citing the criticality of a nuclear plant this method should be used as a redundant technique.

2.2 3D Techniques

As discussed earlier 3D videos are next generation of entertainment for the viewers. Hence video coding techniques such as Multi View Coding (MVC) and High Efficiency Video Coding (HEVC) were developed over the years.

As shown in Fig. 2, 3D video coding can be explained in four steps. Firstly a video is captured using multi view camera to have multiple frames. Then processing is done on the frames collectively to produce a 3D video, Further the 3D video is coded with the latest coding techniques for transmission and finally at the receiver side the video is rendered with depth estimation.

In this section we summarize the complementary techniques associated with the above mentioned coding standards for presenting the best possible experience to the end user.

Motion Vector Inheritance (MVI) The basic differentiation between a 2D and 3D video is the visibility of depth inside the frames. When it comes 3D video coding MVC has limitations as does not support the coding of associated depth information. It basically encodes all the views together hence diluting the all-important depth data while decoding which gives 3D video superiority. In MVI a prediction model is proposed for efficient 3D video coding in which motion vectors are repeatedly used and effective block partitioning of video signal is done [5]. The only difference while using MVI is the increased complexity in encoder side.

Multi-view Video with Depth Data In this technique Müller et al. [6] proposes addition to HEVC standard in terms of inter-view motion parameter and inter-view residual prediction. Authors developed 3D video coding (3DVC) extension for established HEVC standard. Backward compatibility with 2D video coding is maintained by separately coding multi view video and depth. As shown in Fig. 3, an alternative coding tools are introduced for coding the dependent views and the depth data with inter-component prediction techniques that work on data from already coded components simultaneously, as indicated by the grey arrows. At the encoder side depth-enhanced formats using view synthesis optimization with block-wise synthesized view distortion change is achieved while at decoder side Depth image based rendering(DIBR) is done for the required final view.

Multiview Video Plus Depth Coding With Depth-Based Prediction Mode Predictoin plays an important role in high quality video transfer by not only saving the required Data but also increasing the Bit rate for faster communication. Bal

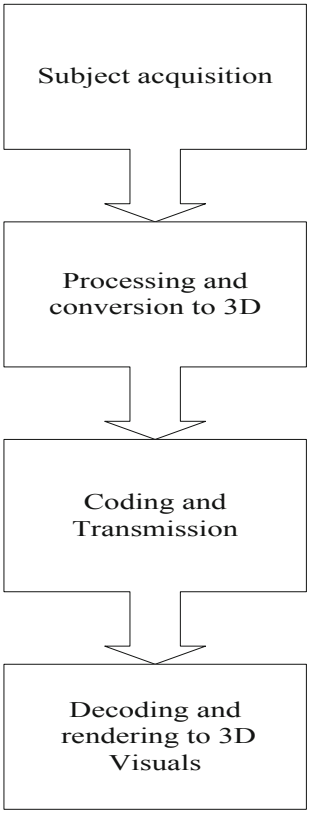

Fig. 2 3D video coding steps

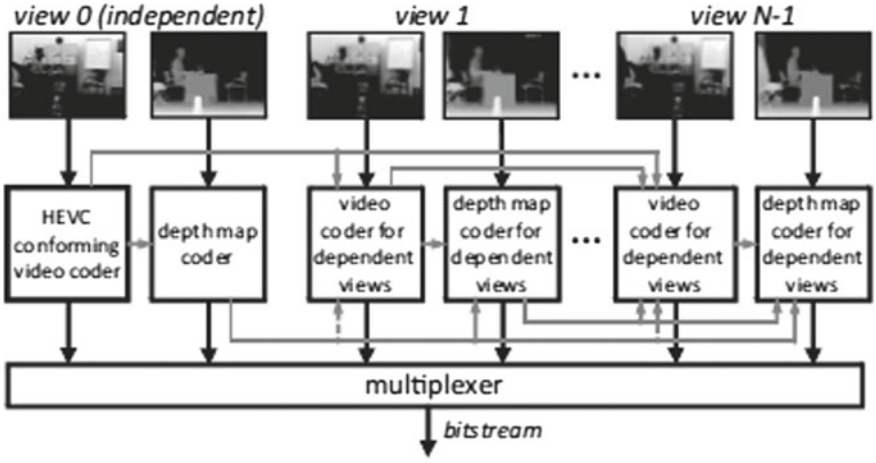

Fig. 3 Encoder structure with inter-view and inter-component prediction [6]

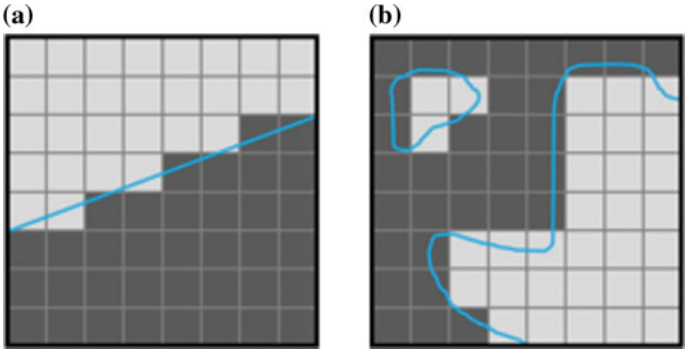

Fig. 4 **a** Wedgelet partition, **b** contour partitions [8]

et al. [7] propose a depth-based prediction mode (DBPM) technique named multiview video plus depth (MVD) which covers video as well as depth data. As the prediction method focuses on depth only, accuracy of encoder increases and efficiency of system to show 3D video increases at a very low cost. Few minor changes needs to be done in the syntax of MVC format.

Depth Intra Coding based on Geometric Primitives The focus is shifted from just depth to geometric analogy in block segmentation. The approach is to approximate an object of interest by reducing the block sections, in turn lowering the load on decoder with giving efficient throughput. New intra and inter-component prediction modes, using wedgelet and contour block partitions, and a complementary residual adaptation method in the spatial domain are introduced shown in Fig. 4. A gap between 3D video and 3D computer graphics is reduced by introducing a 3D-HEVC extension to highly used standard of HEVC [8] Further work can be extended in temporal and inter-view consistency of surface meshes.

3 Comparative Study

After presenting various video signal processing techniques spanning from 2D to 3D, it becomes necessary to compare them in terms of their advantages and disadvantages as shown in Table 1. 2D video signal processing techniques have advantage in terms of simplicity and economical alternatives but as the complexity of the application increases their usability is restricted on the other hand 3D video signal processing techniques stand apart as per the current user requirements an crucial applications but are associated with complex techniques and algorithms with new coding standards and extensions. Based on the comparative study we strongly suggest to work on 3D video signal processing techniques to come up with state of the art coding techniques to fulfil requirements of end user and critical applications.

Table 1 Comparative study

Ref. no.	Technology	Advantages	Disadvantages
[1]	Face recognition on COX face database	Combination of still images and videos with new method PSCL	Work can only be done on available database and not on real-time videos
[2]	Haar Classifier-Adaboost algorithm	Vehicle identification with improved speed	Result may vary for different vehicle models
[3]	Canny edge detection on FPGA	Supports real-time image processing with FPGA as economical Alternative	Complexity of the algorithm is proportional to measuring Cost
[4]	GMM and Camshift	Small percentage errors due to color confusion	Prone to error for people with similar clothes, height and background regions
[5]	Motion vector inheritance (MVI)	Hybrid video coding approach with block partitioning	Small increase in encoder efficiency
[6]	Multiview video with depth	Increased compression and coding efficiency By 3D-HEVC	Unable to handle large arrangements
[7]	Depth-based prediction mode	Complexity analysis insures high encoder accuracy	Tradeoff among depth map resolution and quantization parameter
[8]	Multiview video with geometry	3D-HEVC developed with backward compatibility	High complexity

4 Conclusion

A brief collection of key video signal processing techniques is presented. Journey of video signal processing from 2D to 3D techniques is highlighted with their applications and limitations. Comparative study with respect to the pros and cons of the presented techniques is done. Based on which we conclude that 3D video signal processing is the new emerging and promising technique to be worked upon. The latest work done in 3D video coding iterates its importance in the era of unlimited data. Standards like HEVC and 3D-HEVC are really effective in coding multi view video with depth and geometry respectively. A new displays can be built to show 3D videos without user needing any glasses as Multi view videos with depth and geometry are being developed.

References

1. Huang Z (2015) A benchmark and comparative study of video-based face Recognition on COX face database. IEEE Trans Image Process 24(12)
2. Cao J (2016) Research on urban intelligent traffic monitoring system based on video image processing. Int J Signal Process, Image Process Pattern Recognit 9(6):393–406
3. Shan H, Hazanchuk NA et al (2005) Adaptive edge detection for real-time video processing using FPGAs. Altera Corporation
4. Jorge CAF et al (2013) Improved people detection in nuclear plants by video processing for safety purpose. In: International nuclear Atlantic conference—INAC, ISBN: 978-85-99141-05-2
5. Winken M et al Motion vector inheritance for high efficiency 3D video plus depth coding. In: Picture coding symposium, Kraków, Poland, 2012
6. Müller K et al (2013) 3D high-efficiency video coding for multi-view video and depth data. IEEE Trans Image Process 22(9)
7. Bal C et al (2014) Multiview video plus depth coding with depth-based prediction mode. IEEE Trans Circuits Syst Video Technol 24(6)
8. Merkle P, Müller K, Marpe D, Wiegand T (2016) Depth intra coding for 3D video based on geometric primitives. IEEE Trans Circuits Syst Video Technol 26(3)

Design and Analysis of Elliptical Core Spiral Silica Photonic Crystal Fiber with Improved Optical Characteristics

Ravindra Kumar Sharma, Sunil Sharma, Rajkumar Gupta and Priyajit Dash

Abstract The aim of this paper is to attempt an optimized design from spiral horizontal and vertical core slotted silica photonic crystal fiber through which we can get low dispersion profile, low confinement loss and better transmission curve in both the slotted spiral silica PCF structures. For this purpose we have used opti Finite difference time domain (FDTD) (Liao et al. in EEE Photon Technol Lett. https://doi.org/10.1109/LPT.2015.2443986, [9], Bottacini et al. in J Lightwave Technol 22(7), 10]) with transparent boundary conditions (TBC) (Sinha et al. in IEEE J Sel Top Quantum Electron 22(2), [7], Zhang et al. in Opt Lett 35:3829–3831, [8], Liao et al. in IEEE Photon Technol Lett. https://doi.org/10.1109/LPT.2015.2443986, [9], Bottacini et al. in J Lightwave Technol 22(7), [10], Toulouse in J Lightwave Technol 23(11), [11]). In this design initially the core region is selected in horizontal elliptical shape, while the cladding part is maintained in circular shape. Later on the elliptically core is converted into vertical direction keeping the cladding region in circular shape. The core diameter is maintained at 0.25 and 0.5 μm with minor and major axes, while the cladding diameter varied from 0.5 to 1.25 μm. The design so obtained faced many conflictions but after setting the parameters in proper manner, it is ready for getting the optimized results and it also maintained the refractive index (Birks et al. in Opt Lett 22(13):961–963, [1], Liao et al. in IEEE Photon Technol Lett 26(4), [2], Rabiul Hasan et al. in IEEE Photon Technol Lett. https://doi.org/10.1109/LPT.2016.2572141, [3]) of the silica at 1.457.

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Keywords FDTD · Core · Cladding · Dispersion · Refractive index · TBC

1 Introduction

In the ancient time human beings had the only means of communication that was Dove. As the momentum grew, the humans also made a new invention. If we talk about modern invention, human being has the best medium of communication, i.e. Optical fiber [1, 2]. But in the last few years, there has been a lot of research done on optical fibers and a new concept we got is photonic crystal fiber [1–5]. Nowadays photonic crystal fiber has attracted significant attention towards researchers due to their design simplifications, their flexibility in withstanding with various applications and due to their excellent optical properties. Apart from them features like Endless Single Mode Operation [6, 7], low confinement loss [3–8], high birefringence [1–7], high nonlinearity [5], ultra-flattened dispersion characteristics it is provided to be very useful in the field of communication. In this research paper we have tried to design a photonic crystal fiber so that we can get low deposition and confinement Loss in the output. Although low- Dispersion and Low confinement Loss photonic crystal fiber works in many areas, but it is mainly used in optical sensor designing and signal processing systems. By minimizing dispersion and confinement loss in any PCF, the power consumption of the optical device can also be reduced. So far, many research papers have been published, in which separate photonic crystal fiber has been designed and found out low or almost zero dispersion and confinement loss. Silica glass as an optical fiber material is a great option, so we have also used silica glass as a fiber material in this paper.

2 Proposed Structure of Slotted Silica Spiral PCF

We have designed Four Spiral PCF mainly in this research paper. Is the first and second in which the core air hole is placed Horizontal elliptical and third and fourth are the designs in which the core air hole is placed vertical elliptical. All the air holes of cladding have been arranged according to the rings. The air hole in which the inner ring is the smallest, whose diameter has been named D1. In this way, the diameter of the air hole will be in increasing order i.e., the D4 will be larger than the D1. Spiral lattice has six arms, each having four air holes; the first ring of circular holes has a radius of *r1. The diameter of the air holes is* enlarged *step by step with the aim of obtaining low dispersion and* confinement loss. As previously mentioned, the silica is taken as the core material and the elliptical air hole made in the core is semi-minor axis of "a" and semi-major axis of "b".

The proposed design of slotted silica spiral PCF is designed by keeping minor axes at 0.25 μm and major axes at 0.50 μm for the **elliptical** core. This elliptical slot in core region is used to provide better confinement modes. These elliptical core

regions also offer increased freedom in modal distribution. After that the cladding air holes are used to vary with 0.5–1.25 μm range. It is varying as 0.5, 0.75, 1.0 and 1.25 μm respectively for increasing layers in circular shape.

Final Structure Parameters

For Vertical **elliptical** core

Design 1: D1 = 0.5 μm, D2 = 0.75 μm, D3 = 1.0 μm and D4 = 1.25 μm (When Pitch ^ = 2.0 μm)
Design 2: D1 = 0.5 μm, D2 = 0.75 μm, D3 = 1.0 μm and D4 = 1.25 μm (When Pitch ^ = 1.0 μm).

For Horizontal **elliptical** core

Design 3: D1 = 0.5 μm, D2 = 0.75 μm, D3 = 1.0 μm and D4 = 1.25 μm (When Pitch ^ = 2.0 μm)
Design 4: D1 = 0.5 μm, D2 = 0.75 μm, D3 = 1.0 μm and D4 = 1.25 μm (When Pitch ^ = 1.0 μm).

With the parameter selected we have designed slotted spiral horizontal and vertical silica PCF for 5 layers, which is shown below in Fig. 1.

Figure 2 shows the 3D mode confinement of the proposed design of silica spiral PCF. It includes real and imaginary axes of the proposed design. Along with this it also shows the amplitude and phase variation of the proposed design. Various positions can be measured for the proposed design in both the axes.

With this 3 mode confinement of the proposed design we have varied the amplitude and phase and the resultant variation is shown below in Fig. 3. The inside view of the variation is also shown in the below figure.

Chromatic dispersion is the sum of material and waveguide dispersion. Material dispersion is calculated from the simpler form of Sellemeier equation [11–13], which is known as Cauchy's equation [10], showing the relation of material of the silica glass with the refractive index 1.457.

Cauchy's equation is given by

$$\mathrm{n}(\lambda) = \left(\mathrm{a} + \mathrm{b}/\lambda^2 + \mathrm{c}/\lambda^4\right)^{1/2} \tag{1}$$

where, a = 5.14, b = 0.20 μm^2, c = 0.14 μm^4 and λ is the wavelength

From the wavelength dependence of refractive index, we calculate the total chromatic dispersion which includes material and waveguide dispersion [4–7] as given by the equation

$$D = \frac{\lambda}{c}\frac{d^2 \mathrm{Re}[n_{eff}]}{d\lambda^2} \mathrm{ps/(nm\text{-}km)} \tag{2}$$

Confinement loss can be calculated by using the equation

$$\mathrm{Lc} = 8.686 \mathrm{k}_0 I_m(\mathrm{n_{eff}})_{\mathrm{dB}}/\mathrm{m} \tag{3}$$

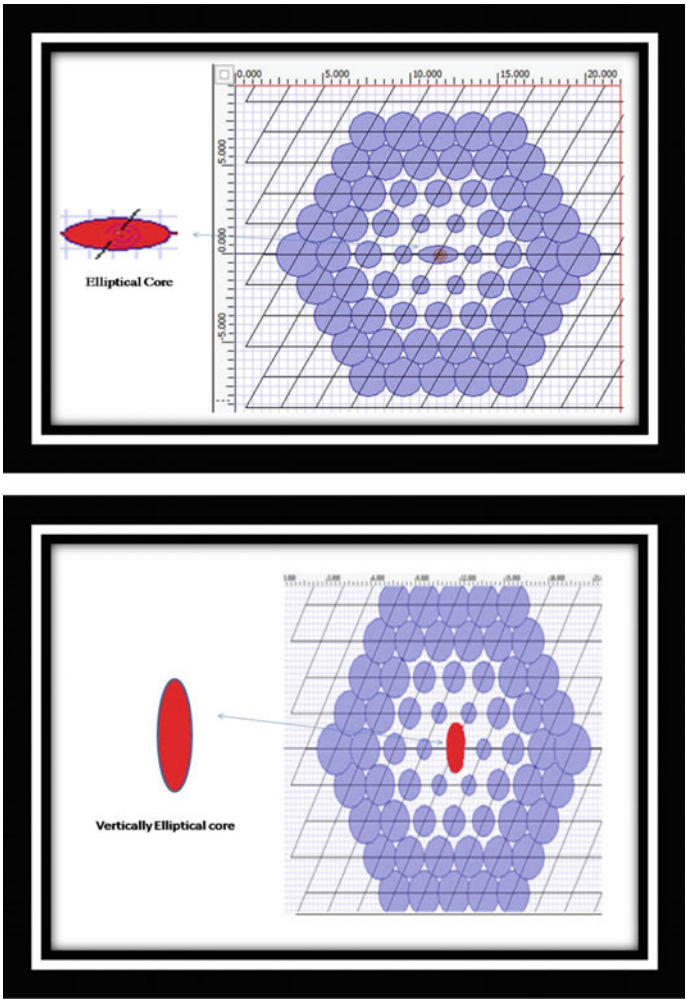

Fig. 1 Proposed structure design of horizontally and vertically elliptical core spiral silica PCF

where I_m is the imaginary part of effective mode index, and k_0 is the free space wave number, which is equal to $2\pi/\lambda$.

3 Result and Discussion

For the design of optimized spiral silica photonic crystal fiber full-vector finite element method (FVFEM) is used. The proposed designed is simulated using opti FDTD simulation tool. The FVFEM directly used to solve the Maxwell equations which

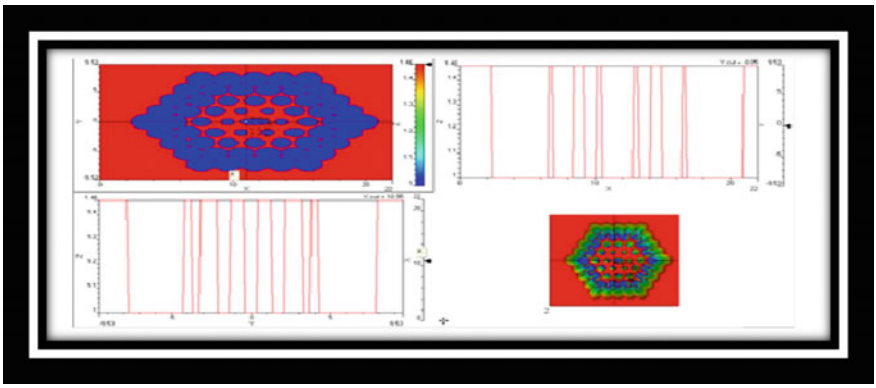

Fig. 2 3D move viewer of the design

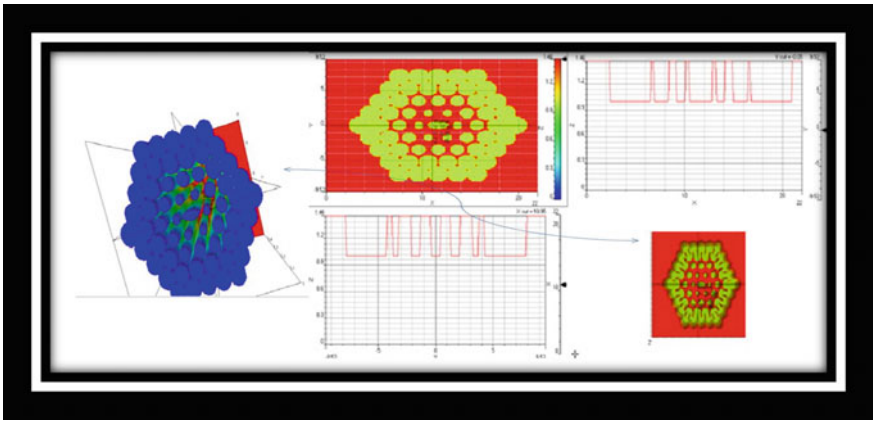

Fig. 3 Amplitude and phase variation of the design

further can be used to obtain optimum value of the effective refractive index, n_{eff}. The Refractive index so calculated for the proposed design is 1.457.

Comparative Analysis of All Structures

All designs have been proposed to minimize the confinement loss, to minimize the dispersion and for getting better transmission curve. And to achieve this, the designs have been proposed by considering the same parameters for all structures like air hole diameter, pitch value, number of rings, and minor and major axes diameter for elliptical core as mentioned above. After setting these parameters the proposed structures have been designed as shown above in Fig. 1. By simulating tool we found that dispersion, confinement loss, refractive index and transmission curve so obtained for all structured designs have been drawn and shown below in Figs. 4, 5, 6 and 7

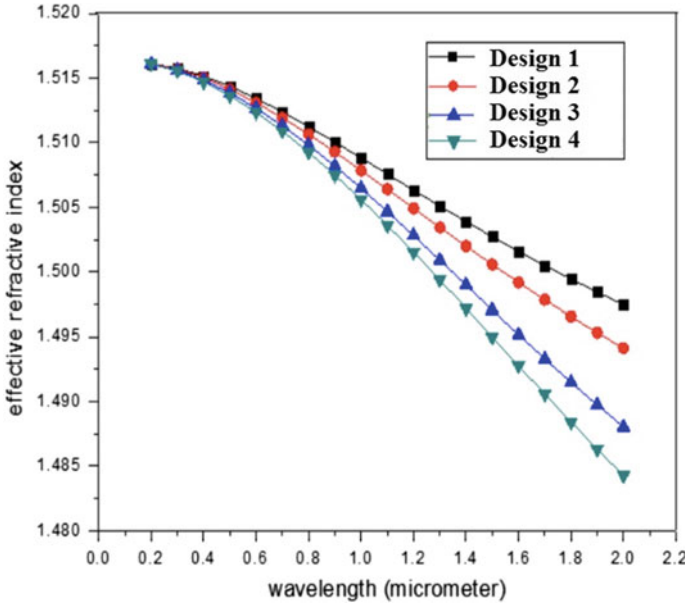

Fig. 4 Shows the difference between effective refractive index of all four designs

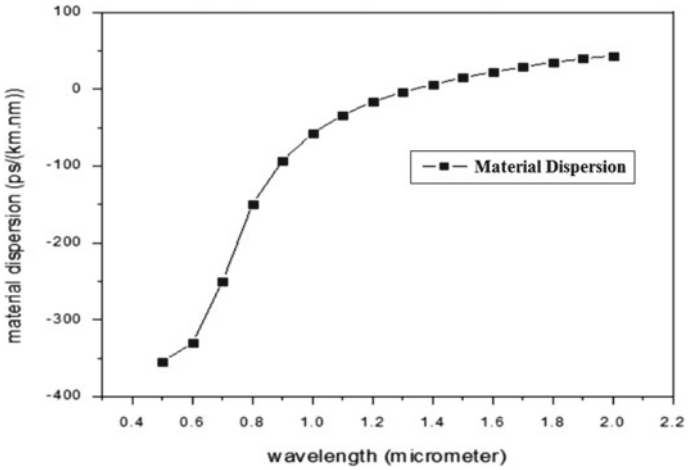

Fig. 5 Material dispersion of silica glass PCF

respectively. This table shows that parameters do matter for getting the optimized result and with this the comparison is shown below.

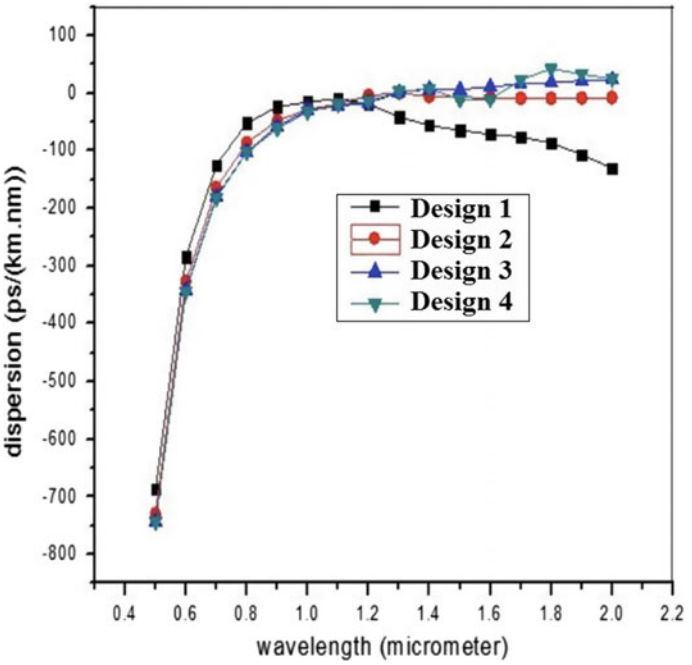

Fig. 6 Comparatively graph of dispersion between all four designs

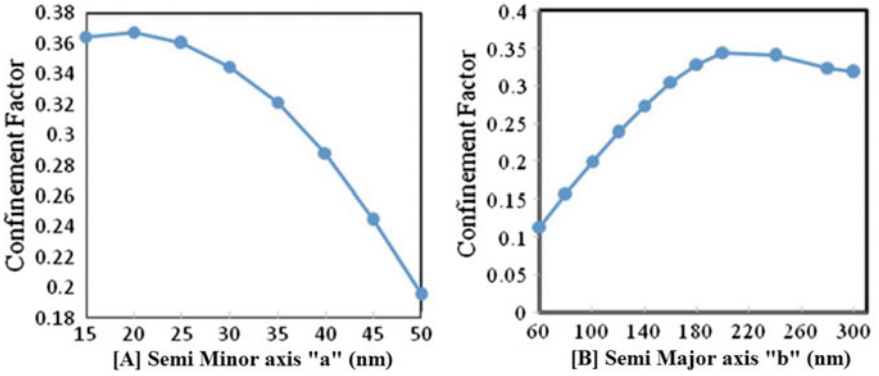

Fig. 7 Confinement factor variation in **A** semi-minor axis "a" and **B** semi-major axis "b"

4 Conclusion

The paper includes all the parameters required for photonic crystal fiber. The proposed design of spiral silica PCF so obtained shows that the design structure is best suited for mode confinement and transmission purpose. The Vertically elliptical core silica PCF provides better results towards low confinement loss, low dispersion and better transmission curve. It is concluded that the structure so obtained is very well suited and optimized for various PCF applications and shows almost zero dispersion and 1.457 refractive index similar to silica material used.

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Compliance with ethical standards

Conflict of interest The authors declare that there are no conflict of interest.

References

1. Birks T, Knight J, Russell P (1997) Endlessly single mode photonic crystal fiber. Opt Lett 22(13):961–963
2. Liao J, Sun J, Du M, Qin Y (2014) Highly nonlinear dispersion-flattened slotted spiral photonic crystal fibers. IEEE Photon Technol Lett 26(4)
3. Rabiul Hasan Md, Shamim Anower Md, Imran Hasan Md (2016) A polarization maintaining single mode photonic crystal fiber for residual dispersion compensation. IEEE Photon Technol Lett. https://doi.org/10.1109/LPT.2016.2572141
4. Samiul Habib M, Selim Habib M, Hasan MI, Razzak SMA (2014) A single mode ultra-flat high negative residual dispersion compensating photonic crystal fiber. Opt Fiber Technol. https://doi.org/10.1016/J.YOFTE.2014.03.005
5. Franco MAR, Serrão VA, Sircilli F (2008) Microstructured optical fiber for residual dispersion compensation over wavelength bands. IEEE Photon Technol Lett 20(9)
6. Russell PStJ (2006) Photonic crystal fibers. J Lightwave Technol 24(12):4729–4749
7. Sinha RK, Kumar A, Saini TS (2016) Analysis and design of single-mode As2Se3- chalcogenide photonic crystal fiber for generation of slow light with tunable features. IEEE J Sel Top Quantum Electron 22(2)
8. Zhang QM, Li M, Hao Q, Deng DH, Zhou H, Zeng HP, Zhan L, Wu X, Liu LY, Xu L (2010) Fabrication and characterization of on-chip optical nonlinear chalcogenide nanofiber devices. Opt Lett 35:3829–3831
9. Liao J, Yang F, Xie Y, Wang X, Huang T, Xiong Z, Kuang F. Ultrahigh birefringent nonlinear slot silicon microfiber with low dispersion. IEEE Photon Technol Lett. https://doi.org/10.1109/LPT.2015.2443986
10. Bottacini M, Poli F, Cucinotta A, Selleri S (2004) Modeling of photonic crystal fiber raman amplifiers. J Lightwave Technol 22(7)
11. Toulouse J (2005) Optical nonlinearities in fibers: review, recent examples, and systems applications. J Lightwave Technol 23(11)
12. Yang T, Wang E, Jiang H, Zhijia H, Xie K (2015) High birefringence photonic crystal fiber with high nonlinearity and low confinement loss. OSA Opt Express 23(7):6
13. Hameed MFO, Obayya SSA, El-Mikati HA (2011) Highly nonlinear birefringent soft glass photonic crystal fiber with liquid crystal core. IEEE Photon Technol Lett 23(20)

A Review on Different Parameters Considered for Improvement in Power Conversion Efficiency of Rectenna

Anand Trikolikar and Swapnil Lahudkar

Abstract Radio Frequency Energy Harvesting is a technique used for gathering electromagnetic energy from various ambient RF sources like cell towers & Wi-Fi hotspots, and convert it into usable direct current (DC) voltage form. The performance of rectenna is measured with the help of parameters like power conversion efficiency (PCE) & sensitivity. High efficient design of rectenna is needed as it can be used in various applications like, wireless power harvesting networks (WSN and IoT), Smart City, Medical & Healthcare, RFID and Smart Jewelry applications. This paper reviews different parameters needed to be optimized which are used for improvement in PCE of rectenna.

Keywords RF energy harvesting · Rectenna · Power conversion efficiency

1 Introduction

(PCE) defines as the ratio of the power given to the load and power received at antenna. While calculating power conversion efficiency (η_{PCE}), the efficiency of the antenna (η_A), efficiency of rectifier or voltage multiplier (η_R), and efficiency of impedance matching network (η_M) are considered, it is calculated as;

$$\eta_{PCE} = P_{load}/P_{received} \tag{1}$$

where, P_{load} is power at load and $P_{received}$ is harvested power at the antenna. Parameters that decide the value of PCE contains effects of components used, leak in the circuits, topologies used for design, as well as varying cut-off values of components used in rectenna.

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This paper reviews different parameters needed to be optimized which are used for improvement in PCE of rectenna. Section 2 describes parameters need to be optimized for improvements in power conversion efficiency. Various applications of rectenna are summarized in Sect. 3 & finally conclusion is drawn from these discussions.

2 Parameters Need to Be Optimized for Improvement in Power Conversion Efficiency

A rectenna contains an antenna and rectifier, it also contain impedance matching network for matching between antenna & rectifier. For improvement in PCE performance of all components present in rectenna needed to be improved, in this section we will see different parameters related to components included in rectenna, responsible for value of PCE.

2.1 Parameters Related to Antenna

Frequency of Operation In ambient environment radio waves are generally located in range of 800 MHz to 2.5 GHz. Operating frequency of rectenna is selected on basis of value of power density at that frequency. For larger frequency input power is also large. A crucial topic in ambient energy harvesting is that available power density is very low in ambient RF environment, which essentially restricts the availability of power for harvesting and this result in lower PCE. To increase harvested energy, antenna needs to collect the signals from different frequency bands; hence a multiband antenna is ideal for collecting more signals & to achieve more PCE.

Polarization The location of radio frequency source is unknown; due to this signal can be collected from different directions. Hence, omnidirectional antenna with circularly polarized; dual polarized [1]; dual circularly polarized [2] antennas will be a good choice for improvement in PCE.

Gain For antenna as a receiver, gain indicates effectiveness of conversion of received signal into electrical power. Antenna efficiency is increased when gain of antenna increased, so a high gain antenna is a good choice. For improvement in gain techniques like, rectenna array [3, 4], differential antenna [5, 6], use of defected ground structures, metamaterial rectenna, slotted antennas are implemented.

Impedance Most of antennas are designed for 50 Ω impedance, but by using increased impedance antenna having impedance in range of 100–200 Ω, matching network can be eliminated, thus improving PCE.

Substrate Material Generally a low cost, easily available substrate material like FR4 ($\varepsilon_r = 4.4$, $\tan \delta = 0.02$) is used for antenna, but a substrate material with lower losses like Rogers RT6002 ($\varepsilon_r = 2.94$, $\tan \delta = 0.0035$) improves PCE of rectenna.

2.2 Parameters Related to Impedance Matching Network

Impedance Matching Network (IMN) is used for transferring maximum power between radio frequency source & load. The performance of system reduced due to impedance mismatch, so an IMN is needed. But, in recent days trend of elimination of matching network is increased as due to presence of matching network 82% of total input power get wasted [7]. Some of the compact & efficient rectennas are presents in [8–10], which uses a high impedance antenna those are directly matched with impedance of rectifier, for elimination of matching network.

2.3 Parameters Related to Rectifier

Rectifiers are used for conversion of AC signals to DC signals, and voltage multiplier is a special type of rectifier that converts and improves AC input to DC output. For selecting rectifier or voltage multiplier for high efficiency rectenna following parameters are considered;

Topology Used The topologies used for rectifier are, half-wave, full-wave & bridge rectifier, in most of the RFEH applications full wave rectifiers are preferred as they provide twice output as compared to half wave rectifier. Fundamental configurations for a voltage doubler are Cockcroft-Walton & Dickson. In RF energy harvesting applications Dickson's performance is better than Cockcroft-Walton at input power greater than −7 dBm & Cockcroft-Walton's performance is better at input power bellow −7 dBm [11].

Type of Diode Mostly Schottky diode is used in low power harvesting applications because of its lower operating voltage & high switching speed. For increased PCE diodes having specifications such as, smaller series resistance R_S, larger breakdown voltage V_{br}, smaller junction capacitance Cj, and smaller turn-on voltage V_T are used [9].

Rectifier Conversion Efficiency Efficiency of rectifier is depend on various parameters like, frequency of operation, input power level, type of diode, topology used, substrate material, value of load resistance & matching with antenna [12]. It can be increased by optimizing signal waveforms, selecting optimal RF-DC conversion technique, constructing adaptive rectifier circuit, minimizing sensitivity by using resistance compression network, designing a custom IC in a boost converter, using

load modulated two branch rectifier cooperating with ultra-low power management unit, using optimal rectifier topology, & optimizing load conditions [9].

Number of Stages of Voltage Multiplier As number of stages increases, losses are also increases which lead to lower PCE, therefore optimum number of stages are preferred. Selection of number of stages of voltage multiplier is also depend on available input power, for low power region (<−20 dBm) efficiency of rectifier decreases with increase in number of stages, while in high power region (>−20 dBm) efficiency increases for increased stages of multiplier [13].

Finally a comparison of highly efficient rectennas recently reported is as shown in Table 1.

Table 1 Performance comparisons of highly efficient rectennas recently reported

Ref. no.	Rectenna parameter	PCE (%)/technique used for improvement of PCE
[5]	Differentially feed square two layered slot antenna with single stage Villard voltage doubler, with dual matching network	53 @ 2 GHz, 31 @ 2.5 GHz and 15.56 @ 3.5 GHz/differential high gain antenna
[1]	Dual port L probe microstrip patch with single series diode rectifier with triple-stub tuning	40 for i/p power density of 500 $\mu W/cm^2$/multiport antenna
[8]	Combination of two off center feed dipole (OCFD) & radial stubs with single shunt rectifier	60 @ 0 dBm, 65 @ 5 dBm, 70 @ 10 dBm, and 75 @ 20 dBm for diodes SMS7630, HSMS2850, HSMS2860 and HSMS2820 respectively/elimination of matching network
[9]	Meandered dipole antenna	61.4, 50.7, 31.8 at Pin = −5dBm, Pin = −10 dBm, and Pin = −15 dBm/elimination of matching network
[10]	Planar folded dipole antenna with Dickson voltage doubler & a PJFET self-oscillating boost converter	Antenna can charge a battery to 3.78 V at 844 MHz for a received power of −11.7 dBm/elimination of matching network
[4]	20 elements tapered log periodic dipole array & voltage doubler with exponentially tapered microstrip line used as matching network	Produce a voltage of 1.7 V at a distance 20 m from cell tower/high gain antennae array

(continued)

Table 1 (continued)

Ref. no.	Rectenna parameter	PCE (%)/technique used for improvement of PCE
[2]	Log periodic crossed dipole antenna with single stage full wave voltage doubler	67 @ −5 dBm input power/multiband antenna
[14]	Printed dipole antenna with proposed rectifier	62 @ −10 dBm, 84 @ 5.8 dBm/multiband antenna
[15]	Rectangular microstrip antenna with pair of truncated corner on jean cotton material & rectifier with HSMS2850 diode	60 for 0 dBm & −3 dBm input power @ 2.45 & 5.8 GHz respectively/compact circularly polarized textile rectenna
[16]	Koch fractal loop antenna with full wave Greinacher rectifier	61 at 1.8 GHz for 10 $\mu W/cm^2$ power density/compact rectenna with in loop ground plane
[17]	Dual port rectangular slot antenna with solar cell	49 at 0 dBm & 20 at −17 dBm at 2.45 GHz/combination of RF & solar energy harvester

3 Applications of Rectenna

3.1 Wireless Power Harvesting Networks (WSN and IoT)

IoT is used for making communication between different devices without human interference and WSN is a part of IoT topology. WSN refers to a group of devoted sensors for checking and recording physical conditions of environment. WSN node contain different sensors like, temperature sensor, humidity sensor etc., and these devices are working on batteries also they are remotely located; a rectenna can replace these batteries & can be act as a source of energy for these devices. A low-cost energy harvesting device using rectenna for IoT applications is presented by [18]. It contains a 2.4 GHz insert fed rectangular microstrip patch antenna with a band pass filter, LC matching circuit & single diode (HSMS 2820) rectifier.

3.2 Medical and Healthcare

Idea of designing energy harvesting device in the form of necklace used for powering wireless electronic health and activity tracking monitors inside their pendants (Smart Jewelry) is presented in [11]. It contains a U shaped dipole antenna operating at 900 MHz with 8 stage Dickson rectifier & a DC-DC boost convertor.

4 Conclusion

The power conversion efficiency is used as a figure of merit for calculating performance of rectenna. Various techniques like use of multiband antenna, high gain antenna, dual port antenna, matching network elimination, use of proper topology and diode for design of rectifier, use of resistance compression network in rectifier, selection of optimized value of load resistance are used for improvement in PCE. This paper reviews different parameters needed to be optimized which are used for improvement in (PCE) of rectenna, it also summarizes recently reported high efficiency rectennas and some of its applications.

References

1. Shen S, Chiu C-Y, Murch RD (2017) A dual-port triple-band L-probe microstrip patch rectenna for ambient RF energy harvesting. IEEE Antennas Wirel Propag Lett (16):3071–3074
2. Song C, Huang Y, Carter P, Zhou J, Yuan S, Xu Q, Kod M (2016) A novel six-band dual CP rectenna using improved impedance matching technique for ambient RF energy harvesting. IEEE Trans Antennas Propaga 64(7):3160–3171
3. Chuma EL, Iano Y, Costa MS, Manera LT (2018), Bravo Roger LL A compact-integrated reconfigurable rectenna array for RF power harvesting with a practical physical structure. Prog Electromag Res M (70):89–98
4. Kumar H, Arrawatia M, Kumar G (2017) Broadband planar log-periodic dipole array antenna based RF-energy harvesting system. IETE J Res
5. Chandravanshi S, Sarma SS, Jaleel Akhtar M (2018) Design of triple band differential rectenna for RF energy harvesting. IEEE Trans Antennas Propag
6. Arrawatia M, Baghini MS, Kumar G (2015) Differential microstrip antenna for RF energy harvesting. IEEE Trans Antennas Propag
7. Lorenz, CHP, Hemour S, Wu K (2016) Physical mechanism and theoretical foundation of ambient RF power harvesting using zero-bias diodes. IEEE Trans Microw Theory Tech 64(7):2146–2158
8. Song C, Huang Y, Zhou J, Carter P, Yuan S, Xu Q, Fei Z (2017) Matching network elimination in broadband rectennas for high-efficiency wireless power transfer and energy harvesting. IEEE Trans Ind Electr 64(5), 3950–3961
9. Chen Y-S, Chiu C-W (2017) Maximum achievable power conversion efficiency obtained through an optimized rectenna structure for RF energy harvesting. IEEE Trans Antenna Propag 65(5):2305–2317
10. Arrawatia M, Shojaei Baghini M, Kumar G (2016) Broadband RF energy harvesting system covering CDMA, GSM900, GSM1800, 3G bands with inherent impedance matching. In: IEEE MTT-S international microwave symposium
11. Nguyen SH, Ellis N, Amirtharajah R (2016) Powering smart jewelry using an RF energy harvesting necklace. In: IEEE MTT-S international microwave symposium
12. Adami S-E, Proynov P, Hilton GS, Yang G, Zhang C, Zhu D, Li Y, Beeby SP, Craddock IJ, Stark BH (2018) A flexible 2.45-GHz power harvesting wristband with net system output from −24.3 dBm of RF power. IEEE Trans Microw Theory Tech 66(1):380–395
13. Agrawal S, Parihar MS, Kondekar PN (2017) A dual-band rectenna using broadband DRA loaded with slot. Int J Microw Wirel Technol
14. Kuhn V, Lahuec C, Seguin F, Person C (2015) A multi-band stacked RF energy harvester with RF-to-DC efficiency Up to 84%. IEEE Trans Microw Theory Tech 63(5):1768–1778

15. Naresh B, Singh VK, Bhargavi V, Garg A, Bhoi AK (2018) Dual-band wearable rectenna for low-power RF energy harvesting. Adv Power Syst Energy Manag, Lect Notes Electr Eng 436:13–21
16. Zeng M, Andrenko AS, Liu X, Li Z, Tan H-Z (2017) A compact fractal loop rectenna for RF energy harvesting. IEEE Antennas Wirel Propag Lett (16):2424–2427
17. Bito J, Bahr R, Hester JG, Abdullah Nauroze S, Georgiadis A, Tentzeris MM (2017) A novel solar and electromagnetic energy harvesting system with a 3-D printed package for energy efficient internet-of-things wireless sensors. IEEE Trans Microw Theory Tech 65(5):1831–1842
18. Shafique K, Khawaja BA, Khurram MD, Sibtain SM, Siddiqui Y, Mustaqim M, Chattha HT, Yang X (2018) Energy harvesting using a low-cost rectenna for internet of things (IoT) applications. IEEE Access (6):30932–30941

Modal Analysis of Triple Frequency Band Notch Ultra-Wideband Monopole Antenna

Ameya A. Kadam, Amit A. Deshmukh, A. P. C. Venkata, Arati Ambekar and K. P. Ray

Abstract A low profile, printed triple band-notched ultra wideband antenna is investigated. The antenna produces notch at three frequency bands 3.25–3.65, 5.2–6.1 and 6.48–7.4 GHz, while yielding UWB performance from 3 to 15 GHz. The modal analysis of the antenna is carried out to investigate the notch band formation. The effect of rounded shaped slots in the patch and two C-shaped slots on both sides of microstrip feedline within the ground plane on the resonant modes is analyzed by observing current distribution in the patch and ground plane. It is observed that smaller round shape slot increases the input impedance of TM_{21} mode while larger round shape slot increases the input impedance of TM_{20} mode which yields band notch response.

Keywords Ultra-wideband antenna · Band notch characteristics · Modal analysis · Slot loaded antenna

1 Introduction

Microstrip antenna (MSA) can be simply cohesive with microwave integrated circuit (MIC) and hence it is generally used in high frequency circuit. Hence microstrip variant of planar monopole antennas are commonly used to cover ultrawide band

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(UWB) within a frequency range 3.1–10.6 GHz as permitted by the Federal Communications Commission (FCC) in 2002 [1]. The regularly used UWB antennas with patch shapes are circular, rectangular, triangular, hexagonal and their amended variations [2–5]. The UWB antennas are designed by cutting various shapes of slots in the ground plane or in the patch. [6, 7]. Other narrowband services like, WiMAX 802.16 (3.3–3.8 GHz), IEEE 802.11a exist over the designated UWB spectrum (3.1–10.6 GHz). For some applications, UWB antenna along with additional filters are used to reject these bands which increases the complication of UWB system and cost. Hence, to reduce the interferences between narrowband systems and UWB, realization of UWB antennas with notched frequency bands are required. The most common technique to obtain notch band is to incorporate slots or slits on the patch or on the ground plane circular or elliptical [8], and rectangular slot [9]. Other methods to yield band-notched response are addition of parasitic elements, incorporate split ring resonator or its complement type slot, realising electromagnetic bandgap (EBG) structure [9]. Also, several other techniques have been realised to create a triple band notch in [10, 11]. However, detailed explanation about the influences of modifications in geometry of patch that results into tunable notch response with respect to patch or ground plane resonant modes is not provided.

In this paper, the reported triple band notch UWB printed monopole antenna [11] is investigated in detail. The round shape slots in the patch are incorporated to obtain the notch bands. But the effect of slots on the resonant modes of the patch is not explained in the paper. The novelty of this paper is analysis of placement and dimension of slots in the patch or ground plane to get frequency notch response by perturbing the resonant modes present at those frequencies. Also, the current distributions on the patch and ground plane at the resonant modes is analyzed to get more insight about the modes. The parametric study of the antenna is brought out by varying various parameters of the antenna which tunes the notch frequency.

2 Reported Antenna Geometry

The geometry of the reported triple frequency band-notched UWB antenna with two rounded shaped slots in the patch and a pair of C-shaped slots on the both sided of microstrip feed line in the ground plane is shown in Fig. 1a [11].

The antenna was realized on low cost glass-epoxy substrate of 0.8 mm thickness with a dielectric permittivity of 4.4, loss factor of 0.02 and is fed by microstrip line with characteristic impedance of 50 Ω. The antenna is composed of a planar radiating patch with two rounded shaped slots S_1 and S_2. The modified rectangular ground plane has a pair of C-shaped slots. The antenna dimension parameters with optimization obtained are as follows: L = 31 mm, W = 22 mm, d_2 = 10.5 mm, d_3 = 4 mm, W_1 = 1 mm, W_2 = 0.5 mm, R_1 = 8 mm, R_2 = 2.3 mm, L_1 = 5 mm, L_2 = 2.3 mm, L_3 = 2.1 mm. The simulated plots of resonance curve and return loss (S_{11}) of the structure are shown in Fig. 1b. The antenna yields notch within three

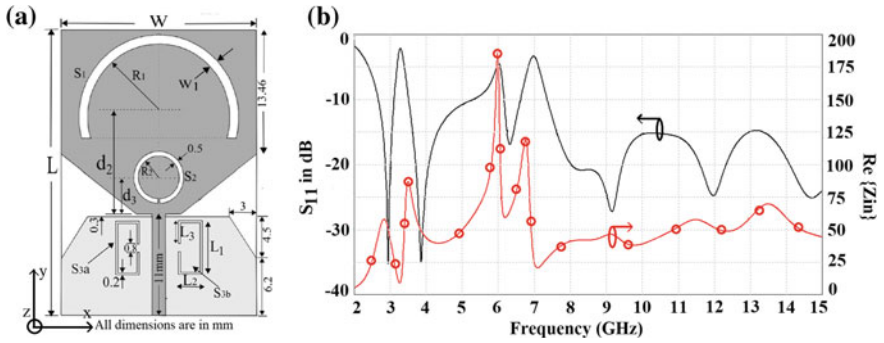

Fig. 1 **a** Reported structure of triple band notch UWB antenna, **b** simulated plots of return loss (S_{11}) and real part of input impedance (Zin) of the reported structure [11]

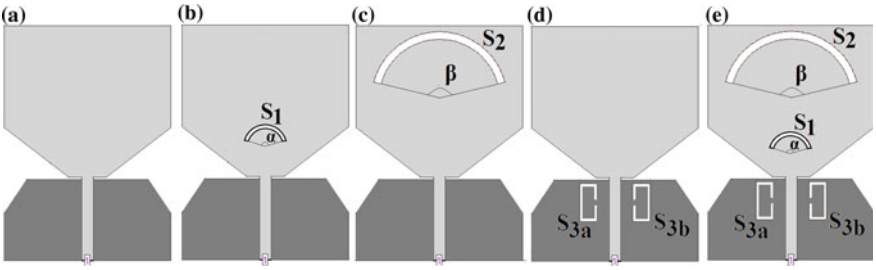

Fig. 2 Evolution of antenna: **a** monopole antenna without slots, **b** with smaller slot S_1, **c** with larger slot S_2, **d** with C-Shaped slots S_3 in ground plan, **e** with slots S_1, S_2 and S_3

frequency bands of 3.3–3.65, 5.2–6.1 and 6.5–7.4 GHz, at the same time yielding UWB response from 2.5 to 15 GHz with a magnitude of $S_{11} < -10$ dB.

3 Analysis of Antenna Design

To realize the working of the antenna and also the consequence of rounded shaped slots S_1 and S_2, an analysis of the antenna was carried out by incorporating slots in the patch and two C-shaped slots on either side of feedline in the ground plane one by one as shown in Fig. 2a–e. First, the antenna without any slot is simulated using IE3D and resonant modes are identified. The simulated plots of resonance curve and return loss (S_{11}) of the antenna without any slots are shown in Fig. 3a.

It is seen that the antenna structure without slots yields UWB response from 3 to 15 GHz. The input impedance lies within 40–75 Ω indicating a good match within the frequency band. The current distributions at resonant modes are shown in Fig. 3b–d.

To investigate the effect of smaller round shape slot on the resonant modes the angle of annular sector slot α is varied. The corresponding simulated resonant plots

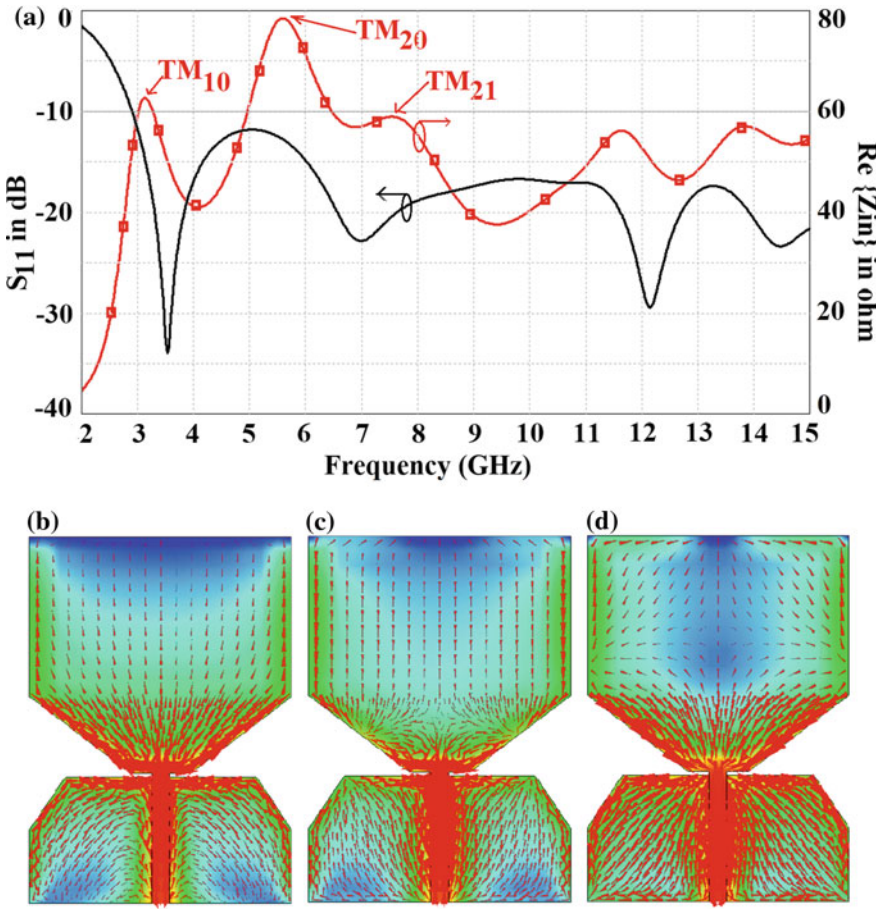

Fig. 3 **a** Simulated plots of Resonance curve and return loss (S_{11}) for the monopole antenna without slots and Current distributions at resonant modes, **b** 3.13 GHz, TM_{10}, **c** 5.58 GHz, TM_{20}, **d** 7.63 GHz, TM_{21}

are shown in Fig. 4a. As the angle α increases, the resonant frequency corresponds to TM_{21} mode gets lowered significantly and the impedance at this mode gets increased beyond 80 Ω resulting into band notch characteristics. However, TM_{10} and TM_{20} resonant mode frequency of patch remain unaltered.

The simulated surface current distribution at TM_{21} modal frequency for corresponding value of α are shown in Fig. 4b–d. A dense current distribution is observed about the periphery of smaller slot S_1, at their corresponding notch frequency which corresponds to TM_{21} mode. Similarly, to investigate the effect of larger round shape slot which yields another notch on the resonant modes the angle of annular sector slot β is varied. The corresponding resonant plots are shown in Fig. 5a. As the angle β increases, the resonant frequency corresponds to TM_{20} mode gets lowered

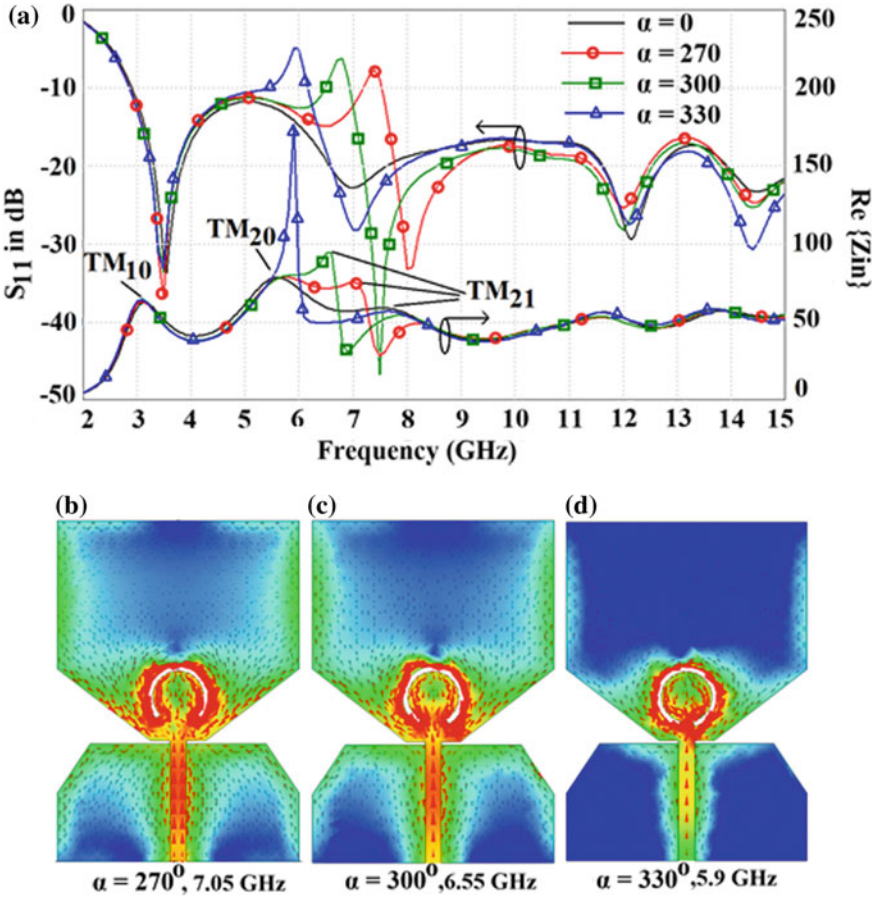

Fig. 4 **a** Simulated plots of Return Loss and Resonance curve, **b–d** current distributions at resonant mode TM_{21} for various values of angle α

significantly and the impedance at this mode gets increased beyond 90 Ω resulting into band notch characteristics. At other frequencies the real part of the impedance remains near about 50 Ω showing good impedance match. However, TM_{10} and TM_{21} resonant mode frequency of patch remain almost constant. The third notch band has been realised by incorporating two same C-shaped slots S_{3a} and S_{3b} with overall length of $L_S = L_1 + 2L_2 + 2L_3$ in the ground plane. To investigate the effect of these slots overall length of slot Ls is varied by varying L_2. The resonance plot and return loss (S_{11}) for different values of L_2 are shown in Fig. 5b. The values of L_2 are taken as 1.8 mm, 2.3 mm and 2.8 mm which further corresponds to overall slot length of slots S_{3a} and S_{3b} as 13, 14 and 15 mm respectively as the values of $L_1 = 5$ mm and $L_3 = 2.1$ mm for C-shaped slots are kept constant.

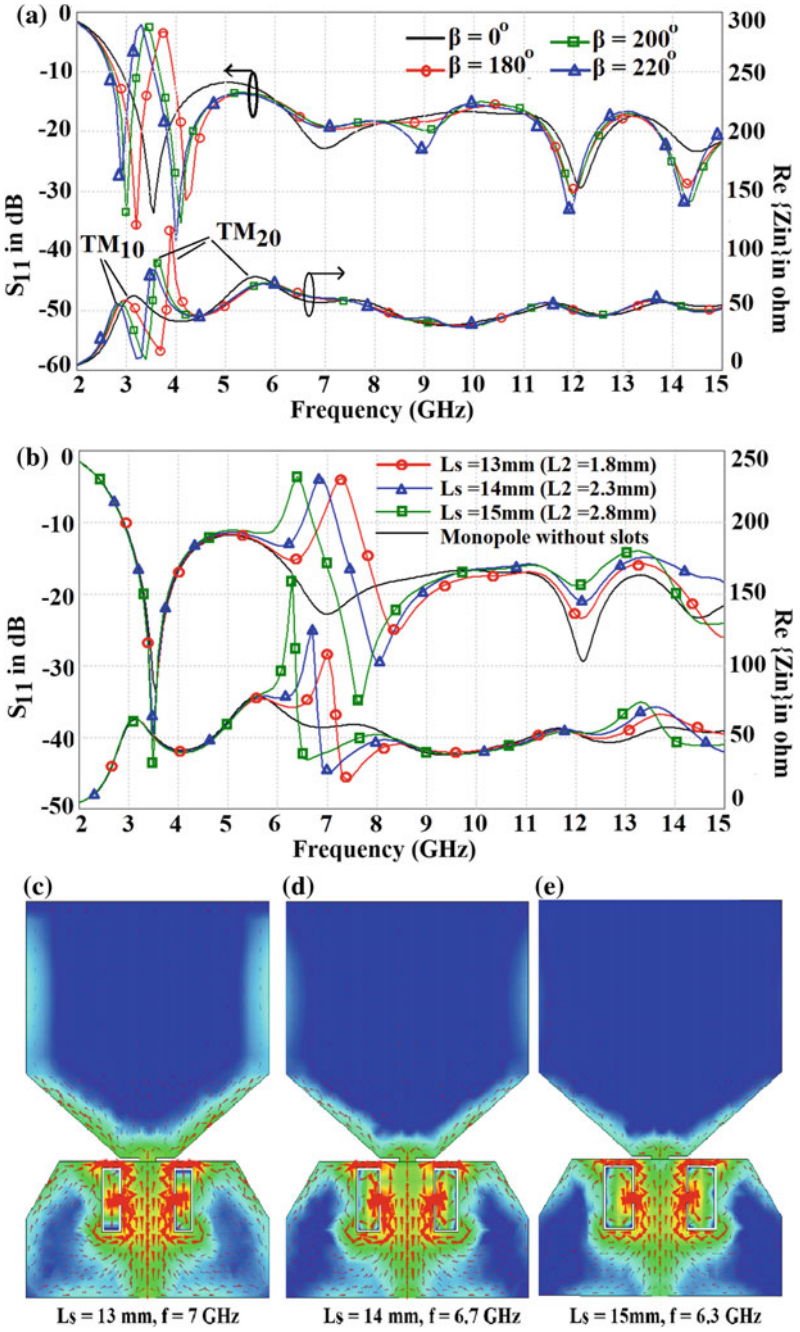

Fig. 5 Plot of simulated return loss and resonance curve for various values of **a** angle β **b** slot length Ls; **c**–**e** current distribution at resonant mode TM_{20} for monopole antenna with C-shaped slot for various values of L_s

The simulated surface current distribution at TM_{20} modal frequency for corresponding value of Ls are shown in Fig. 5c. Around the periphery of C-shaped slots S3a and S3b, a dense current distribution has been seen at their respective notch frequency which corresponds to TM_{20} mode. The current intensity in the patch is almost zero as the slots S_{3a} and S_{3b} provides high impedance at the corresponding frequencies resulting into poor radiation which yields notch response. Hence, a pair of C-shaped slots introduce additional mode in the ground plane giving a notch response.

4 Conclusions

A compact triple frequency band-notched ultra-wideband printed monopole antenna is investigated in detail with respect to resonant modes. The modal analysis of the antenna structure is carried out to investigate the notch band formation. The effect of round shape slots in the patch and a pair of C-shaped slots in the ground plane on the resonant modes of the patch and ground plane is analyzed by observing current distributions. The smaller round shape slot increases the input impedance of TM_{21} mode while larger round shape slot increases the input impedance of TM_{20} mode which yields band notch response. Two C-shaped slots on either side of feedline in ground plane introduce additional mode which yields notch response.

References

1. FCC (2002) FCC report and order for part 15 acceptance of ultra wideband (UWB) systems from 3.1 to 10.6 GHz. Washington, DC
2. Ray KP, Thakur SS, Deshmukh RA (2012) UWB printed Sectoral monopole antenna with dual polarization. Microw Opt Technol Lett 54:2066–2070
3. Kumar G, Ray KP (2002) Broadband microstrip antennas. Artech House
4. Ray KP (2008) Design aspect of printed monopole antenna for ultrawide band applications. Int J Antennas Propag 1–8
5. Ray KP, Ranga Y Printed rectangular monopole antennas. In: IEEE antenna propagation society international symposium, pp 1693–1696 (2006)
6. Hong T, Liu Y (2010) A novel monopole antenna for ultra-wide band application. Microw Opt Technol Lett 52(12):2694–2696
7. Zhang Y, Hong W, Yu C (2008) Planar ultrawideband antennas with multiple notched bands based on etched slots on the patch and/or split ring resonators on the feed line. IEEE Trans Antennas Propag 5:3063–3068
8. Sarkar M, Daniel A, Dwari S (2013) Compact printed monopole antenna for ultra-wideband application with dual band notched characteristic. Microw Opt Technol Lett 55:2595–2600
9. Li T, Li GH, Liang CH (2012) Design of compact UWB band-notched antenna by means of electromagnetic-bandgap structures. Electron Lett 48:608–609
10. Nguyen DT, Hyun D (2012) Very compact printed triple band-notched UWB antenna with quarter-wavelength slots. IEEE Antennas Wirel Propag Lett 11:411–414
11. Bakariya PS (2014) Triple band notch UWB printed monopole antenna with enhanced bandwidth. AEU -International Journal Electronics Communication

A Review on IOT Based Health Care Monitoring System

Pravin Kshirsagar, Akshay Pote, K. K. Paliwal, Vaibhav Hendre, Pranav Chippalkatti and Nikhil Dhabekar

Abstract Unique In the most recent decade the human services checking frameworks have drawn impressive considerations of the scientists. The prime objective was to build up a dependable patient checking framework with the goal that the social insurance experts can screen their patients, who are either hospitalized or executing their ordinary day by day life exercises. In this work, we present a cell phone-based remote human services checking framework that can give constant online data about physiological states of a patient. Our proposed framework is intended to quantify and screen imperative physiological information of a patient so as to precisely depict the status of her/his wellbeing and wellness. By utilizing the data contained in the content or email message the human services proficient can give vital therapeutic exhorting. The framework predominantly comprises of sensors (i.e. temperature sensor, gyrator, accelerometer), area locker (i.e. GPS), microcontroller (i.e. Raspberry Pi), and programming (i.e. Raspbian, Disk imager). The patient's temperature, no. of steps he/she strolls, area information is observed, shown, and put away by our framework. Alongside the above notice parameters, the android application will show timing and sum for drinking water and alarm about same.

Keywords GPS · Internet of things · Smart health care · Raspberry Pi

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1 Introduction

Prosperity is one of the overall challenges for mankind. As shown by the constitutions of the World Health Organization (WHO) the most raised achievable standard of prosperity is an urgent perfect for an individual. Strong individuals incite secure their lifetime compensation and therefore to increase in all-out national yield and in obligation wages. Strong individuals also reduce the load on the starting at now overwhelmed mending focuses, offices, and helpful specialists and decline remarkable weight on general society prosperity frameworks, establishments, and regulatory (or non-authoritative) affiliations. To keep individuals strong a convincing and instantly accessible present-day social protection structure is fundamental.

A modernized social protection system should give better restorative administrations organizations to people at whatever point and from wherever in a budgetary and patient welcoming way. At this moment, the human administration's structure is encountering a social movement from a traditional method to manage a modernized patient-centered philosophy. In the standard philosophy, the therapeutic administration's specialists expect the noteworthy activity. They need to visit the patients for basic investigation and inviting. There are two key issues related to this system. Immediately, the therapeutic administration's specialists must be close-by of the patient continually and besides, the patient remains surrendered in a specialist's office, wired to bedside biomedical instruments, for a time allotment. With the true objective to deal with these two issues the patient masterminded approach has been envisioned. In this philosophy the patients are furnished with learning and information to accept a progressively powerful activity in sickness assurance, and abhorrence. The key part of this second approach is a strong and expeditiously available patient watching system (PMS).

Starting late, flexible frameworks are seen as fundamental for understanding future overall prosperity challenges. With the overall market invasion of the mobile phones, the versatile social protection system (i.e., mHealth) is a created idea now. By using the wireless therapeutic administration's structure can be made open for people, who are living in remote districts missing much access to various sorts of trades. Without a doubt, even a fundamental phone can transform into an astonishing human administrations instrument now. Texts and phone calls can quickly pass on consistent and fundamental information of a patient to a remote region. As such the patients, living in remote domains can lessen pointless forward and in reverse travel to the far discovered social protection centers. In any case, mobile phones have advanced toward getting to be "quick" presently to achieve more instead of simply transmit therapeutic information and appeal.

2 Literature Survey

In this work maker, Amna Abdullah and et al. demonstrate a LabVIEW based patient checking framework. The framework undertaking is done in five key advances. We think about two frameworks to execute the structure. In the rule system, we interface the sensors joined with the patient's body to a transmitter unit related with a ZigBee or GSM orchestrate. The transmitter transmits the information remotely to a recipient that is additionally connected with a ZigBee or GSM engineer. The beneficiary is connected directly to the USB port of a near to watching unit (which is a Laptop with LabVIEW programming in it). The region watching unit shows the last information [1].

This paper exhibits the upgrade of a microcontroller based structure for remote heartbeat and temperature watching utilizing ZigBee. In India, different patients are passing on due to heart assaults and illumination for that they are not getting profitable and reasonable help. To give them worthwhile and bona fide enable first we to need to unending seeing of patient flourishing. The settled watching structure can be utilized precisely when the patient is on intriguing little lodging framework are enormous and just open in the retouching workplaces in ICU. The framework is made for home use by patients that are not in a central condition but rather should be persistent or sporadically observed by clinician or family. In any major condition, the SMS is sent to the expert or any relative. With the target that we can without a considerable amount of a stretch additional different lives by giving them brisk association [2].

Online telemedicine structures are noteworthy because of the likelihood of promising and productive social insurance associations. These structures depend after frontline remote and wearable sensor advancements. The snappy progression being developed has astoundingly improved the level of remote flourishing watching structures. In this paper, a consistent heart watching structure is made contemplating the cost, ease of use, accuracy, and information security. The framework is conceptualized to give an interface between the master and the patients for two-way correspondence. The real motivation driving this examination is to empower the remote cardiovascular patients in getting most recent therapeutic organizations associations which in all likelihood won't be workable generally in perspective of low ace to-consistent degree. The made watching framework is then assessed for 40 people (built up someplace in the extent of 18 and 66 years) utilizing wearable sensors while holding an Android contraption (i.e., cell phone under the supervision of the aces). The execution examination demonstrates that the proposed structure is dependable and obliging because of brisk. The examinations displayed that the proposed framework is advantageous and solid and guarantees information security expecting no effort [3].

The Body Sensor Network (BSN) improvement is a hero among the most basic advances utilized in IOT based present-day therapeutic organizations system. IOT has now changed into the most remarkable correspondence standard of the 21st century, by broadening the likelihood of Internet and making it increasingly inevitable, permitting unsurprising relationship among various sorts of contraptions. In the con-

text of that reason, IoT has now wound up being increasingly advantageous in two or three zones, for example, social security structure. This paper proposes a structured plan for marvelous helpful organizations dependent on GPS and GSM Technologies, containing cut back body sensor units(Bsus), which can quantify beat, heartbeat rate and body temperature and pass on them in instances of excellent practices to supervision healing segments utilizing GSM, GPS to pass on inciting activities to anchor patients nearness with likelihood later on to fuse other essential parts estimations as indicated by accessible sensor in the market which can accomplish the goal of giving a solid sensible application to constant flourishing checking and following [4].

Future in various nations has been broadening constantly over the few couples of decades as a result of basic enhancements in prescription, general flourishing, and besides individual and ordinary tidiness. In any case, expanded future joined with falling birth rates are relied on to actuate a wide creating estimation in- side the not so distant future that would drive massive loads on the cash related structure of these nations. Therefore, it is basic to make fiscally clever, simple to- utilize structures for elderly social security and achievement. Remote flourishing checking, in context of non-intruding and wearable sensors, actuators and current correspondence and data movements offers a skilled and shrewd strategy that engages the elderly to keep living in their satisfying home condition rather than costly human organizations work environments. These frameworks will in like way engage helpful organizations to work capacity to screen essential physiological indications of their patients constantly, diagram flourishing conditions and give commitment from far away from work environments. In this paper, we have appeared and contemplated a few unimportant efforts and non-intrusive thriving and movement watching frameworks that were spoken to recently. An examination on material based sensors that can be utilized in wearable frameworks has moreover appeared. At long last, the closeness of several correspondence types of progress and in like manner future points of view and research difficulties in re- mote watching structures will be investigated [5]. A man who requires treatment in crisis conditions must be accepted beyond what many would consider possible the time delay. This implications of a man getting to be sudden sick can be found with the assistance of electronic structures, for example, sensors and controllers. Eventually, this information must be exchanged to the relatives to screen the patient's flourishing condition. The present success watching structures works completely fine. Regardless, these advancement trackers shift information of the individual from the gadget to the adjacent telephone through short-range correspondences like Bluetooth. The client can screen or the information would now have the ability to be exchanged to the web or relatives from the near to dealing with the unit like versatile or pc. The present paper consolidates the most recent improvement of microcontroller from which the information of the patient can be exchanged to the web from the patient's wearable gadget itself. In this structure, we utilized heartbeat sensor to quantify the heartbeat rate of a man, and accelerometer to check the number of steps, free, speed, calories ate up and a controller board Ti's CC3200, which has inbuilt Wi-Fi that works in both station mode and way mode. The beat sensor's information goes to controller, by then the controller sends this information to the web-connected with the versatile application by utilizing accessible Wi-Fi plan. The

data can be seen from the versatile application with security accreditations like login motivations behind interest [6].

3 Proposed System

Proposed System have the temperature, breath; patient's body developments and heartbeat perusing are observing utilizing Raspberry Pi. These sensors signals send to the Raspberry Pi through speaker circuit and flag molding unit (scu), on the grounds that the signs levels are low (gain), so enhancer circuit is utilized to pick up the flag and transmit the signs to the Raspberry Pi. Raspberry Pi is a Linux based working framework fills in as a little pc processor framework. Here patients body temperature, body developments, breath and pulse is estimated utilizing individual sensors and it tends to be observed in the screen of PC utilizing Raspberry Pi and also checking through anyplace on the planet utilizing web source.

The proposed strategy for patient checking framework is screen patient's body temperature, Blood weight, and Respiration rate and body developments utilizing Raspberry Pi. In the wake of interfacing web to the Raspberry Pi, it goes about as a server. At that point, the server consequently sends information to the site. Utilizing IP address anyone can screen the patient's wellbeing status anyplace on the planet utilizing PCs, tablets and advanced mobile phones. On the off chance that these parameters are going to anomalous it will consequently send ready mail to the specialists and relatives. After full equipment culmination process, at that point putty programming is utilized for the finish of full task Then MIT application innovator programming is utilized for exchange these parameters (Patient's body temperature, Blood Pressure, and Respiration rate and body developments) from Raspberry Pi to Android App as shown in Fig. 1.

This paper proposes an ongoing minimal effort electronic saline observing and control framework which can naturally screen the saline stream rate, remaining time and can likewise control imbuement rate. It can remotely send the data to the server and show the outcomes as saline bead rate, disappointment condition.

4 Conclusion

This paper proposes an ongoing minimal effort electronic saline observing and control framework which can naturally screen the saline stream rate, remaining time and can likewise control imbuement rate. It can remotely send the data to the server and show the outcomes as saline bead rate, disappointment condition, and remaining time to purge the saline jug and show mixture volume showed on focal screen.

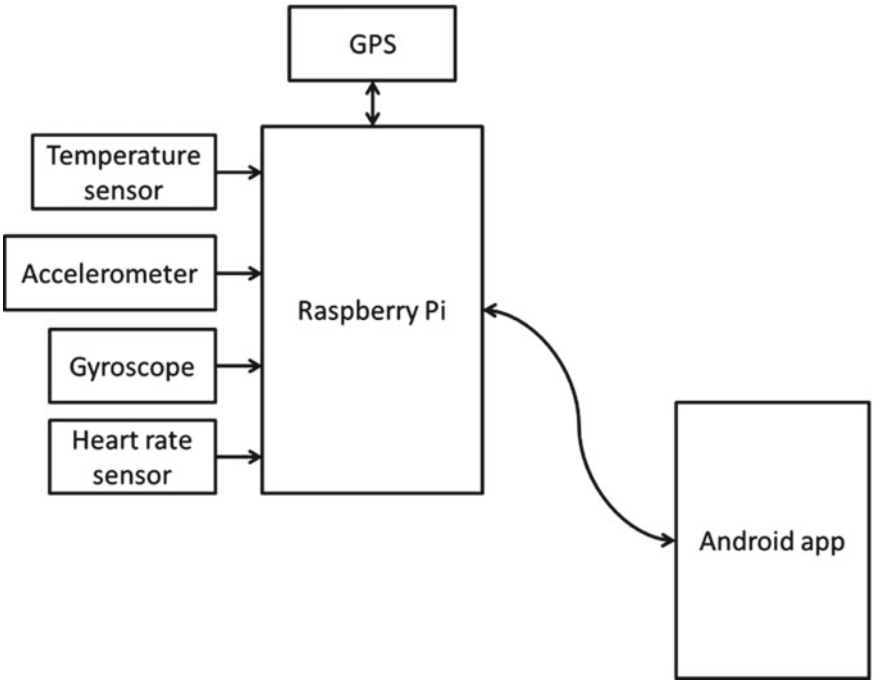

Fig. 1 Proposed system

References

1. Abdullah A, Ismael A, Rashid A, Abou-ElNour A, Tarique M (2015) Real time wireless health monitoring application using mobile devices. Int J Comput Netw Commun (IJCNC) 7(3):13, May 2015
2. Shelar M, Singh J, Tiwari M (2013) Wireless patient health monitoring system. Int J Comput Appl (0975–8887) 62(6):1, Jan 2013
3. Kakria P, Tripathi NK, Kitipawang P (2015) A real-time health monitoring system for remote cardiac patients using smart-phone and wearable sensors Hindawi Publishing Corporation. Int J Telemed Appl 2015, Article ID 373474, p 11. https://doi.org/10.1155/2015/373474
4. Shahzad A, Lee YS, Lee M, Kim Y-G, Hindawi NX (2018) Real-time cloud-based health tracking and monitoring system in designed boundary for cardiology patients. J Sens 2018, Article ID 3202787, p 15
5. Fatima S, Sayeed A (2017) IOT based health care monitoring and tracking system using GPS and GSM Technologies. Int J Prof Eng Stud VIII(5), 2017
6. Majumder S, Mondal T, Deen JM Sensors wearable sensors for remote health monitoring. US National Library of Medicine National Institutes of Health Medical. https://doi.org/10.3390/s17010130

ACADF: Ant Colony Unified with Adaptive Dragonfly Algorithm Enabled with Fitness Function for Model Transformation

Pramod P. Jadhav and S. D. Joshi

Abstract Model transformation is a key factor in the software project management. Model and its transformation is a key factor of software project process. This can be adapted by using some new transformation language. This paper aims to convert a class diagram (CLD) to Relational Schema (RS). Which include different perspective like, blocks, fitness function, and algorithm. Model transformation contribute major role in Model Driven Engineering (MDE). So transformation is perspective for the agile software development methodology. Transformation is part of agile methodology, which makes a better result for whole transformation process. For the same different algorithm are requiring for calculating the concern value for fitness function. This research work refer a optimization algorithm for phase 1 and phase 2 module and try to get a better output as compare to other algorithm like DA, PSO, ADF. This work will consider the Ant Colony optimization (ACO) algorithm integrated with dragonfly algorithm (ACADF) for the model transformation. These model transformations also consider the fitness function accordingly. Further it evaluate and analyzed using Automatic correctness (AC) and related fitness function, which pave the blocks for better result.

Keywords Model transformation · Relational schema · TDD · Class diagram · Model-driven engineering · Dragonfly · Ant colony · Optimization

1 Introduction

Now a day model transformation plays a major contribution in model driven development (MDD). It provides a different aspect of software project management. Even software development life cycle (SDLC) also contain the key role of model trans-

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formation, which support the aspect like test driven development(TDD), test cases, and different algorithm which will consider for this research work [1]. All this agile technique can be perform a better quality transformation along with various testing strategies. So model transformation is preferable research area of software era [2]. Graph transformation is another flavor of model transformation. Graph transformation requires a formal verification language and its related algorithm for the dynamic result [3]. Many researchers are work on the transformation and searching with different algorithm for concrete output. On the other side un-formal perspective are also consider for a transformation like Object Constraint Language (OCL) [4], but result showing that formal language are more efficient as compare to un-formal perspective. Atlas Transformation Language (ATL) is basically a popular language in model transformation [5, 6]. For relational data model various conceptual data constraints are used, and after adding some algorithmic strategies relational (ER) model can be work for better result [7]. For all these concern, Model-driven Engineering is accepted for software development process and broadly used for model transformation and its modification purpose [8]. The main contribution in this paper is:

Proposed Ant Colony unified with adaptive dragonfly algorithm (ACADF) The proposed ACADF is consider with the Adaptive Dragonfly (ADF) algorithm along with ACO algorithm using TDD based fitness function and block codes, for model transformation of class to relational model.

This Paper is Framed as
Segment 1 introduce to the paper, segment 2 consider the previous works and made a literature review, Segment 3 elaborate the proposed work of this research, segment 4 discus the outcome of the proposed work and compare the result with existing work. And finally, put up the conclusion.

2 Motivation of the Work

This segment explains the literature survey of the existing approach of Model Transformation and tries to find out the key factor of model transformation.

2.1 Literature Survey

Different model transformation technique is study and provides a survey based on various research paper. Fleck et al. [9] discus the complexity reducing technique called automated search approach and tries to improve the fundamental perspective of model transformation. This technique also improves the effectiveness of transformation. This method also support ATL approach. The repository structure of

transformation is not able to found using this technique. Cuadrado et al. [5] develop a statistically analyzed method for ATL model transformations which is generally used as input, and discover the error detection static method, provided approach unable to find some common errors. LoïcGammaitoni et al. [10], develop a different concept for transformation which include validation. This is most dynamic approach which was based on effective control of model transformation. But it is a time consuming process as far as concern to F-module integrated with augmented module towards Alloy analysis. Liu et al. [11] develop a TP model algorithm which improved capability of reshaping process. This method not preferable because of tightness of convex hull association with TP model which affect on performance of the model transformation. Cuadrado et al. [12] develop a innovative reutilization approach for model transformation, where format was reusable and can be used for multiple time and multiple system for different meta model. This methods failed due to constraint like, attribute, class, reference are need to use combined for particular system. Kessentini et al. [13] consider a process which was based on optimization process apply in source data model, and compare with PSO and simulated annealing method.

3 Proposed ACADF for Effective Model Transformation

Here class diagram is consider as a source data model and Relational schema (RS) model is consider as target data model. For the betterment of the model transformation Ant Colony technique is used important key factor in this work. This work develop an Ant Colony Optimization unified with Adaptive Dragonfly algorithm (ACADF) along with TDD fitness function for effective model transformation. Here CLD model is considered as an input of the Adaptive dragonfly algorithm along with TDD fitness function [14, 15]. ACO is used for selecting suitable block which is a first phase of this proposal. ACADF algorithm is depicted in Fig. 1 in this block diagram CLD are considering as a input along with Solution encoding. Block will identified by taking the support of ADF and TDD fitness function. Selected block will used for the further process and apply for the second phase effectively. Phase–I contain ACADF algorithm which combine the properties of ADF and ACO. After phase-I suitable block called best solution provided to phase-II.

3.1 First Module of ACADF Algorithm

The class diagram model is provides a source-input to projected system in order to make example base. CLD basically a combination of multiple classes, aggregation, association. These are the constraints of the given CLD model. In order to have a number of these constrains the block are generated.

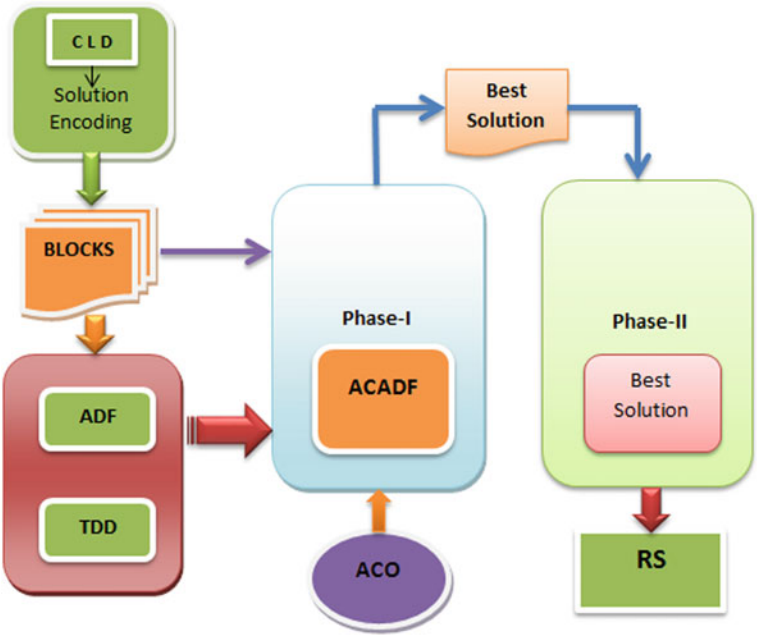

Fig. 1 Blocked diagram of proposed ACADF for model transformation

(a) ***Block sets scenario***

As explain above segment blocked is generated through solution encoding as depicted in Fig. 2. CLD model contain a set of classes, association and aggregation which form a basic model. In Fig. 2 there are 4 classes, 2 Aggregation, and 2 Association which comprises total eight (8) blocked produced from existing block (t), which can be represented as B = {b1,b2,b3,…bs….bt}, whereas bs consider as a selected block according to available constraints in the CLD. [16, 17] These eight construct unified with ACADF algorithm which determine the eight.

(b) ***Fitness function***

This work considers the function to select the best suitable block for transformation. By considering the parameter such as Internal coherence, External coherence, Adequacy, and Association of the transformations fitness function will work. In the case test case also consider for the function along with TDD properties. Which can be depicted in following way [17].

$$Fitness = Ft_1 + Ft_2 \tag{1}$$

where, the fitness Ft_1 and Ft_2 are indicate by using the following equation,

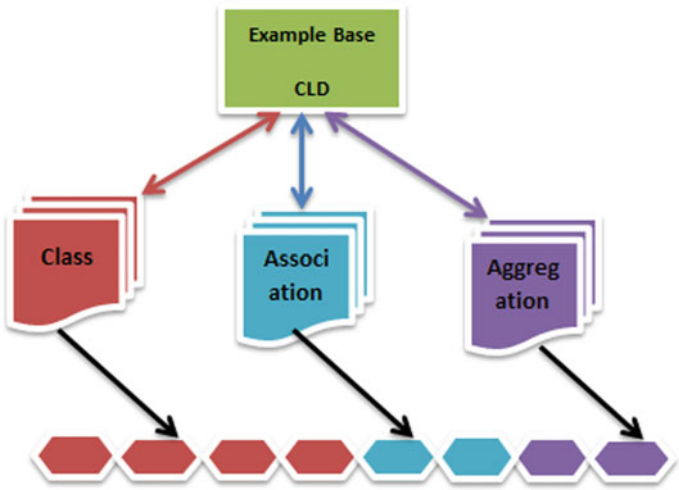

Fig. 2 Block set scenario for ADF algorithm

$$Ft_1 = \sum_{k=1}^{8} a_k * (In_k + Ex_k) \tag{2}$$

where, a_k is adequacy factor, In_k is an internal coherence, and Ex_k consider as extramural integrity factor for kth construct. TDD fitness formula is,

$$Ft_2 = \frac{Count\ of\ satisfied\ test\ cases}{TotalCount\ of\ test\ cases} \tag{3}$$

(c) ***Position update of ADF***

In Eq. (4), A_i, B_i, C_i, D_i and E_i represent the cohesion, distraction, attraction, alignment, and separation, of the ith dragonfly which update the velocity. Term λ_2 indicates that weight updating along with number of iteration. ADF algorithm, the more sophisticated working of ADF consider the value of a = b = c = d = e = λ_1. For each iteration,

$$\Delta V(t+1) = \lambda 1(A_i + B_i + C_i + D_i + E_i) + \lambda_2.\Delta V(t) \tag{4}$$

where, λ_1 and λ_2 refers to updating weight factor, which depend on total number of iteration. The equation for the adaptive weights are further modified as follows.

(d) ***Proposed ACADF algorithm for position update***:

As considering the ACO algorithm value of pheromone with iteration can be updated using equation number six (5), which is as follow. This update the value of final path selection and used for further calculation. As the ADF algorithm also consider the

updating weight of the dragonfly and hence the these two updating value considered for the final update, and represent as λ_3. This value represent the position update of the provided algorithm, and used for further calculation.

$$\tau_{ij} = (1 - \varphi) \cdot \tau_{ij} + \varphi \cdot \tau_0 \tag{5}$$

Equation (5) is referred as the ACO and used for the updating the value of ant path selection by considering the number of pheromone. Value of τ_{ij} is equivalence to $\Delta V(t + 1)$ in ADF algorithm, because both the value are consider for the updating the value of position. Hence λ_3 is anew factor which collaborate these two value and modified equation is produced based on the ACO and ADF algorithm (6).

$$\lambda_3 = \tau_{ij} = \Delta V(t + 1) \tag{6}$$

Final Eq. (7) shows that combination of ACO and ADF algorithm, by considering the both position updating value. By referring Eqs. (5) and (6) modified Eq. (7) as assigned with τ_{ij} and also used for further result calculation and comparison.

$$\tau_{ij} = (1 - \varphi) \cdot (\lambda 1(A_i + B_i + C_i + D_i + E_i) + \lambda_2.\Delta V(t)) + \varphi \cdot \tau_0 \tag{7}$$

3.2 Second Module of ACADF Method

The best solution is generated using ACADF algorithm and generates the result from class to relational diagram. Main factor of this work is Block set which can be selected by using different parameter and best solution is provided to the second phase. Second phase basically a second module provides solution and consider for effective and efficient model transformation process.

4 Results and Discussions

The result produced through ACADF algorithm and available algorithms of Model transformation is discussed through this segment. ACADF algorithm comprises different CLD model which later on transform into relational schema (RS). For available method dragonfly, ADF, and PSO are consider for comparison [18]. The performance measure factor such as Automatic correctness (AC) and Fitness measure are consider for the evaluation.

4.1 Analysis Factor

Projected ACADF methods are comparing with other algorithm, and measure the performance using AC and fitness function. Here above fitness function is used for the analysis along with Eq. (7).

Automatic Correctness: result is produced based on above comparison methods and AC as a performance measure. Relational schema (RS) is obtain based on fitness function, AC and specified algorithm. The range of AC is varying from 0 to 1, and result showing accordingly.

4.2 Comparative Discussion

Table contains the comparison between proposed ACADF and the method DA, PSO, ADF. The comparative measures are AC and Fitness function, which depict the result having the CLD 1 and CLD 2 models. The two CLD model are consider for the comparison and improvement in the proposed work. Following figure show a comparison of CLD1 on basis of AC and Fitness measure (Fig. 3).

ACADF algorithm is proving the effectiveness of the model transformation, as compare to other method; AC and fitness are also helpful as a performance measure. So this measure is important for performance and comparison. Here iteration is consider for 100, 200, 300, 400, and 500, for the comparison 100 and 500 iteration is depicted in segment 4, and iteration 500 are consider for following table with CLD 1 and CLD 2 as a input. Table 1 contain result and comparison which proves ACADF is performing better result than existing methods.

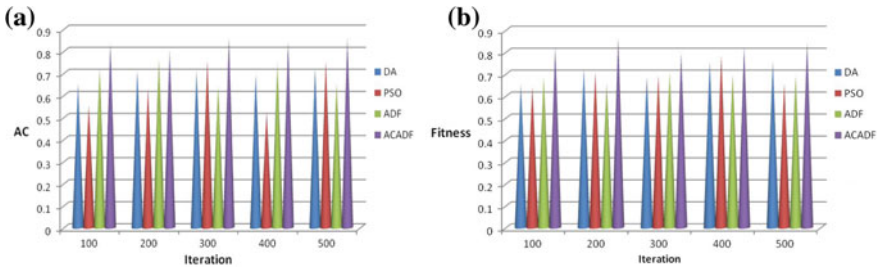

Fig. 3 Comparison of CLD 1 based on **a** AC and **b** fitness measure

Table 1 Comparison with ACADF with two inputs

Input	Performance metrics	Comparative methods			
		DA	PSO	ADF	Proposed ACADF
CLD 1	AC	0.7212	0.7568	0.6578	0.8647
	Fitness	0.7584	0.6584	0.6982	0.8485
CLD 2	AC	0.6258	0.7869	0.6985	0.8654
	Fitness	0.6589	0.7589	0.7489	0.8612

5 Conclusion

In this work, the proposed Ant Colony unified with Adaptive dragonfly (ACADF) algorithm is used for model transformation. This method combined with ACO algorithm and Adaptive dragonfly method improvement for transformation. Ant Colony depends on random iteration of ant which follows the pheromone. It is path finding algorithm which will used for the finding the best solution of blocks. After selecting the best blocks it is consider for the input of second phase. Second phase is testing the scenario based on algorithm and TDD approach, which gives a better performance for the model transformation. For proving the same, AC and fitness function are used for the evaluation. Comparison technique depict that value of ACADF is better than existing one. For more improvement in the model transformation, other optimization algorithm can be used.

References

1. Sendall S, Kozaczynski W (2003) Model transformation: the heart and soul of model-driven software development. IEEE Softw 20(5), 42–45
2. Rahim LA, Whittle J (2015) A survey of approaches for verifying model transformations. Softw Model 14(2), 1003–1028
3. Ehrig H, Ehrig K, Taentzer G (2006) Fundamentals of algebraic graph transformation. Monographs in Computer Science
4. OMG (2018) OCL 2.4 specification. http://www.omg.org/spec/OCL/2.4/
5. Cuadrado JS, Esther G, Lara J (2017) Static analysis of model transformations. IEEE Trans on Softw Eng 43(9):868–897
6. Jouault F, Allilaire F, Bézivin J, Kurtev I (2008) ATL: a model transformation tool. Sci Comput Program 72(1):31–39
7. Czarnecki K, Helsen S (2006) Feature-based survey of model transformation approaches. IBM Syst J 45(3):621–645
8. Schmidt D (2006) Model-driven engineering. IEEE Comput 39(2):25–31
9. Fleck M, Troya J, Kessentini M, Wimmer M, Alkhazi B (2017) Model transformation modularization as a many-objective optimization problem. IEEE Trans Softw Eng, 43(11), 1009–1032
10. Gammaitoni L, Kelsen P, Ma Q (2018) Agile validation of model transformations using compound F-Alloy specifications. Sci Comput Program 162:55–75

11. Liu X, Yu Y, Zhen L, Herbert H. C. Iu, Tyrone F (2017) An efficient algorithm for optimally reshaping the TP model transformation. IEEE Trans Circ Syst II 64(10):1187–1191
12. Cuadrado JS, Guerra E, Lara J (2014) A component model for model transformations. IEEE Trans Softw Eng 40(11):1042–1060
13. Kessentini M, Sahraoui H, Boukadoum M, Ben O (2012) Search-based model transformation by example. Softw Syst Model 11(2):209–226
14. Blum C (2005) Ant colony optimization: introduction and recent trends. Phys Life Rev 2(4):353–373
15. http://www.scholarpedia.org/article/Ant_colony_optimization
16. Kessentini M, Boukadoum H, Omar O (2012) Search-based model transformation by example. S/w & Syst Model 11(2), 209–226
17. Jadhav PP, joshi S, Fractional weightage based objective function to hybrid optimization algorithm for Model Transformation, Evolutionary intelligence. Springer; ISSN-1864-5909
18. Ko JW, Beak S, Song Y (2012) Model optimization with graph transformation and PSO algorithm for model transformation verification. In: Proceedings of international conference on IT convergence and security, vol 120, 2012

Compact Stub Loaded Modified Plus Shape Microstrip Antenna for Broadband Response

Venkata A. P. Chavali, Aarti G. Ambekar, Ameya A. Kadam, Amit A. Deshmukh and K. P. Ray

Abstract In this paper a compact stub loaded modified plus shape microstrip antenna is proposed for broadband response. Enhancement in bandwidth is observed due to proximity of fundamental TM_{10} mode and higher order TM_{20} mode. Wider bandwidth of about 38% is achieved exhibiting broad side radiation pattern at the VSWR band edge frequencies with about 8dBi gain. The surface current distributions of the same configuration optimized at different lengths of stub and width of RMSA shows uni-directional behavior of currents. Also, comparison of simulated and measured gain plots of fabricated patches along with simulated gain plots of the antenna at different stub dimensions and widths of RMSA is presented. The measured and simulated radiation patterns and gain values showed high degree of agreement.

Keywords Compact MSA · Modified plus shaped MSA · Higher-order modes · Rectangular stub

1 Introduction

The main drawbacks of microstrip antennas (MSA) are its lower bandwidth and less gain. So far, many configurations are reported to enhance the bandwidth (BW) of MSAs using techniques such as increasing substrate thickness, utilizing stacked and gap-coupled configurations [1–4], loading the MSA with slots and stubs at appro-

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priate location [1, 2]. Using slot cut techniques by maintaining the same patch area broad bandwidth can be achieved by inserting slots of half wave length or quarter wave length size resembling shapes like U, E and V [5–10]. The bandwidth in slot cut techniques improves as slot increase the surface current path length due to which higher order mode frequency comes near to the frequency of fundamental mode of the antenna. In [11] multiple slots are cut in MSA to bring the frequency of TM_{02} and TM_{12} modes, near the fundamental TM_{10} modes of RMSA to realize larger bandwidth. In [12] a detailed explanation of variations of U-slot cut RMSAs is presented, where a second U-slot in double U-slot cut RMSA configuration optimizes the impedance and frequency at higher order modes with respect to fundamental mode enhancing bandwidth. However, modes reported in [11, 12] has a conical pattern exhibiting high cross-polarization at higher frequencies of the band width reducing the gain. One more technique to realize broad band response is to load MSA with stubs at appropriate locations. In [13] combination of slot and stub are used to achieve wide impedance bandwidth. Also, stubs are loaded to make the surface current uni-directional which reduces the cross-polarization at higher frequencies of the bandwidth. In present work a compact stub loaded modified plus shape microstrip antenna for broadband response is proposed, which optimizes the spacing between the fundamental TM_{10} mode of RMSA and TM_{20} mode of the antenna due to the additional stubs inserted. The proposed configuration is compared with traditional E-slot cut MSA in which two parallel slots are cut to realize larger bandwidth by reducing the space between frequency values of TM_{10} and TM_{02} modes, causing high cross-polar component due to the direction of surface currents of TM_{02} mode. Also, the area occupied by the proposed configuration is less compared to that of E-slot MSA designed at the same fundamental mode frequency, making the antenna compact. A bandwidth of 370 MHz (38%) and broadside gain of 8dBi is realized using proposed configuration, whereas 315 MHz bandwidth is observed in E-slot MSA, with a gain which is slightly higher than that of compact stub loaded modified plus shape microstrip antenna. Different variations of proposed compact stub loaded modified plus shape microstrip antennas are simulated using IE3D software and further experiments were carried out on two fabricated prototypes to validate the result using Vector Network Analyzer, Spectrum Analyzer and Frequency Generator in antenna laboratory. Close agreement between measured and simulated results is observed.

2 E-Shape Microstrip Antenna

An RMSA embedded with two parallel slots is given in Figs. 1a, b. It is well known that for a given feed location the modes excited on RMSA are TM_{10}, TM_{02}, TM_{12} etc. Depending on the length and width dimensions of RMSA the mode whose surface currents exists along the longer dimension of RMSA dominates at lower frequency and vice versa. The two parallel slots cut in the RMSA, resembling the shape of ‘E’ are normal to the width of the RMSA so the frequencies of the modes existing along

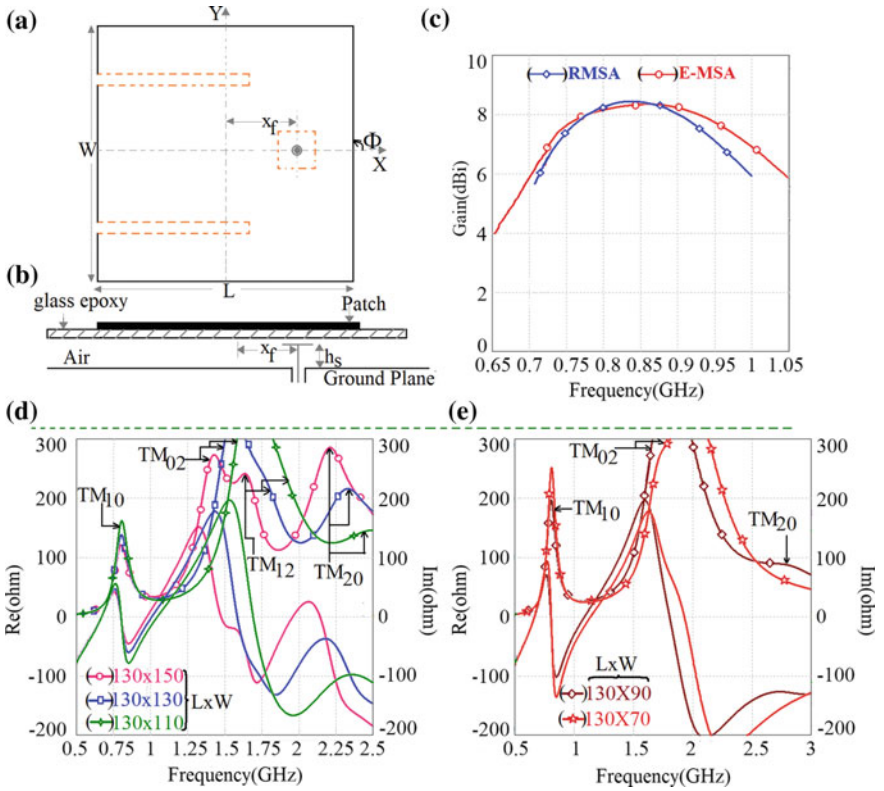

Fig. 1 **a**, **b** E-shape MSA geometry, **c** gain comparison of RMSA and E-shape MSA, **d**, **e** effect of RMSA width variation

the width such as TM_{02} and TM_{12} decreases towards fundamental mode frequency, increasing antenna's bandwidth. Though BW of E-slot MSA increases, reduced gain at higher frequencies of the bandwidth is observed as TM_{02} mode currents are normal to the direction of fundamental mode surface currents increasing cross-polar level along H-plane. The gain comparison of RMSA and E-slot microstrip antenna are shown in Fig. 1c. Also, in Figs. 1d, e the effect of width variation on the modal frequencies of RMSA is shown. When the width increases the frequencies of the TM_{02} and TM_{12} modes whose surface currents exists along the width reduces and vice versa. The impedance TM_{02} and TM_{12} modes decreases with increase in width and impedance of TM_{20} increases. Similarly, it is observed that when width is very small modes which are along the length such as TM_{10} and TM_{20} are dominating at lower frequencies.

3 Compact Stub Loaded Modified Plus Shape Microstrip Antenna for Broadband Response

To increase the bandwidth of RMSA as mentioned in Sect. 1 when slots are loaded they may introduce bi-directional current variations and increase the x-polar component towards the higher order band edge frequencies of the BW. Thus, instead of using slot-cut techniques stubs can be included at appropriate locations on the patch so that the impedance and frequency of fundamental mode and other higher order modes can be optimized to enhance band width. A compact stub loaded modified plus shaped microstrip antenna is proposed to obtain wider BW. The geometry of the proposed structure is shown in Figs. 2a, b. The antenna is designed on dielectric substrate with permittivity 4.4 and loss tangent 0.02 and thickness $h = 0.077\lambda_g$ which is suspended in air. In order to identify the modes excited in the proposed compact stub loaded modified plus shaped microstrip antenna, initially an RMSA of dimensions of proposed configuration without stubs with L = 130 mm and W = 60 mm is simulated using IE3D. The effect of stubs on resonant frequencies of different modes of RMSA is shown in Figs. 2c–e. Gradual increase in stub length ($L_v + L_h$) shifts the frequency values of TM_{20} and TM_{30} modes towards TM_{10} modal frequency realizing broadband response.

Surface currents distributions of TM_{10} and TM_{20} modes responsible for wider bandwidth of the optimum proposed configuration are given in Figs. 2f, g. For all configurations fundamental mode remains almost at the same frequency but TM_{20} experiences a small variation in their frequencies with variation in stub length. The simulated and measured impedance locus of W = 60 mm and W = 30 mm antennas are given in Figs. 2h, i respectively and fabricated prototypes of proposed configurations W = 60 mm and W = 30 mm antennas are given in Figs. 2j, k respectively. Close agreement in simulated and measured values is observed for both configurations. Simulated and measured radiation patterns at band edge frequencies of the impedance locus are as shown in Figs. 3a–d exhibiting broadside radiation pattern across entire VSWR bandwidth. There is a close agreement in simulated and measured values.

A plot of simulated and measured gain comparison of W = 60 mm and W = 30 mm antennas and simulated gains of proposed configuration with different widths and optimized stub dimensions is given in Figs. 4a, b respectively, which represents reduction in gain with reduction in width (W) of the antenna but gain remains almost flat for a constant stub length at given width.

4 Conclusions

A compact stub loaded modified plus shape microstrip antenna is proposed to reduce the cross-polar component at high frequencies as at higher order modes, the stubs loaded on RMSA directs the surface currents along the direction of length of RMSA

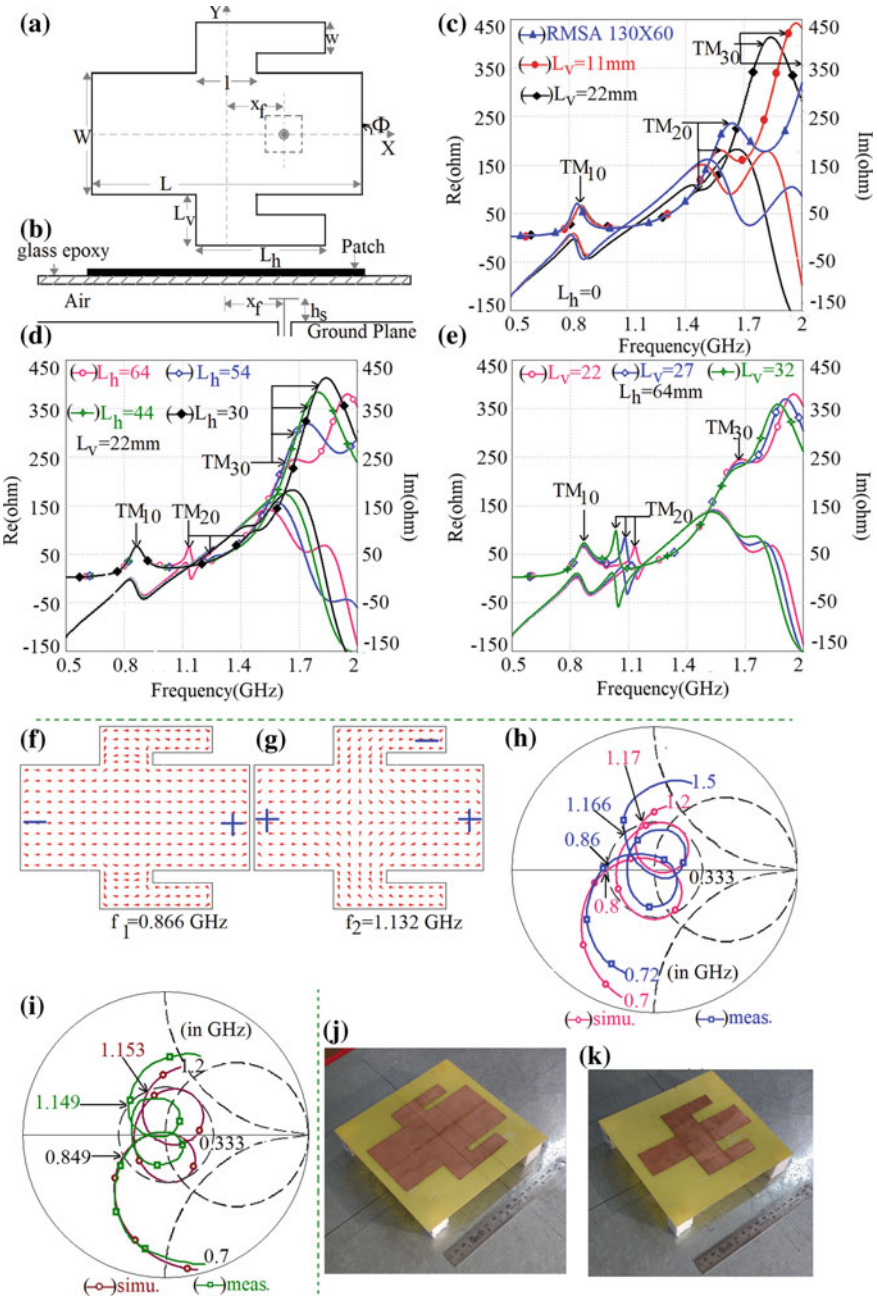

Fig. 2 **a**, **b** Geometry of compact stub loaded modified plus shape microstrip antenna, **c**–**e** resonant frequency plot for different values of horizontal and vertical length of stub, **f**, **g** surface current distributions, **h**, **i** simulated and measured impedance locus of W = 60 mm and W = 30 mm configurations, **j**, **k** fabricated prototypes of W = 60 mm and W = 30 mm configurations

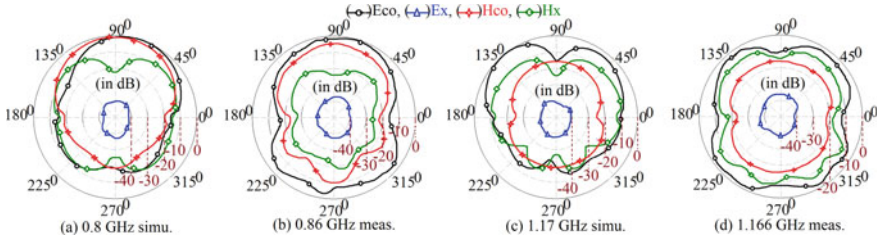

Fig. 3 Simulated and measured radiation patterns of W = 60 mm antenna at band edge frequencies

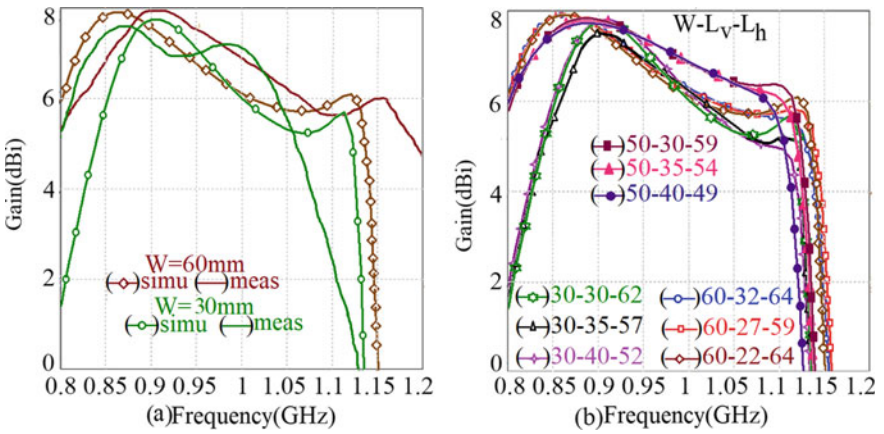

Fig. 4 Simulated gain plots at different W and corresponding optimized stub dimensions **a** Measured and simulated gain comparison, **b** simulated gain comparison

making it uni-directional and reducing the cross-polar levels which were observed in slot loaded MSAs. A close agreement between simulated and measured radiation patterns and gain values at different values of widths is observed.

References

1. Wong KL (2002) Compact and broadband microstrip antennas, 1st edn. Wiley, New York
2. Kumar G, Ray KP (2003) Broadband microstrip antennas, 1st edn. Artech House, USA
3. Abraham J, Mathew T, Aanandan CK (2016) A novel proximity fed gap coupled microstrip patch array for wireless applications. Prog Electromag Res 61:171–178
4. Egashira S, Nishiyama E (1996) Stacked microstrip antenna with wide bandwidth and high gain. IEEE Trans Antennas Propag 44(11):1533–1534
5. Weigand S, Huff GH, Pan KH, Bernhard JT (2003) Analysis and design of broad-band single-layer rectangular U-slot microstrip patch antennas. IEEE Trans Antennas Propag 51(3):457–468
6. Huynh T, Lee KF (1995) Single-layer single-patch wideband microstrip antenna. Electron Lett 31(16):1310–1312

7. Chair R, Lee KF, Mak CL, Luk KM, Kishk AA (2005) Miniature wideband half u-slot and half e patch antennas. IEEE Trans Antenna Propag 52(8):2645–2652
8. Sharma SK, Shafai L, Jacob N (2004) Investigation of wide-band microstrip slot antenna. IEEE Trans Antennas Propag 52(3):865–872
9. Wong KL, Yang KP (1998) Compact dual-frequency microstrip antenna with a pair of bent slots. Electron Lett 34(3):225–226
10. Ansari JA, Ram RB (2008) Broadband stacked U-slot microstrip patch antenna. Prog Electromag Res 4:17–24
11. Islam MT, Shakib MN, Misran N (2009) Multi-slotted microstrip patch antenna for wireless communication. Prog Electromag Res 10:11–18
12. Deshmukh AA, Ray KP (2015) Analysis of broadband variations of u-slot cut rectangular microstrip antennas. IEEE Antennas Propag Mag 57(2):181–193
13. Chen HD (2003) Broadband CPW-fed square slot antennas with a widened tuning stub. IEEE Trans Antennas Propag 51(8):1982–1986

Slit Cut Circular Microstrip Antenna for Multiband Response

Aarti G. Ambekar, Venkata A. P. Chavali, Ameya A. Kadam, Amit A. Deshmukh and K. P. Ray

Abstract Dual frequency configuration of a circular microstrip antenna embedded with slits fabricated on a thinner substrate was reported which gave dual band operation at 1.64 and 1.89 GHz of frequencies with broadside radiation pattern. On the other hand, a clear description of resonance modes of slit cut circular microstrip antenna that not only results in multiband operation was not given. In this paper, a detailed investigation explaining the multiband response of the reported work is presented using resonance curve plots, return loss plots and its surface current distributions. It is observed that dimensions of slits embedded in the given patch antenna modifies the various frequencies modes in such a way that yields multiband response with more than two bands of frequencies. The position and dimensions of the slits with offset feed results in matched input impedances at TM_{11}, TM_{21} and TM_{02} modes of the circular patch. These slit dimensions causes the degeneration of these modes that results into dual polarized multiband response.

Keywords Multiband response · Mictrostrip antenna · Slits · Dual polarization

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1 Introduction

Microstrip antennas are used in large quantities in various communication applications because of its compact size [1–3]. Patch antennas are available in various shapes like rectangular, Circular, triangular etc. Out of which circular (CMSA) shape gives better harmonic rejection. Further now days in mobile, multiple applications can be run at a time, which requires different frequency bands. Further multipath propagation is a big issue in today's wireless communication though it is desirable in some applications. Polarization diversity is most frequently used technique for reducing this. Multiband operation with dual polarization can be obtained in microstrip antennas by embedding slots or by connecting a stub in such a manner that patch mode will be in orthogonal with slot mode [4–10]. In this paper, a widespread analysis of multiband response of reported slit cut patch antenna fabricated on thinner glass epoxy substrate is presented using resonance curve plots, return loss plots and surface current distributions [11]. In the present analysis, the effect of variations in slit lengths embedded vertically and horizontally is studied. The frequencies and impedances of the various modes of the reported antenna are modified by the slits. From the simulated resonance curve and current distributions, it is observed that the combination of various slits modifies the various mode frequencies like f_{11} and f_{21} also affect their impedances as well as polarization at the respective frequencies. This results into multiband dual polarized response. For verification of the same simulation of the slit cut circular microstrip antenna is done using IE3D antenna simulation software. Similarly an antenna is designed and fabricated for getting multiband dual polarized response, in which degeneration of TM_{11}, TM_{21} and TM_{02} is observed. The antenna measurements were carried out using high frequency instruments like, Vector Network Analyzer (ZVH–8), Spectrum Analyzer (SMB 100A) and Frequency Generator (FSC 6), inside an antenna lab.

2 Slit Cut Circular Mictrostrip Antenna for Dual Band Response

A circular microstrip antenna embedded with two vertical and two horizontal slits reported in [11] is as shown in Fig. 1a. As revealed, the reported structure is fabricated on a dielectric substrate with relative permittivity 4.4. The main patch is separated by a height of 1.6 mm above the ground plane. This structure results into dual band response because of unequal orthogonal slit lengths. Patch is fed by SMA connector with inner wire radius of 0.6 cm. The slits embedded in the antenna lengthen the surface current path. Figure 1b shows measured return loss plots of reported structure for two different cases of horizontal slit lengths lx, where vertical slit length ly is kept constant. From the return loss plot the dual frequency band observed are at 1.6 and 2.09 GHz at lx = 10 mm while 1.64 and 1.89 GHz at lx = 12 mm.

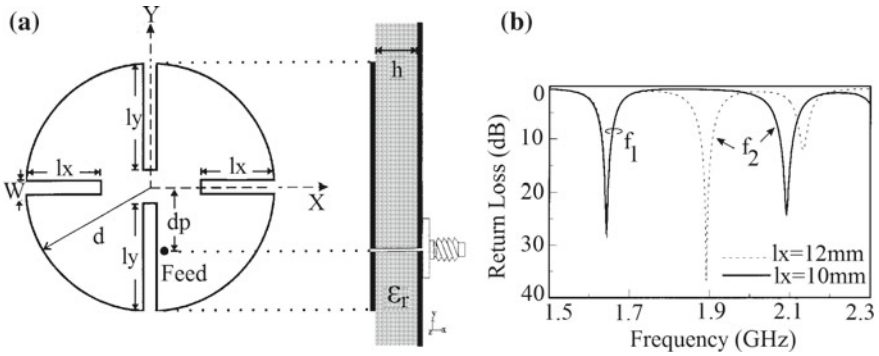

Fig. 1 **a** Geometry of CMSA with slits. **b** Measured return loss plot for slit cut CMSA [11]

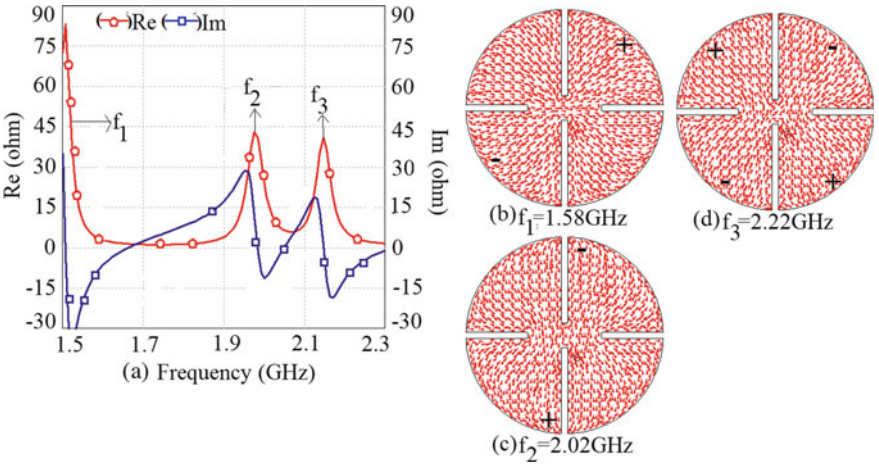

Fig. 2 **a** Simulated Resonance curve. **b–d** Simulated surface current distribution for slit cut CMSA with multiband response

The reported configuration for one of the cases lx = 10 mm and ly = 14 mm is simulated using IE3D and corresponding resonance curve plots is as shown in Fig. 2a As per the resonance plots peaks are observed respectively at $f_1 = 1.58$ GHz, $f_2 = 2.02$ GHz and $f_3 = 2.22$ GHz. Explaination of peak observed at f_1 is not mentioned in reported work [11]. For the three peaks surface vector current distributions are as shown in Fig. 2b–d. From the surface current distributions it is clear that perturbation caused in corresponding surface current path because of introduction of slits. This excites different modes at each peak. However the thorough explanation of various modes of reported slit cut circular microstrip antenna gives dual band response has not been given in [11]. Hence a detailed investigation is done with respect to various slit dimensions of the reported antenna giving the explanation of its effect on modes those results into dual band response. The same is explained in the next section.

3 Analysis of Slit Cut CMSA with Multiband Response

Resonance frequencies of various modes of basic CMSA are calculated using basic equations of CMSA. Verification of the same is done by simulating basic CMSA in IE3D simulated software. The simulated and calculated frequencies are observed to be nearly matching with each other. Analysis of actual reported structure in [11] is started with simulation of basic CMSA with optimized feed positions. The given offset feed position, excites two corresponding modes respectively TM_{11} at 2.53 GHz and TM_{21} at 4.27 GHz. Next parametric is continued for observing effect of vertical slit ly. Corresponding simulated resonance curve plots for various lengths of ly are as shown in Fig. 3a–b. As per the resonance plot for basic CMSA only two peaks are observed, but perturbation caused by embedding slits in vertical direction excites other modes also. For ly = 4 mm a third peak is observed at 4.03 GHz. As the length of slit incremented further to 7 mm, one more peak is observed at 2.29 GHz. For identification of the modes vector surface current distributions are observed corresponding to the four peaks at 7 mm slit lengths as shown in Fig. 4a–d. As per the current distributions for first and second frequencies half wave length variations are observed along circumference as well as diameter of the circle which corresponds to basic TM_{11} mode. But directions of currents are observed to be orthogonal to each other. Similarly at third and fourth peak two half wave length variations are observed along circumference while one half wave length variation is observed along diameter which corresponds to TM_{21} mode. But again direction of current is observed to be orthogonal with each other. This means this slit length lengthen the surface current paths and causes the perturbation which results into degeneration of basic TM_{11} mode into horizontal direction (TM_{11H}) and vertical direction (TM_{11V}). Similarly degeneration of TM_{21} mode basic into horizontal direction (TM_{21H}) and vertical direction (TM_{21V}). This degeneration is responsible for dual band dual polarized response. As the length of ly increase further corresponding mode frequencies goes on reducing.

Further analysis is continued by embedding horizontal slit and observing effect of its length variations. Corresponding simulated resonance plot and current distribution for lx = 6 mm is as shown in Fig. 5a–e. Four peaks corresponding to TM_{11H}, TM_{11V}, TM_{21H} and TM_{21V} mode are observed. As the length of slit increases, corresponding mode frequency decreases further. Thus from the parametric study it is observed that slit length variations causes the perturbation in current path which causes the degeneration of corresponding modes which is responsible for getting multiband dual polarized response. Similarly an antenna is designed at lx = 9 mm and ly = 12 mm for getting multiband dual polarized response. The same was fabricated on glass epoxy and tested. The corresponding fabricated prototype with observed return loss plots are as shown in the Fig. 6a–b. From the return loss plots, total six modes are observed which are due to degeneration of TM_{11}, TM_{21} and TM_{02} modes respectively in horizontal and vertical direction which yields dual polarized response. The simulated and measured radiation patterns are as shown in Fig. 7a–d. Radiation pattern observed throughout the bandwidths are in broadside direction.

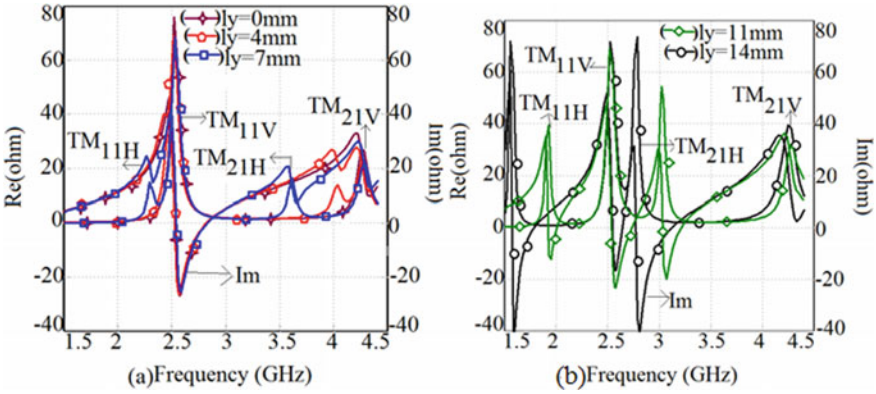

Fig. 3 **a**–**b** Resonance plots for varying vertical slit dimensions for slit cut CMSA

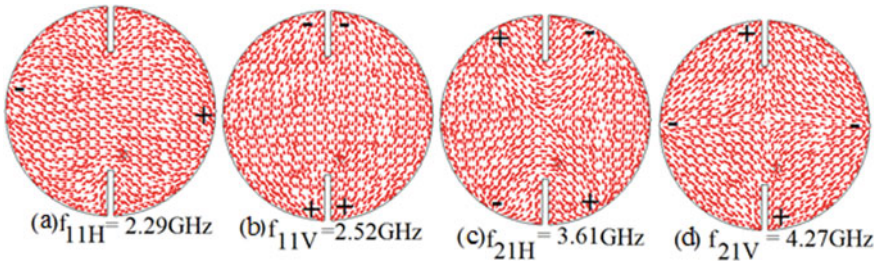

Fig. 4 **a**–**d** Surface current distributions for ly = 7 mm for slit cut CMSA

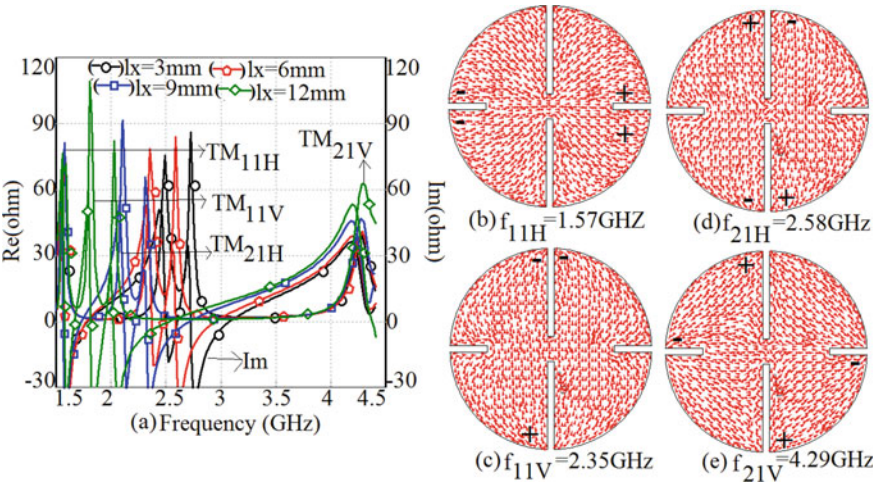

Fig. 5 **a** Resonance plot. **b**–**e** Surface current distribution at lx = 6 mm for horizontal slit length variations of slit cut CMSA

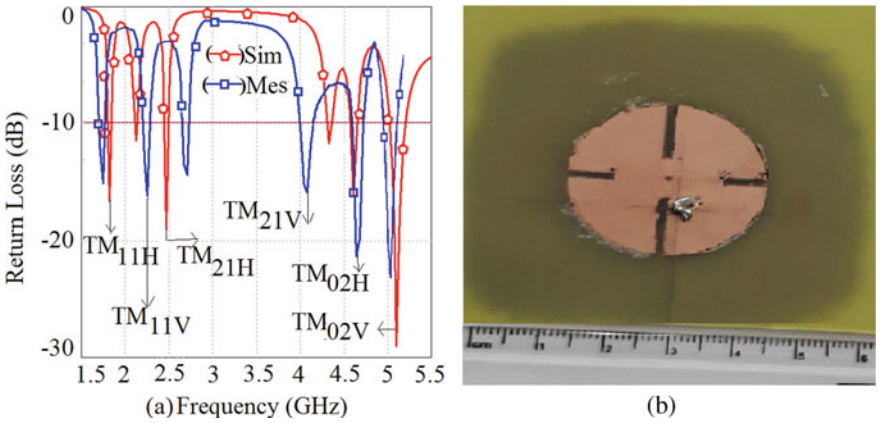

Fig. 6 **a** Return loss plot. **b** Fabricated prototype for multiband dual polarized CMSA

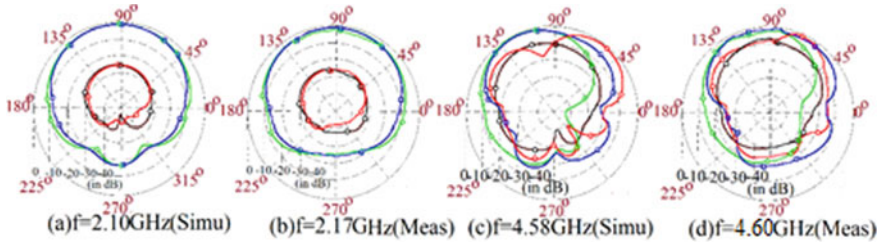

Fig. 7 **a–d** Radiation patterns for multiband dual polarized CMSA

4 Conclusions

An extensive investigation of a slit cut circular microstrip antenna designed for multiband operation is carried out in the present work. The frequencies for basic circular microstrip antenna patch are calculated are closely matching with simulated values. The investigation is carried out using simulated resonance curve and surface vector current distributions Introduction of slits in vertical direction affects the current path length and effective area of patch which degenerates the corresponding modes in horizontal and vertical directions that yields multiband dual polarized operation. Introduction of horizontal slit affects more on lower order mode TM_{11H}, TM_{11V} and TM_{21H} frequency. Further an antenna is designed for getting dual polarized multiband response where degeneration of TM_{11}, TM_{21} and TM_{02} mode is observed. So this type of study provides insight into functioning of antennas with slots. This will also help in designing of similar types of antennas at different frequency range.

References

1. Bahal IJ, Bhatia B (1980) Microstrip antenna, 1st edn. Artec House
2. Kumar G, Ray KP (2003) Broadband microstrip antennas, 1st edn. Artech House, USA
3. Wang KL, Yang KP (1997) Small dual frequency microstrip antenna with cross slot. Electron Lett Lett 33(23):1916–1917
4. Dahele J, Lee K, Wong D (1987) Dual frequency annualar-ring microstrip antenna. IEEE Trans Antennas Propag 35(11):1281–1285
5. Deshmukh A, Ray KP (2009) Stub loaded multi-band slotted rectangular microstrip antennas. IET Microwaves Antennas Propag 3(3):529–535
6. Jhamb K, Li L, Rambabu K (2011) Novel integrated patch antennas with multi-band characteristics. IET Microwave Antennas Propag 5(12):1393–1398
7. Zhong L (1983) Single element rectangualr microstrip antenna for dual frequency operation. Electron Lett 19(8):298–300
8. Chen J, Wang J, Tong KF Armaghany A (2017) A dual band dual polarization slot patch antenna. In: International proceedings on IEEE international conference on computational electromagnetics (ICCEM). IEEE, Kumamoto Japan, pp. 34–35
9. Mathew S, Anitha R, Deepak U, Aanandan CK, Mohanan P, Vasudevan K (2015) A Compact tri-band dual polarized corner truncated sectoral patch antenna. IEEE Trans Antennas Propag 63(12):5842–5845
10. Sun SB (2010) Circular slotted microstrip antenna for GPS. Microwave Optical Technol Lett 52(5):999–1000
11. Wong KL, Fang ST (1998) Reduced size circular microstrip antenna with dual-frequency operation. Microwave Optical Technol Lett 18(1):54–56

Design of Rectangular Microstrip Antenna on Finite Ground Plane for Circular Polarized Response

Amit A. Deshmukh, Chinmay Kudoo, Shefali Pawar, Amita Mhatre and Vivek Chaudhary

Abstract Rectangular microstrip antenna with proximity feed is proposed for circular polarized response. An offset placement of proximity feed excites TM_{01} and TM_{10} modes in rectangular patch which gives impedance bandwidth of higher than 760 MHz (>65%) with axial ratio bandwidth of 48 MHz (5.28%) on an infinite ground plane. The antenna exhibits broadside pattern with maximum gain of 8 dBi. In practical application of proposed antenna finite ground plane will be used. Further in the proposed paper, detailed study to outline the effects of finite dimensions of ground plane below the rectangular patch and its effect on axial ratio bandwidth is presented. With smaller ground plane, dimensions of rectangular patch have to be altered against larger and infinite ground plane design, for to cover same frequency range of axial ratio bandwidth. Thus proposed study will be helpful in understanding the effects of ground plane dimensions on circular polarized bandwidth while designing antenna for given circular polarized application.

Keywords Circular polarization · Circular polarized microstrip antenna · Proximity feed · Finite ground plane

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1 Introduction

Microstrip antenna (MSA) are widely preferred in wireless communication applications due to their advantages like, planarity in configuration and ease of fabrication using printed circuit technology [1, 2]. While designing the antenna for receivers, uncertainty in incoming signal orientation is present. This results due to multi-path propagation terrain, wherein wave arriving at receiver undergoes reflections from many surrounding objects which changes the polarization of received wave [3]. If here antennas with linear polarization are used then it leads to signal loss since they offer very low cross polarization component in the radiation pattern plot. To nullify this effect circular polarized antennas are used since they receive signal from any orientation of the incoming wave [4]. In MSA, circular polarized (CP) response is realized using single radiating patch [5, 6]. There have been many methods reported to yield CP response like, coaxially fed patch using equal power divider, diagonally fed MSAs employing narrow slits, various shapes of the radiating patch using single feed, or use of resonant slots like U-slot and pair of rectangular slot in MSA [7–9]. Another important parameter in MSA design is the ground plane dimension. Antenna characteristics like gain, bandwidth (BW), impedance variation across the patch for given mode changes as per the ground plane dimensions [1, 2, 5, 6]. To duplicate the results of infinite GP using the finite GP, size of the ground plane from all the sides of the patch should be taken to be at least larger than 6–8 times total substrate thickness of the patch [5]. However such large ground plane dimensions are not realizable in practical antennas due to limited space available in practical systems. In the literature various techniques discussed above to realize CP response are reported, but detailed study highlighting the effects of finite ground plane on axial ratio (AR) BW as well as its band center frequency is not mentioned. Here finite size of ground plane can alter the operating frequency of antenna due to variations in fringing fields present towards patch edges.

In the present paper detailed study to bring out the effects of finite ground plane on realized CP response in proximity fed rectangular MSA (RMSA) is presented. The antenna configuration is presented in 900–950 MHz frequency range. This band is chosen since mobile communication GSM band and personal communication low power systems like Bluetooth and Zigbee uses this spectrum. Initially infinite ground plane is selected in the CP design. The offset position of proximity feed excites TM_{10} and TM_{01} modes in RMSA which yields Axial Ratio BW of 48 MHz (5.28%) which has impedence of more than 760 MHz (>65%). Detailed parametric study is carried out to analyze the effect of finite ground plane dimension on realized AR BW as well as the center frequency of the same. With decrease in ground plane length and width frequency separation between orthogonal mode increases. For ground plane dimension nearly equal to patch dimension, CP response was not obtained. To realize the CP response for smaller ground plane dimensions, patch dimension and hence accordingly ground plane dimensions are needed to be changed so as to realize AR less than 3 dB. Also with smaller ground plane dimension, center frequency of the AR BW increases by nearly 100 MHz as compared to the infinite ground plane and

larger ground plane cases. Thus selection of ground plane dimensions is an important parameter while realizing CP response in the desired frequency spectrum. Although effects of ground plane dimensions on antenna characteristics are well known, but proper documentation of same highlighting their effects on resonant modes was not explained in literature specifically for CP designs for given band of application. This paper addresses this research gap in the design of CP RMSAs on finite ground plane. Further on finite ground plane dimension, proximity fed RMSA design was optimized for CP response. It yields CP BW of 42 MHz (4.6%) with impedance BW of 484 MHz (>45%). The antenna offers broadside gain of larger than 7.5 dBi across complete AR BW. The antenna using finite ground plane was fabricated and measurement was carried out which showed reasonable agreement. The finite ground plane antenna was also tested in the field using low power Xbee module as a trans-receiver. In the multi-path propagation terrain, above the background noise, range of higher than 1.2 km was noticed. This proves the working of antenna in practical system. The MSAs discussed here were first verified for their working using IE3D simulations. Further high accuracy instruments like FSC–6, ZVH–8, and SMB–100A, were used to carry out gain, radiation pattern and polarization measurements.

2 Proximity Fed RMSA

The proximity fed design of RMSA is given in Fig. 1a, b. Throughout the paper, patch dimensions and frequencies are, in mm and MHz. The RMSA is used in 3 layer suspended configuration in which 2 layers of FR4 substrate having substrate parameters $h = 0.16$ cm, $\varepsilon_r = 4.3$ and $\tan \delta = 0.02$, having air gap of thickness 'h_a' cm. Proximity strip of length 'L_s' is placed at thickness of 'h_s' above the bottom FR4 layer. On the top surface of top FR4 layer patch is fabricated whereas on the bottom surface of bottom FR4 layer, ground plane is present. The RMSA dimensions 'W' and 'L' are calculated such that its TM_{10} and TM_{01} mode frequencies are around 900–950 MHz frequency band [5]. For the excitation of two fundamental orthogonal resonant modes, the proximity feed is placed at an offset position below the patch at co-ordinates 'x_f' and 'y_f'.

By optimizing aspect ratio in RMSA and proximity feed location below the patch, CP response on infinite ground plane is realized as shown in Fig. 1c. Antenna parameters in the optimum design are, 'L' = 125, 'W' = 104, 'h_a' = 25, 'h_s' = 22, 'x_f' = 26 and 'y_f' = 38 cm. The simulated VSWR and AR BW are, 754 MHz (65.39%) and 48 MHz (5.29%), respectively. The antenna offers broadside pattern having gain of above 6 dBi over complete VSWR and Axial Ratio BW. Obtained Axial Ratio BW in the return loss (S_{11}) plot above, lies nearer to the TM_{10} and TM_{01} mode frequencies present in the MSA. The impedance BW in higher range of frequencies is due to TM_{11} mode. In practical applications of CP antenna, MSA on finite ground plane is needed. Therefore, effects of using finite ground plane on the realized AR BW, pattern and gain characteristics are studied. The parametric study is carried out and resonance curve plots, smith chart, AR BW and broadside gain plots for ground

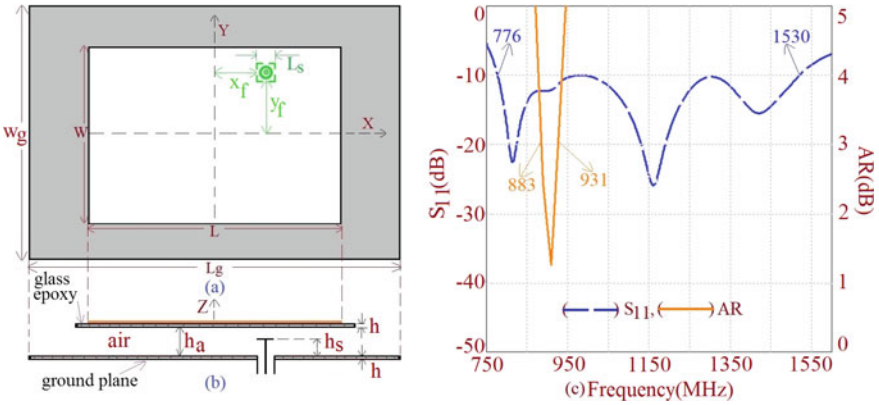

Fig. 1 **a** Top and **b** side views of proximity fed RMSA, and **c** return loss and AR plots for proximity fed RMSA on infinite ground plane

plane dimension ('L_g' × 'W_g') variations are shown in Fig. 2a–h. In this parametric analysis rest of the antenna parameters are kept the same as optimized in design with infinite ground plane. For ground plane dimension reduction from infinite to 250 × 210 mm and further to 210 × 170 mm, marginal variations in antenna characteristics like, AR BW and gain, were observed. Here, with respect to infinite ground plane results, center frequency of the AR BW has increased marginally. For ground plane dimensions reducing from 190 × 150 to 150 × 110 mm, frequency of TM_{01} mode increases which increase the frequency ratio between orthogonal mode frequencies.

The reduction in TM_{01} mode frequency is attributed to larger reduction in ground plane dimension along RMSA width as against the dimension along RMSA length. The smaller ground plane reduces fringing field extension length along patch width that increases TM_{01} mode frequency. Due to this for ground plane dimensions from 190 × 150 to 150 × 110 mm, AR BW reduces. With decrease in ground plane dimensions, broadside gain plots shows variations with distinct peaks due to TM_{10} and TM_{01} modes. To optimize for AR BW in these ground plane dimensions, RMSA width was further increase in each case so as to reduce the separation between TM_{10} and TM_{01} mode frequencies. The optimum AR BW in these three ground plane dimensions is obtained for patch length and width as, 125 × 110, 125 × 118 and 125 × 110 mm, respectively. The smith chart and AR BW plots for these optimized proximity fed RMSAs using small ground plane is shown in Fig. 3a, b. Here the CP response is observed nearer to the smaller loop located inside VSWR circle = 2 in smith chart. AR BW in three cases is 42 MHz (4.51%), 34 MHz (3.68%) and 36 MHz (3.46%), respectively. As compared with infinite and larger ground plane, AR BW here is formed in higher frequency region. Thus for desired frequency range, antenna dimensions for CP response needs to be carefully chosen.

Further design of RMSA for CP response is realized for to cater to frequency of 913 MHz with AR BW of at least 25 MHz, where low power trans-receiver like Xbee pro are used in personal communication/short distance communication

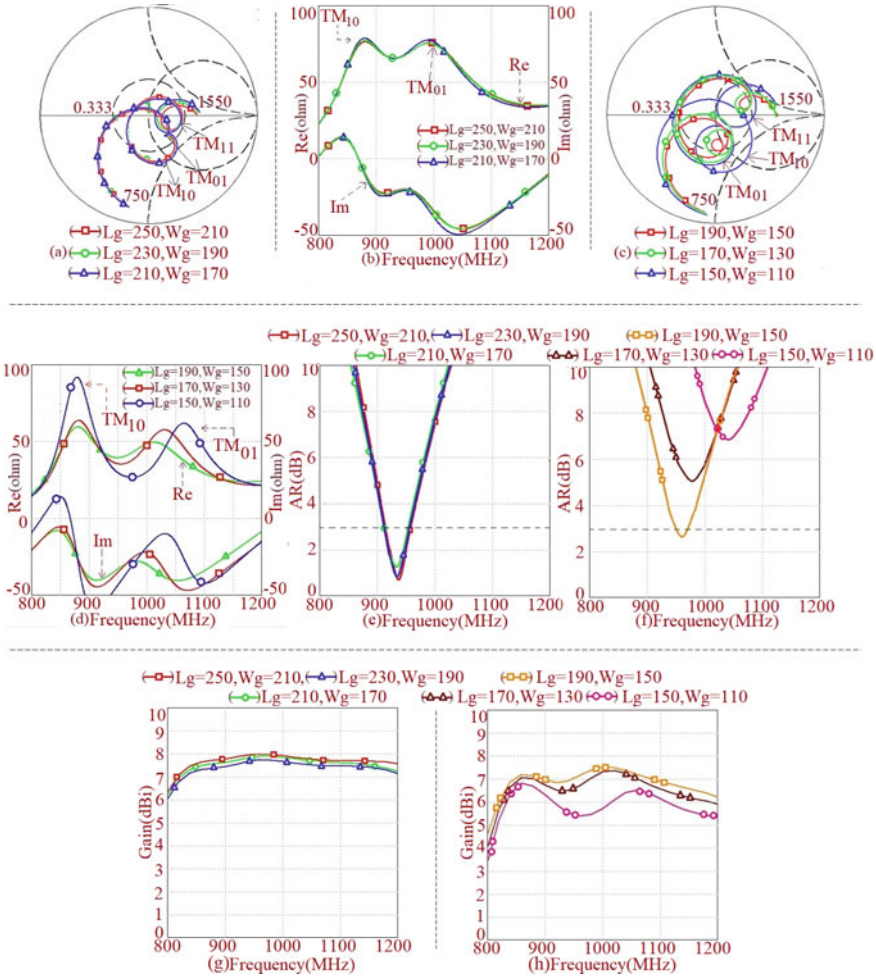

Fig. 2 **a**–**d** Resonance curve plots and Smith chart and **e**, **f** AR BW plots for proximity fed RMSA against varying dimensions of the finite ground plane

systems. While using smaller ground plane, center frequency of the Axial Ratio BW increases. Hence for nearly same RMSA dimension as that present in infinite case for which center frequency is nearer to 913 MHz, ground plane size of 200 × 175 mm is taken. Proximity fed RMSA was optimized for CP response and antenna parameters for same are, 'L' = 123, 'W' = 102, 'h_a' = 25, 'h_s' = 22, 'x_f' = 26 and 'y_f' = 38 mm. The measured and simulated impendence plot, gain and AR BW plots, and fabricated design are shown in Fig. 3c–e. Impedance BW in simulation and measurement is 483 MHz (46.5%) and 499 MHz (48.14%), respectively. Here next higher order TM_{11} mode was not optimized inside VSWR = 2 circle hence it offers lower BW as compared with infinite ground design. Radiation pattern is broadside

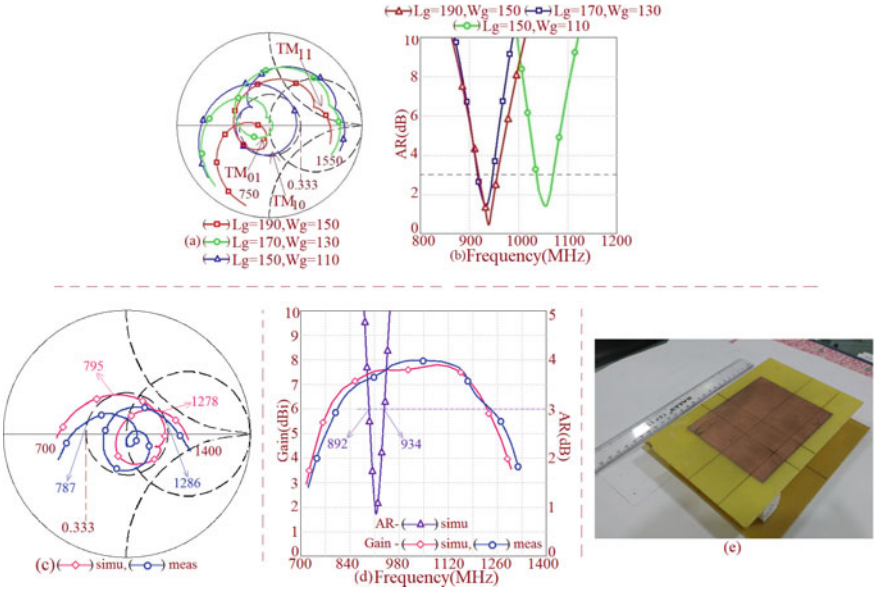

Fig. 3 **a** AR BW and **b** gain variation plots over the BW for proximity fed RMSA against varying dimensions of finite ground plane, **c** Impedence plot and **d** Variation of AR BW over frequency for re-optimized proximity fed RMSA for CP response

and shows higher cross polar levels. For proximity feed position shown in Fig. 1a, antenna exhibits left hand CP (LHCP) response. The CP design yields 42 MHz of AR BW which is centered around 913 MHz. Further for verifying the CP response in field, measurement was carried out with Xbee module which was connected through serial port in Laptop. In both trans-reception modes, this CP antenna, gives range of above 1.2 km. Thus proposed work presents design of simpler proximity fed CP design in GSM band and also explains effects of finite ground plane on AR BW. This kind of detailed study is not reported. Thus these are all the novelties in present paper.

3 Conclusions

Simple proximity fed design of RMSA for CP response is presented. On infinite/very large ground plane, it yields Axial Ratio BW of 48 MHz (5.29%) which reduces to 42 MHz (4.6%) on finite ground plane. Detailed study explains the effects of finite ground plane on AR BW is presented. The reduction in ground plane size alters the frequencies of orthogonal patch modes and leads to formation of CP BW in

higher frequency range. This detailed study will be useful for designing CP antenna at desired frequency, where smaller ground plane size is available. Proposed CP antenna provides a peak gain of 8 dBi. It is applicable in personal communication systems and mobile communication in 900 MHz range.

References

1. James JR, Hall PS (1989) Handbook of microstrip antennas, vol 1. Peter Peregrinus, London
2. Bahl IJ, Bhartia P (1980) Microstrip antennas. Artech House
3. Pozar DM (2008) Microwave engineering, 3rd edn. Wiley, Singapore
4. Balanis CA (1997) Antenna theory, analysis and design. Wiley, New York
5. Kumar G, Ray KP (2003) Broadband microstrip antennas, 1st edn. Artech House, USA
6. Lee HF, Chen W (1997) Advances in microstrip and printed antennas. Wiley, New York
7. Baudha S, Dinesh Kumar V (2015) Corner truncated broadband patch antenna with circular slots. Microwave Optical Technol Lett 57(4):845–849
8. Khidre A, Lee KF, Yang F, Eisherbeni A (2010) Wideband circularly polarized e-shaped patch antenna for wireless applications. In: IEEE antennas and propagation magazine, vol. 52, no. 5
9. Chen HM, Wong KL (1999) On the circular polarization of angular-ring microstrip antennas. IEEE Trans Antennas Propagation 47(8):1289–1292

Innovative Technique to Realize Circular Polarization Using Sinusoidal Perturbation for Square Microstrip Antenna

Anuja A. Odhekar, Poonam A. Kadam, Sanjay B. Deshmukh and Amit A. Deshmukh

Abstract Innovative technique to produce circular polarization for square microstrip antenna using sinusoidal perturbation along its length is suggested. In and Out-of phase addition at corners of square patch degenerate orthogonal mode as function of difference between patch diagonal lengths. Depth of perturbation decides separation between orthogonal modes whereas periodicity defines multiband operation for circular polarization. Proposed structure results in bandwidth more than 320 MHz (35%) and circularly polarized bandwidth 55 MHz (6%). The structure give gain more than 6.5 dBi.

Keywords Circularly polarized patch antenna · Sinusoidal perturbation · Sense of polarization

1 Introduction

Circularly polarized (CP) antennas are widely used in wireless system to get rid of polarization mismatch and signal loss due to multipath propagation. CP can be obtained using Dual and Single feed. Though CP realization using dual feed result in circularly polarized bandwidth (CP BW) greater than 10%, it results in complicated feed network [1–3]. Most of wireless systems prefer CP antennas using single feed only. Single feed CP antenna results narrow VSWR bandwidth (BW) and CP BW. Though single feed CP antenna are compact, they results in poor gain. More than

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decade researchers are working on CP antenna to obtain high gain of antenna over wide CP BW. Square microstrip antenna (SMSA) uses V-shaped slit along its diagonal to realized CP [4]. Perturbation along SMSA diagonal is at 45° to feed. Thus both orthogonal modes are excited which gives radiation. CP BW is tuned easily by adjusting slit dimension. The technique results in BW of 4.7% and CP BW of 1.3%. Further square slits are attached to V-slit in order to give compact design. Though parametric study gives compact CP antenna it results in narrow CP BW along bore-site. The paper does not give any technique to enhance CP BW. In order to increase CP BW, CP is realized using slot antennas. Most attractive features of the slot antennas are broad bandwidth and effortless incorporation with MMIC [5, 6]. Though CP realization based on slot antenna [7, 8] results in compact design give narrow CP BW. To increase CP BW various shapes of the slot antennas are tried either by using open or short circuited stub of specific length [9–11]. Using the techniques discussed in [9–11] broad CP response is obtained. These techniques results CP BW almost up to 35%. The wide band CP response is obtained at the cost of low gain and complex antenna structure. The wide band CP response is obtained at the cost of low gain and complex antenna structure. Even most of the antennas give bore-site radiations. Reported work studied till now does not give any explanation regarding orthogonal mode formation which results in CP. Though in some papers detailed parametric study is carried out, it won't results in empirical formulation which is useful in redesigning of the same technique at some other frequency.

This paper presents simple and innovative technique to produce CP. Sinusoidal perturbation along length of SMSA produce CP. The antenna is designed at 900 MHz to aim at mobile communication. Sinusoidal perturbations are embedded along length of SMSA. It results in two different resonant lengths which are perpendicular to each other. These two different resonant length results in orthogonal modes to give CP. Parametric study is carried out for several amplitude of perturbation. Amplitude of perturbation tunes CP BW as mode degeneration is function of perturbation amplitude. Feed position is optimized to maximize the CP BW by increasing current at both orthogonal modes. The proposed structure is fabricated on suspended FR4 of thickness 1.6 mm with dielectric constant of 4.3 having loss tangent (tanδ) of 0.02. Structure results in bandwidth more than 320 MHz (>35%). Obtained CP BW is 55 MHz (6%) over VSWR BW. The proposed antenna gives gain greater than 6 dBi over complete CP BW having right hand circular polarization (RHCP) in broadside direction. The observed left hand CP (LHCP) component which is cross-polar is less than 23 dBi. Positioning and periodicity of sinusoidal perturbation which degenerates' fundamental mode in two orthogonal modes to give CP defines novelty of the proposed work. Main advantage of proposed technique as compared to Slot antenna and fractal antenna is that without use of any additional technique CP BW more than 6% is obtained with broadside gain of 6 dBi. Ease of fabrication and simpler design are key feature of proposed technique. Future scope of work lies in getting multiband CP response as it is function of perturbation periodicity. Initially simulations are carried out using electromagnetic simulation software IE3D. Measurements are carried

out for fabricated prototype. The instruments ZVH–8, SMB 100A and FSC–6 were used for measurements in Antenna laboratory. Smith chart is observed for antenna input impedance. Radiation characteristics are verified with measurements radiation pattern and gain.

2 SMSA Embedded with Sinusoidal Perturbation for CP Response

For SMSA feed placed either along X or Y axis, resonates either at TM_{10} or TM_{01} mode which does not support CP radiations. This is because CP generation needs degeneration of fundamental mode in two orthogonal modes which has time and space Orthogonality. If feed is placed along SMSA diagonal, both fundamental modes TM_{10} and TM_{01} are overlapped as diagonal length is same. Thus perturbation which results in separation of diagonal modes is necessary for SMSA to produce CP. SMSA using FR4 dielectric material suspended on air dielectric having length 'L' which will resonate at 1000 MHz. This is fundamental ($TM_{10/01}$) patch frequency. Tolerance of 100 MHz between desired resonant frequency (900 MHz) and SMSA frequency (1000 MHz) is kept as reduction in frequency is expected after embedding perturbation. Length of SMSA 'L' is kept as 100 mm. Height of air substrate 'ha' is 28 mm. Sinusoidal perturbation of depth i.e. amplitude 'Vm' is embedded along the length of SMSA which is shown in Fig. 1a. The periodicity of perturbation is 't'. Two sinusoidal waves are perturbed along SMSA length. Thus periodicity of perturbation 't' is 'L/2'. Along 45° diagonal of SMSA, in-phase portion of SMSA is deleted after the perturbation. Along 135° diagonal, in-phase portion of SMSA is added. Thus addition and deletion of perturbation at corners creates difference in diagonal length of SMSA. Result of deletion at corners along 45° diagonal creates petal shaped stub. This stub has point contact to the SMSA. Due to this point contact, current through this is minimal and is not altering diagonal length along 45° which in turn not contributing resonant frequency of corresponding mode. Therefore petal shaped stub is removed. The ultimate proposed structure is shown in Fig. 1. Dimensions in all figures are mentioned in 'mm'.

The parametric study is carried out for different amplitude 'V_m' of sinusoidal perturbation. It is varied from 5 to 20 mm. Variation in V_m is not affecting diagonal length 'L_{d-135}'. Increase in 'V_m' decreases 'L_{d-45}'.This creates difference in diagonal length which is function of 'V_m'. Simulations carried out for $V_m = 5$ and 7.5 shows that this amount of perturbation is insufficient to degenerate fundamental mode in two orthogonal modes. This is given in resonance curve in Fig. 2a. When V_m is 7.5 mm slightly mode starts getting separated but is insufficient to generate CP.

When V_m varies from 10 to 15 mm, degeneration of fundamental mode in two orthogonal modes is observed. This is because depth of perturbation is sufficient to separate out two mode. The corresponding degeneration is shown in Fig. 2b. This mode separation results 'Time Orthogonality'. The obtained 'Space Orthogonality'

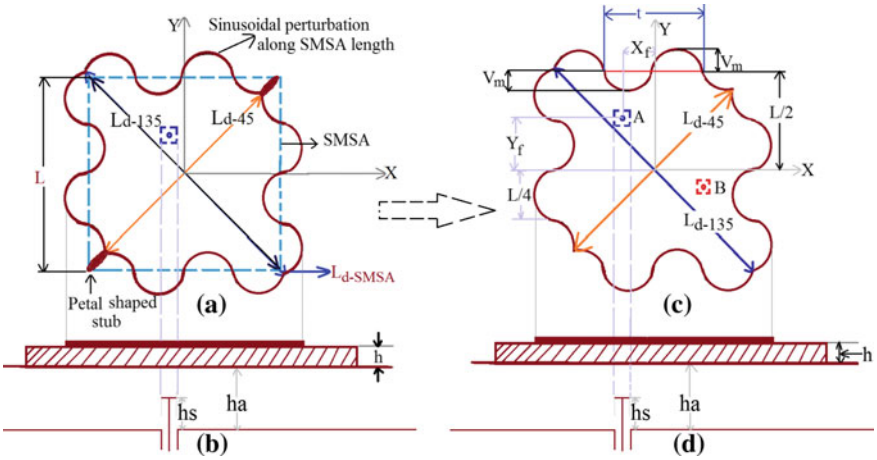

Fig. 1 **a**–**b** Top and Side view of Air Suspended SMSA with Sinusoidal perturbation to generate CP. **c**–**d** Top and Side view of Ultimate Proposed Air Suspended SMSA with Sinusoidal perturbation to obtain CP

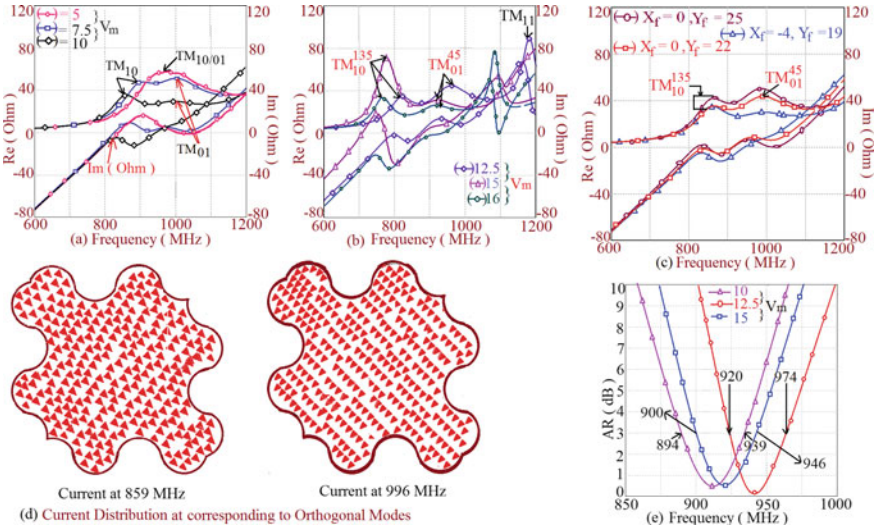

Fig. 2 **a** Resonance Curve showing overlapping for fundamental modes. **b** Resonance Curve showing degeneration of Fundamental mode in two orthogonal modes as function of 'V_m'. **c** Variation of feed location to maximize current amplitude **d** Current Distribution **e** Tuning the CP BW by varying depth of perturbation

is shown with the help of current distribution drawn at frequencies corresponding to resonance frequency of orthogonal mode. As proposed structure results in 'Time' and 'Space' Orthogonality, CP is achieved. The same study is observed for obtained CP BW. Simulated results shows that when $V_m = 12.5$ maximum CP BW of 55 MHz centered at 942 MHz is obtained as compared to depth of sinusoidal amplitude of 10 and 15 mm. Further increase in 'V_m' increases separation in orthogonal modes and no CP is obtained as orthogonal modes moves away from each other. To maximize the current amplitude at $V_m = 12.5$ mm, feed location is varied. Figure 2c shows enhancement in 'Time Orthogonality' with help of resonance curve plotted w.r.t feed location and Fig. 2d gives corresponding 'Space Orthogonality 'at resonance frequencies for degenerated modes. Observation made from simulated results shows that depth of perturbation not only defines orthogonal spacing but at desired SMSA resonant frequency it defines CP BW. It is shown in Fig. 2e. The proposed structure given in Fig. 1c for feed location 'Á' supports RHCP whereas for feed position 'B' it radiates in LHCP manner. Another technique to change sense of orientation for CP operation is to swap L_{d-135} with $L_{d-45.}$ From parametric study carried out, maximum CP BW is obtained for 12.5 as depth of perturbation for feed positioned at $X_f = -4$ and $Y_f = 19$ at a height of 'h_s' = 26 mm from ground plane. Configuration is fabricated, measurements are carried out. For finest design, smith chart is studied. Experimentally radiation pattern is studied at center frequency of 942 MHz for gain, CP BW and CP orientation (LHCP/RHCP). The measured results and photograph of fabricated sample antenna is given in Fig. 3a–e.

Prototype is suspended on air substrate with help of foam spacers above ground plane. An investigated BW is 300 MHz (40%). The antenna's measured CP BW is 55 MHz centered around 942 MHz. It offers gain of above 6.5 dBi over BW. Presence of CP is confirmed with measurement of CO and Cross polar levels. Difference between them is less than 3 dB along broadside. As the perturbations changed the diagonal length which in turn gives CP, E and H-planes are aligned them. Proposed structure offers RHCP response. The next mode TM_{11} and TM_{02} came closer to TM_{01} as shown in Fig. 2b. In further study, structure can be modified to obtain multiband CP response.

3 Conclusions

Innovative technique using Sinusoidal perturbation along length to SMSA to obtain CP is proposed. Addition and deletion of sinusoidal perturbation at corners creates difference in diagonal length of SMSA. Degeneration of fundamental mode in two orthogonal modes is results of this difference. It gives CP. Depth of perturbation tunes CP BW whereas periodicity decides multiband operation along the same orientation of CP. Proposed structure gives BW greater than 300 MHz (>40%) and CP BW more than 54 MHz (>6%). The CP BW is function of depth and periodicity of perturbation. This antenna results in RHCP with gain more than 6 dBi along broadside direction. Proposed antenna gives compact design which can be used for mobile application.

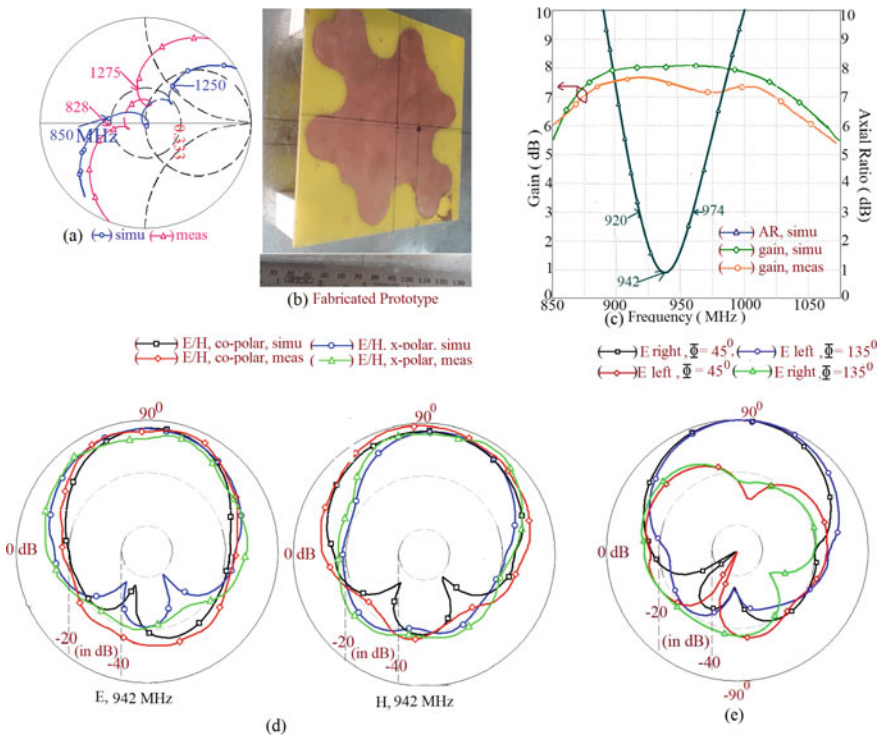

Fig. 3 **a** Input Impedance for proposed structure, **b** Fabricated Prototype, **c** Antenna gain and Axial Ratio variations across BW, and **d** Verification of CP response from radiation pattern at center frequency **e** Polarization plot

References

1. Balanis CA (1997) Antenna theory, analysis and design. Wiley, New York
2. Robert JM (2017) Phased array antenna handbook 2edn. Artech House, Boston, London
3. Kumar G, Ray KP (2003) Broadband microstrip antenna, 1st edn. Artech House, USA
4. Nasimuddin N, Qing X, Chen ZN (2010) Slits–loaded microstrip antenna for circular polarization. Microwave Optical Technol Lett 52(9):2043–2049
5. Chiang M-J, Hung T-F, Bor S-S (2010) Dual band circular slot antenna design for circularly and linearly polarized operation. Microwave Optical Technol Lett 52(12):2717–2721
6. Hwang KC (2009) Broadband circular polarization spidron fractal slot antenna. Electronica Lett 45:3–4
7. Guo YX, Khoo KW, Ong LC (2008) Wideband circularly-polarized planar antenna with broadband baluns. IEEE Trans Antennas Propagation 56:319–326
8. Fu S, Fang S, Wang Z, Li X (2009) Broadband circularly polarized slot antenna array fed by asymmetric CPW for L-band applications. IEEE Trans Antennas Propagation 8:1014–1016
9. Tsai C-L, Deng S-M, Liu L-W (2009) A compact shorted rectangular-ring slot antenna fed by a CPW for circularly polarized wave operations in the WLAN 2.4 GHZ band. Microwave Optical Technol Lett 51:2229–2232

10. Sze J-Y, Chang C-C (2008) Circularly polarized square slot antenna with a pair of inverted-L grounded strips. IEEE Antennas Wireless Propagation Lett 7:149–151
11. Yang G, Ali M, Dougal R (2005) A wideband circularly polarized microstrip patch antenna for 5–6 GHz wireless LAN applications. Microwave Optical Technol Lett 45:279–285

Fractal Patch Antenna with Exalted Bandwidth and Harmonic Suppression for WiMAX Applications

Kshitija Sanap and Rekha P. Labade

Abstract Here, a compact and single-layer fractal patch antenna is proposed, having potential of bandwidth enhancement and harmonic rejection. For achieving these two crucial factors, a pair of quarter wavelength microstripline resonator is instigate and coupled in proximity to a rectangular patch. Miniaturization is explored by Koch slot to radiating edge of the reference antenna through its symmetry plan. The broadband property can be obtained by making partial ground and coupled radiating λ/4 resonators. This antenna is having a low-profile property since it does not need electrically thick substrate. Harmonic suppression-the necessity of highly advanced communication systems has achieved with aid of good aspects of λ/4 resonators and partial ground scheme. The antenna has been designed on FR4 substrate having dielectric constant 4.4 with an overall dimension of 34 mm * 36 mm * 1.5 mm. The substrate has thickness of 1.5 mm. According to simulated results, fractal patch antenna achieves good impedance matching over operating bandwidth 2.52–4.27 GHz (52.09%). Thus, it covers Wi-MAX 3.30–3.70 GHz band. Finally, an antenna operating at 3.5 GHz is designed on HFSS software operating at wide impedance bandwidth of 1752 MHz (see the below comparison table) and effectively wipe out higher order radiating modes up to fourth harmonics of fundamental frequency.

Keywords Harmonics · Bandwidth enhancement · Partial ground · Harmonic suppression · Koch slot · λ/4 resonator and Single-Layer

1 Introduction

Miniaturization is crucial factor in today's modern communication system giving rise to integrated devices. Microstrip patch antenna is much suitable for integrated devices in highly advanced communication and radar systems because of its easy integration property with other active and passive circuits, also its highly compactness

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makes it more popular. But, unfortunately patch antenna has some pitfalls such as small bandwidth and high level of spurious radiation, which are not desirable. For decreasing these drawbacks, many researches have been made such as by using multilayer configuration and electromagnetic coupling feed [1, 2], using slits and stub [3–5], photonic bandgap structure [6–8], Defected ground structure [9], band reject filter [10], metamaterial-inspired compact shunt C capacitor [5], λ/4 microstripline resonators and capacitive feeding scheme [11].

In this paper, electromagnetically coupled fractal patch antenna with exalted bandwidth and reduced harmonic radiating modes is presented. For this, a pair of λ/4 resonators and partial ground structure is used. Benefits of this method are given below.

(1) Despite of electrically thin substrate, the operating bandwidth of this antenna is boosted up. Furthermore, operating bandwidth can be controlled by customizing the gap width in between of quarter wavelength resonator and patch.
(2) Due to partial ground structure and λ/4 resonators, high order harmonics get suppressed successfully.
(3) Small size patch antenna since the feeding line section is small.

2 Working Principle

Usually electrically thin substrate is required to resonator type patch antenna which in turn causes narrow bandwidth. So, Dual resonance structure is the more suitable solution method for enhancement of bandwidth. To obtain dual resonance property, an auxiliary non-radiating resonator is placed close to the radiating patch, which form a coplanar distributed resonator, combining two narrower bands to form a single wideband, see Fig. 2. Hence, we get improved bandwidth than the traditional fractal patch antenna shown in Fig. 1.

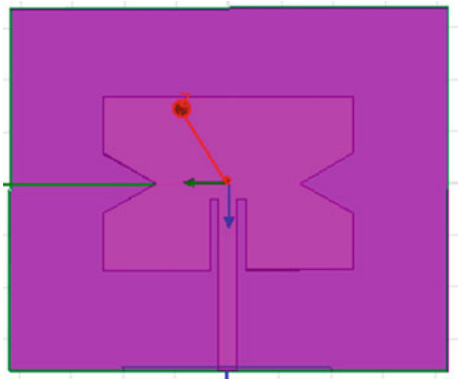

Fig. 1 Traditional Koch fractal patch antenna

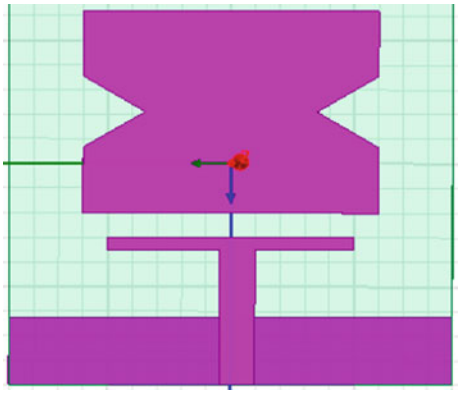

Fig. 2 Proposed Koch fractal patch antenna

For harmonic suppression, we used electromagnetically coupled feed which reduces the higher order radiating modes up to fourth harmonics of fundamental frequency. Because of the proposed feeding technique shown in Fig. 2, the energy can only be transmitted to the patch in discrete frequencies where both the patch and quarter wave resonators are resonating, which is absolutely contrasting from the traditional insert-fed Koch fractal patch antenna.

3 Results and Discussions

Simulation of this proposed Koch fractal antenna has been carried out in HFSS. The simulation results are given in the following section:

From Fig. 3, Return loss value of proposed antenna is −31.35 dB whereas −12.67 dB is of traditional antenna at 3.5 GHz, return loss indicates matching between transmitter and receiver. From simulated results we get large bandwidth about 1752 MHz for designed Koch antenna while bandwidth of traditional antenna is 32.5 MHz and there is harmonic reduction at 5.9, 6.95, 7.65, 10.9 GHz.

From above Fig. 4 we can clearly conclude that at length 5.5 mm we get better harmonic reduction rather than other lengths also we get better return loss at length 5.5 mm. Partial ground effects on bandwidth too, at length 5.5 mm and width 36 mm we get better bandwidth of 1752 MHz which is 54 times more than the bandwidth of traditional antenna.

From Fig. 5 VSWR of proposed antenna at 3.5 GHz is 1.05 which shows that mismatch between transmitter and receiver is very less.

From Fig. 6 it is observed that the radiation patterns of antenna are Omnidirectional in E-plane & bidirectional in H plane at frequency 3.5 GHz.

Figure 7 shows surface current distribution of designed Koch antenna at 3.5 GHz, red color indicates maximum current along the edge of radiating patch. From Fig. 8 we get idea about simulated gain of proposed antenna which is of 1.50 dBi at 3.5 GHz.

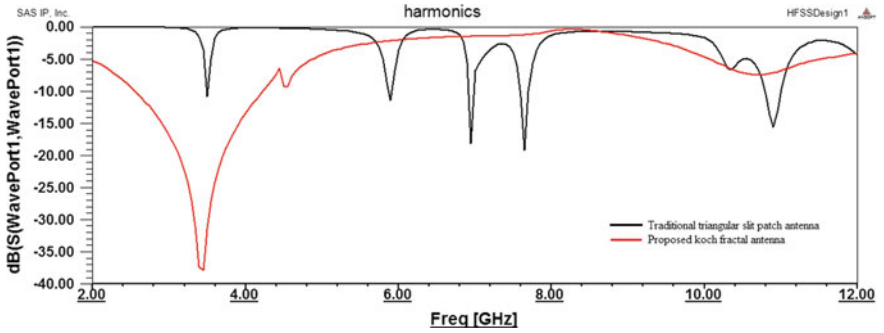

Fig. 3 Return loss of the traditional and proposed patch antennas up to 12 GHz frequency range

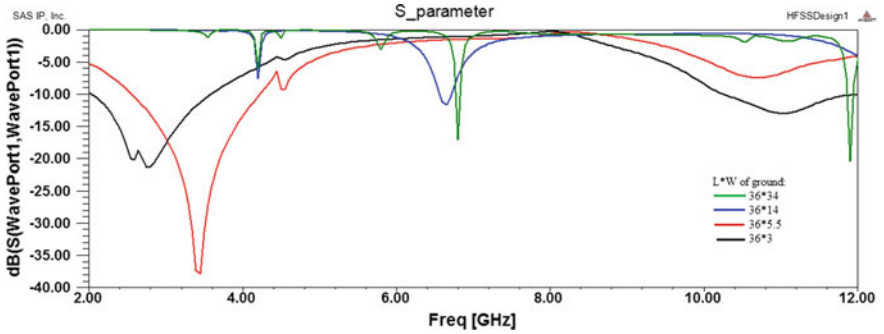

Fig. 4 Effect of different lengths of ground plane on harmonic reduction and bandwidth

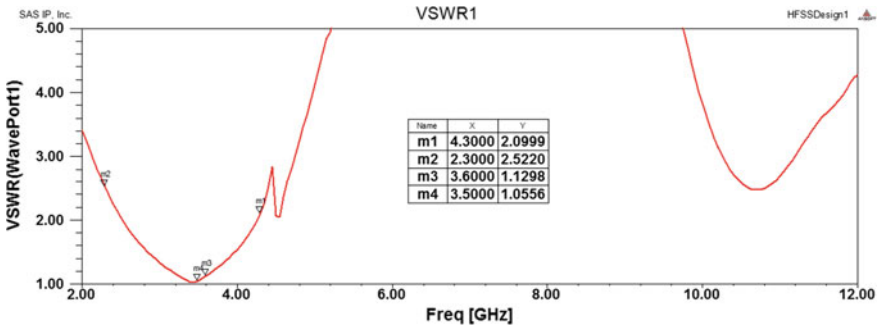

Fig. 5 Voltage standing wave ratio (VSWR) of proposed antenna

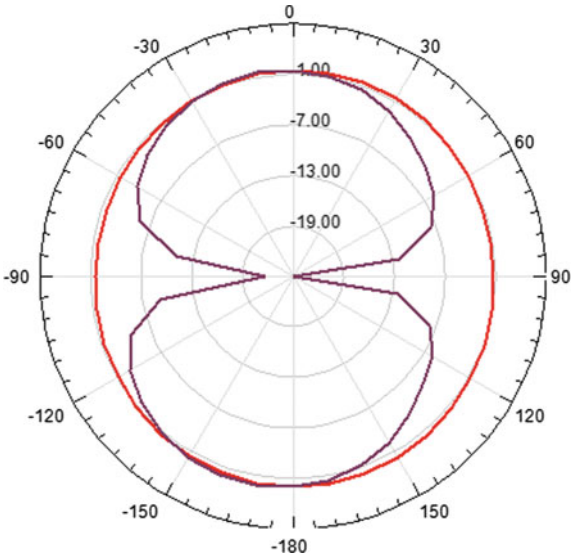

Fig. 6 Radiation pattern

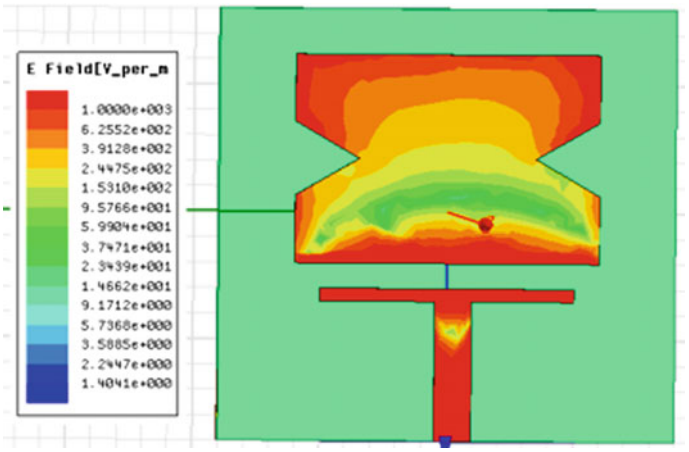

Fig. 7 Surface current distribution

4 Comparison Table

To improve the performance of this antenna, a pair of λ/4 microstripline resonators is introduced. As seen from the table, Traditional patch antenna, and proposed Koch fractal patch antenna are described. It concludes that proposed patch antenna technique improved both bandwidth & harmonic of antenna.

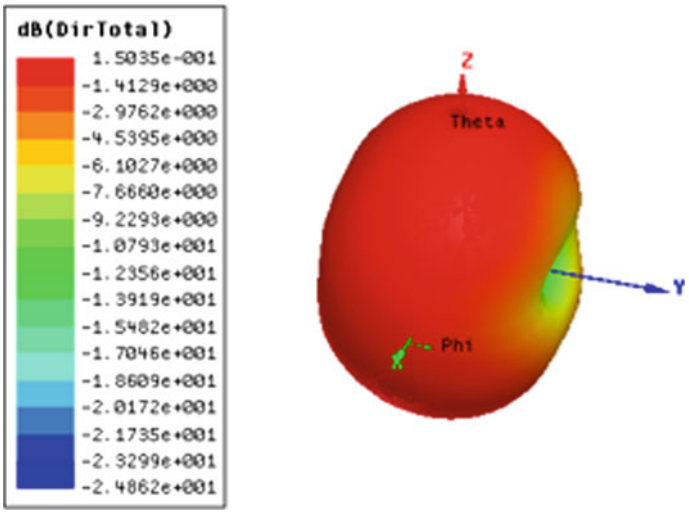

Fig. 8 3D Gain

Results	Freq (GHz)	Return loss(dB)	VSWR	BW(MHz)	Gain(dB)	Harmonics
Traditional antenna	3.5	−12.67	1.60	32.5	4.75	4th harmonic
Proposed antenna	3.5	−31.35	1.05	1752	1.50	No harmonic

5 Conclusion

In this paper, a new single layer, compact, proximity coupled fractal patch antenna. After design and simulation of Koch fractal patch antenna we get the antenna comprising of enhanced bandwidth (1752 MHz) and harmonic rejection (up to fourth harmonic), after introducing a pair of λ/4 resonator. With these two benefits other advantages of microstrip patch antenna remains untouched such as affordable cost, mini size, easy incorporation.

We analyzed traditional inset fed patch antenna and proposed antenna. Our analysis result shows that operating bandwidth can be widen by customizing the gap width in between of λ/4 resonators and patch. For validation of design, antenna operating at band Wi-MAX 3.5 GHz is designed. By comparing proposed antenna with traditional inset fed antenna, we get clear idea about its good performance. From above simulated results we can conclude that our designed antenna successfully minimized the unwanted harmonics (up to 4th harmonic) also we get boosted bandwidth of

1752 MHz along with these two benefits we get, more symmetric radiation pattern and gain. These properties of proposed antenna show that it could be successfully used for Wi-MAX applications.

References

1. Horii Y, Tsutsumi M (1999) Harmonic control by photonic bandgap on microstrip patch antenna. IEEE Microw Guided Wave Lett 9(1):13–15
2. Inclan-Sanchez L, Vazquez-Roy JL, Rajo-Iglesias E (2009) Proximity coupled microstrip patch antenna with reduced harmonic radiation. IEEE Trans Antennas Propag 57(1):27–32
3. Biswas S, Ghosh CK (2016) Harmonics suppression of microstrip patch antenna using defected ground structure. In: Proceedings of IEEE Antennas and Propagation, IEEE. 978-1-4673-6621-2/16
4. Kumar Ghosh C (2016, June) Harmonic suppression of microstrip antenna using open ended stub. Department of ECE, Dr. B. C. Roy Engineering College, Durgapur, Microwave Optical Technol Lett 58(6)
5. Rahim RA, Hassan SLS, Junita1 MN, Hassan HF, Tazi ALA (2015) Harmonic suppression circular disk microstrip patch antenna At the 2.45 GHz Frequency. IEEE Antenna Wireless Propag Lett
6. Inclán-Sánchez L, Vázquez-Roy JL, Rajo-Iglesias E (2006) Microstrip patch antenna with compact feed to reduce harmonics
7. Rahim RA, Hasan SLS, Malek F, Junita MN (2012) A 2.45 GHz circular patch antenna with harmonic suppression for wireless power transmission. In: 2012 IEEE colloquium on Humanities, Science and Engineering Research
8. Sung YJ, Kim YS (2005) An improved design of microstrip patch antennas using photonic bandgap structure. IEEE Trans Antennas Propag 53(5):1799–1804
9. Biswas S, Guha D, Kumar C (2013) Control of higher harmonics and their radiations in microstrip antennas using compact defected ground structures. IEEE Trans Antennas Propag 61(6):3349–3353
10. Ali M, Yang G, Dougal R (2006) Miniature circularly polarized rectenna with reduced out-of-band harmonics. IEEE Antennas Wireless Propag. Lett. 5(1):107–110
11. Zhang JD, Zhu L, Wu QS, Liu NW, Wu W (2016) A compact microstrip-fed patch antenna with enhanced bandwidth and harmonic suppression. IEEE Trans Antennas Propag 64(12)

An Automatic Real Time Speech-Speaker Recognition System: A Real Time Approach

Mandar Nitin Kakade and D. B. Salunke

Abstract In this paper, an automatic speech-speaker recognition system is implemented in real time noisy environment. The database creation with personalized voice in noisy environment is done with microphone arrangement. Various techniques in preprocessing step can be used to remove noise from sampled voice signal. Mel Frequency Cepstral Coefficient (MFCC) technique is used to extract Mel Cepstral Coefficients from each speech sample and thus database is created during training phase. For testing purpose, each input sampled speech signal is mapped with stored database using Vector Quantization (VQ) and Dynamic Time Warping (DTW) techniques. Output of mapped VQ is Speaker Recognition and output of mapped DTW is Speech Recognition. Using single sampled voice, real time Speech and Speaker can be recognized. This system is very useful for various applications such as Forensic, Banking where security is at highest priority.

Keywords MFCC · DTW · VQ · FORENSIC

1 Introduction

In the process of Automatic Speech-Speaker recognition, spoken words or sentences are converted into texts. This is very effective and simple way of communication between computer and human as it does not require devices like Keyboard, Mouse etc. So physically challenged people can also use this way of communication.

Main aim of Automatic Speaker Recognition system is to accept or reject the claim of speaker after analyzing their speech sample with stored database [1]. These systems were developed and tested under very low noise conditions so that output

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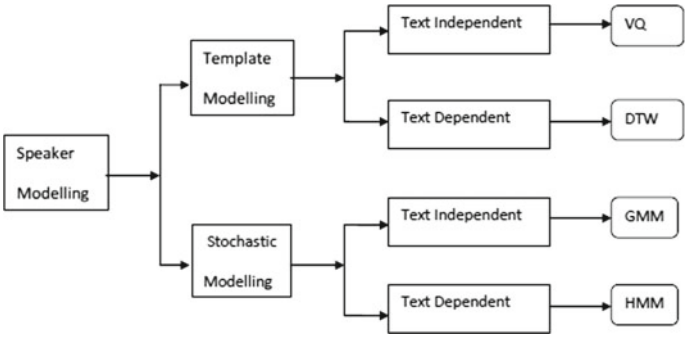


Fig. 1 Speaker modeling techniques [2]

efficiency and recognition rate should be very high. Therefore automatic speaker recognition is used in Digital Forensic application.

The process of identification of speech samples can be closed set identification or open set identification. It is also Isolated word recognition or continuous word recognition. For isolated word recognition, presence of silence period in both sides of word is a must, whereas in continuous word recognition, it is difficult to identify silence period after utterance to identify the word which is spoken by speaker [2].

Automatic Speech-Speaker recognition system has many application areas including—Education sector, Medical sector, Military applications, Banking sector, Forensic applications, Security applications etc.

For speech recognition system, various feature extraction techniques such are MFCC, LPC, RASTA and various feature matching techniques are DTW, VQ, HMM, GMM, ANN.

For speaker recognition, techniques are divided into Template modeling & Stochastic modeling which is further classified as Text dependent method and Text independent method [2]. This is summarized as follows (Fig. 1).

Basic block diagram of Automatic Speech-Speaker recognition is as follows (Fig. 2).

2 Speech Features Analysis Techniques

From speech, we can extract specific information of speaker. This explicit information is due to variation of vocal track and excitation source of various speakers. Excitation source is Larynx and resonating structure is Vocal track. Parameters related to speaker such as shape of vocal track varies accordingly. The information present in speech signal contains identity of speaker at various levels. This is summarized as follows.

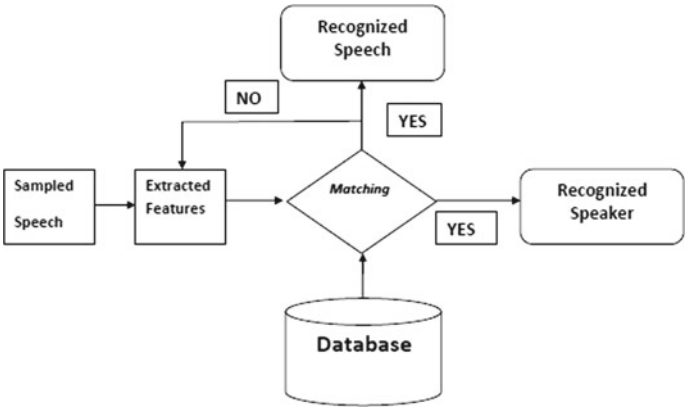
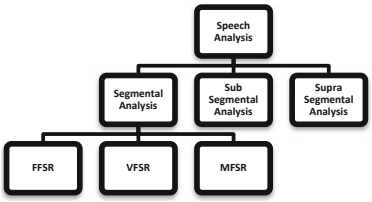


Fig. 2 Block diagram of automatic speech-speaker recognition system [1]



3 Algorithms & Methodology

Figure shows steps in training phase of Automatic Speech and Speaker Recognition system (Figs. 3 and 4).

Figure shows steps in testing phase of Automatic Speech and Speaker Recognition system.

INPUT SPEECH

The input speech given is the voice sample of a speaker or various speakers to carry out the speech and speaker recognition of the same.

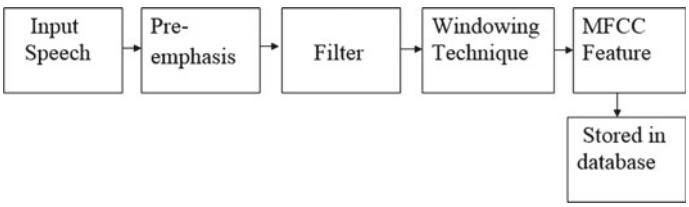


Fig. 3 Training phase [3]

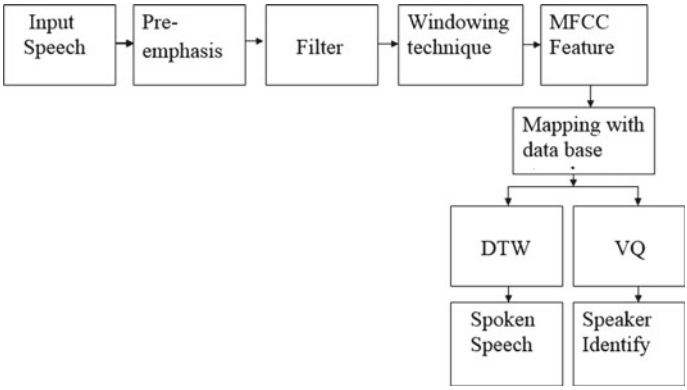


Fig. 4 Testing phase [3]

PRE-EMPHASIS

The pre-emphasizing is nothing but boosting of the signal. The desired output signal is boosted in order to get an emphasized output. The low frequency which contains noise is discarded [3].

FILTERING

Filtering is done to filter out the noise of the ambient and surrounding. High pass filter is used in speech and speaker recognition, as all the desired data is in the high frequency band. The low frequency band is the noise, which is discarded [3].

FRAMING & WINDOWING

In framing, speech signal is divided into smaller frames of 20–30 ms duration. Aliasing effect is reduced by convolving every frame with window function. Various windowing techniques like Hamming, Hanning, Rectangular, Kaiser Window etc. Hamming window is being used because the other windows are less efficient. The rectangular window has got sharp cut-offs and also has got ringing effect.

MEL FREQUENCY WARPING

Mel scale is based on perception of human hearing which is linear below 1 kHz and logarithmic above 1 kHz. Therefore to map these variations, Triangular Mel filter bank which is having overlapping nature is used to produce MFCC coefficients [3].

MFCC

The MEL Frequency Cepstral Coefficients Features (MFCC) is the feature extraction technique. It is applied to get the coefficients of every speaker's voice samples differently. The graph used to plot such coefficients is called as MEL scale. The Mel scale relates perceived frequency, or pitch, pure tone to its actual measured frequency. Thus, the very first step for speaker recognition is to extract the features [3].

DTW

The Dynamic time wrapping (DTW) is the technique of comparing the frame wise sequence of vectors from the feature extraction with set of stored templates. It is a technique which "wraps" the time axis to detect the best match between the sequences

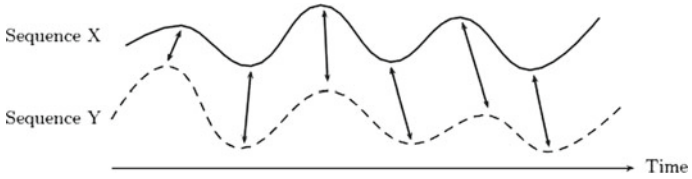


Fig. 5 Dynamic time warping [4]

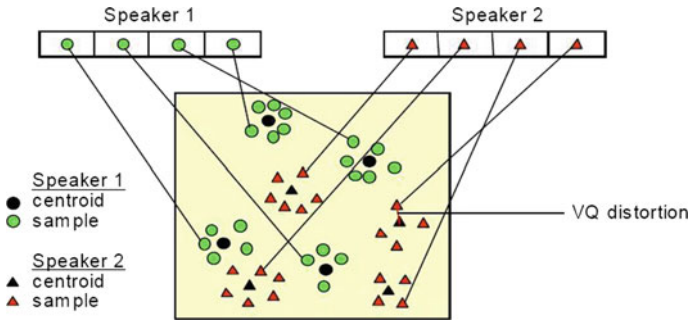


Fig. 6 Codebook of speaker [5]

[4]. In DTW, entire utterance is divided into smaller frames and local distortion is calculated and overall decision is done based on these smaller distortions (Fig. 5).

VECTOR QUANTIZATION (VQ)

Vector Quantization converts large set of feature vectors into smaller set of feature vectors which denotes centroid. Vector Quantization is the matching technique. In this, codebooks are generated by using Linde-buzo-gray (LBG) algorithm [5]. In this algorithm, good set of codebooks are selected so that a good match can be done. The codebooks are nothing but the set of vectors which contains different voice samples of each speaker. Speaker specific code is generated containing feature vectors of single speaker. During testing phase, distortion in VQ is calculated over entire speech uttered and based on mapping, recognition decision is done (Fig. 6).

SPEAKER

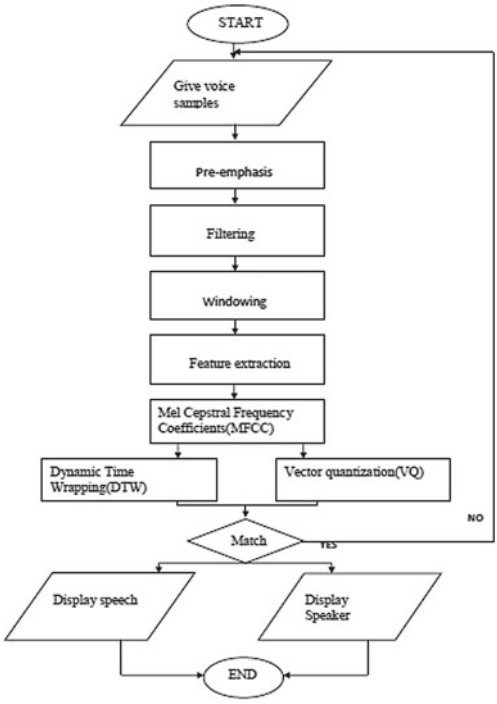
After all the above steps, the accurate speaker is recognized. Speaker recognizing means the identity who is speaking is displayed.

SPEECH

After all the above steps, the accurate speech is recognized. Speech recognizing means the identity what he/she is speaking is been displayed.

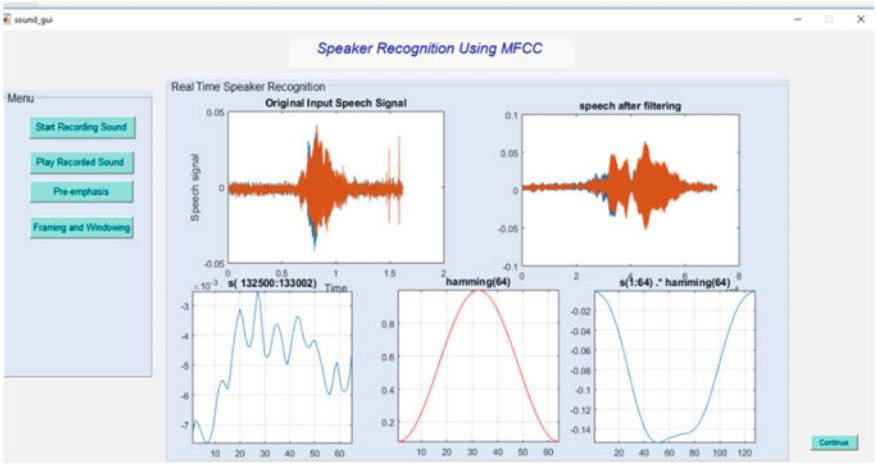
4 Flow Diagram of Automatic Speech and Speaker Recognition System

Figure indicates flow of speech sample from input speech up to final speech recognition as well as speaker recognition.

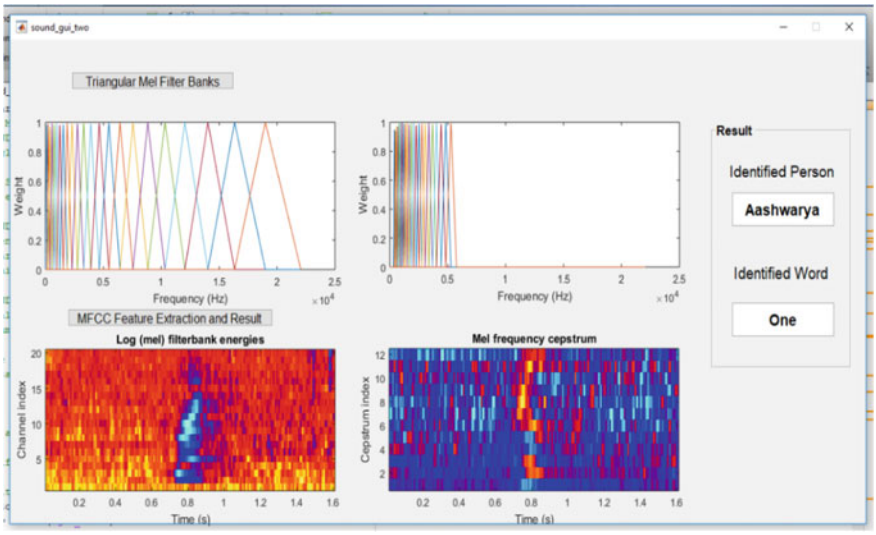


5 Results & Discussions

All results are summarized in following Graphical User Interfaces.



Above shows various output windows such as real time recorded speech, speech after filtering, framing and windowing.



Above figure shows various output windows such as Triangular filter bank, Log spectrum of MFCC, Extracted MFCC coefficients, Recognized Speech and Speaker.

6 Conclusion

After analyzing all the information, we found that the audio signal can be represented as coefficients even if audio signal is a quasi-stationary. For studying the mechanism of speaker, we studied the basic human vocal system and from that proposed a system of speaker recognition. The main part of paper is the MFCC extraction technique. There are many other techniques of extraction but because of accuracy MFCC was chosen over LPC, LPCC, and RASTA etc. Using the MFCC, we try to represent the human voice in a better way. Usually LPCC is used in digital communication, so the main purpose of this technique is not represent the voice, is to compress and transmit the information that contain the voice. As the MFCC uses the MEL scale, the approximation to the human voice behaviour is good. As speaker increases, the noise gets added. Having many applications, it makes the speaker recognition more robust. The results obtained using MFCC and VQ are appreciable. MFCCs for each speaker were computed and vector quantized for efficient representation. The code books were generated using LBG algorithm which optimizes the quantization process. VQ distortion between the resultant codebook and MFCCs of an unknown speaker was taken as the basis for determining the speaker's authenticity. It can be optimized by using high quality audio devices in a noise free environment.Use of more number of centroid increases the performance factor but degrades the computational efficiency. Hence an economical trade-off between code vectors and number of computation is required for optimized performance of VQLBG algorithm. The next method implemented was DTW. It has its own virtues of being very simple and astonishingly computation efficient. Instead of data sample, MFCCs of a test utterance were warped with respect to reference speaker and the least Euclidian distance was taken as basis for speaker identification. DTW doesn't take into account vocal tract information of a particular user. It only tries to align two vectors efficiently in time domain. Still its simplicity and easy hardware implementation has made it a regular tool for mobile applications. We can achieve 82% of accuracy by using MFCC which is more compared to other techniques. Thus, we can recognize the voice with more accuracy and make an useful application out of it.

References

1. Ishac D et al (2017) A text-dependent speaker-recognition system. In: Direction of IEEE Instrumentation and Measurement Society prior to the acceptance and publication
2. Campbell JP (1997) Speaker recognition: a tutorial. In: Proceedings of the IEEE
3. Leu F-Y,Lin G-L (2017) An MFCC-based speaker identification system TungHai University. In: IEEE 31st international conference on advanced information networking and applications, Taiwan
4. Saxena A et al (2013) Speech recognition using matlab. Suresh Gyan Vihar University, Jaipur, Rajasthan, India
5. Tiwari V (2010) MFCC and its applications in speaker recognition. Int J Emerg Technol
6. Lawrence R, Juang B-H (1993) Fundamental of speech recognition. Prentice-hall International

Indoor Navigation with Augmented Reality

Rhuta Joshi, Anuja Hiwale, Shivani Birajdar and Renuka Gound

Abstract This paper is a survey of types of Augmented Reality or AR interfaces and different indoor positioning and navigation techniques. Various existing methods are briefly elaborated and compared to build a set of techniques which can be used to develop a visual positioning and navigation system to implement handheld, mobile indoor navigation using augmented reality. The paper also illustrates about the newest and most trending technological advancements and available tools that enhance and ease the implementation of Augmented Reality applications.

Keywords Indoor positioning · Visual positioning system · Indoor navigation · Augmented reality · Computer vision

1 Introduction

In today's world, humans are extensively dependent on smartphones for navigation in unfamiliar environments. While there are many techniques and applications for outdoor navigation using GPS, there are limited options for indoor navigation, which is equally desired in large indoor spaces such as malls, office spaces, and institutions. The trending technology of AR can help us make the navigation feel more interactive and immersive. In AR, the world itself becomes the interface as people exercise more intuitive controls. With the help of direction arrows augmented in the real world

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seen through handheld devices like smartphones, the user should be navigated in an unfamiliar indoor setting for which the application has been configured.

2 Indoor Positioning and Navigation

Navigation is the task of finding a path from one place to another by finding current location, determining a destination and how to reach that destination from current location. Nicholaus R. Mrindoko and Dr. Lusajo M. Minga have provided a review after comparing different indoor positioning techniques [1]. While GPS is the primary player for outdoor navigation, indoor navigation techniques have certain additional requirements to be met, due to infrastructural barriers, privacy restrictions, signal attenuation etc. Some of the common indoor positioning techniques such as Wi-Fi are explored here. These techniques however have a lesser accuracy as compared to the GPS as stated by A. Sudarsanan and team in their research paper [2] which is discussed further.

2.1 Older Techniques

Magnetic Beacons. Array of magnetic beacons with sensors can be used for indoor navigation. The navigation area has to be covered with the beacons which generates AC magnetic field with unique signature [3]. The smartphone's internal magnetometer can act as receiver to sense the signals. As the signals are unique the receiver is able to distinguish between the beacons, a result location detection can be done by capturing and analyzing the signals.

Wi-Fi. Nicolas Le Dortz and co-authors explain how to use WI-Fi Fingerprinting for indoor navigation in their paper, using probability distribution comparison [4]. Fingerprints are known locations or landmarks in a building. The strength of the Wi-Fi and the MAC are used for Wi-Fi fingerprinting [5]. During an offline phase, fingerprints are collected at known positions in the building. This database is called the radio map. In the online mode, the current Wi-Fi fingerprint probability distributions are compared with those of the radio map. The user location is estimated by calculating a weighted average of the three offline positions that best match the online measurements [1].

RFID. Radio Frequency Identification consists of two main components reader and transponder(tag). The tag stores a serial number which gets activated when there is energy field generated by the reading unit. This data is forwarded to the reader [6]. The reading chips can be inserted into the mobile phones for activating and capturing the data. As this data is different for every reader the location can be identified by mapping these serial numbers to specific area of navigation stored in the database, hence location is identified. However, RFID offers a range of less than meter which is a limited range.

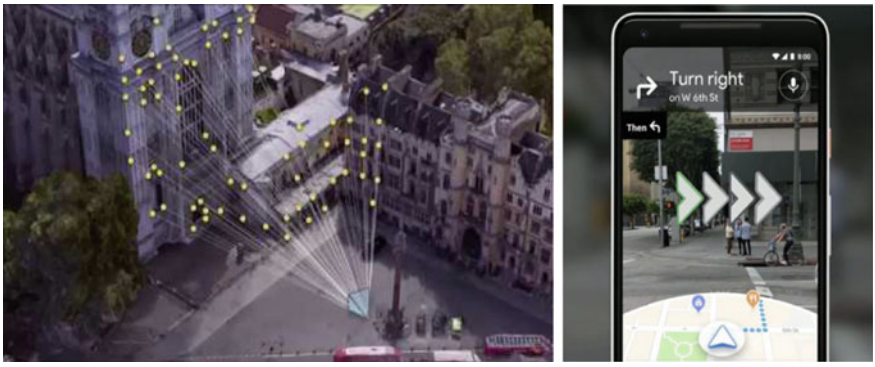

Fig. 1 Google VPS capturing visual features in the environment [8]

2.2 Modern Techniques

Vision Based Navigation. Vision based navigation is extensively used for guiding robots in an indoor environment used with object detection techniques. Athira Sudarsan and Team in their paper on "Global Image Descriptor Based Navigation System for Indoor Environment" proposed a novel technique of carrying out vision based navigation which includes creation of a topological map created from keyframes extracted from a walkthrough video of the indoor environment, using the GIST descriptor [2]. Also, a scalable navigation system in an indoor library environment was proposed by Jennifer Pearson and team by the name Bookmark. In their paper regarding the same, they have discussed how existing identifiers of books such as their barcodes can be used to locate the books in the existing infrastructure of a library [7].

Visual Positioning System. VPS is now a popular navigation system under development by Google. For better visual experiences during navigation where the GPS does not suffice, VPS can be used to estimate precise positioning and orientation [8]. VPS uses the visual features in the environment to determine locations. Google Maps can now use your camera to identify your surroundings, visually communicate your route right in front of your eyes (Fig 1).

3 Augmented Reality

The reality that a human brain perceives is the result of all the sensory information taken as input which creates an experience. The main focus of different techniques in the reality-virtuality continuum is to recreate these sensory experiences with artificial information, so that our brain perceives these as real.

3.1 Reality Virtuality Continuum in History

Many developers and researchers confuse between the terms AR and VR. Paul Milgram and co-authors explained these differences in their paper on the reality virtuality continuum [9]. In AR, we increase the usability of an interface by adding or augmenting sensory information like computer generated images, sounds and in some cases, touch feedback over user's view of the real world. This enhances user's current perception of reality. VR, on the other hand refers to creating a simulated environment using computers and replacing users' environment by placing them inside the created experience. For his invention of Sensorama Simulator [10], Morton Heilig came to be known as the father of VR though the term was formally coined later by Jaron Lanier [11]. The first experiments with a head-mounted 3D display were conducted by Ivan Sutherland [16]. Modern headsets require powerful, low-latency displays which are capable of projecting complete digital worlds without dropping a frame. AR technology does not share this requirement.

3.2 Types of Augmented Reality

Marker based AR. Based on image recognition, marker-based AR works by recognizing a visual marker in the environment and generating a digital image only when a known marker is sensed. The markers are simple and unique, such as the QR codes [12]. It finds its applications in the manufacturing and construction industry.

Markerless AR. In markerless AR, sensors in devices are used to detect the real-world environment. With the emergence of smart devices, elements such as GPS, accelerometers, velocity meter, digital compass are pre-included in the device which make the existence of Markerless AR possible.

Projection based AR. This is a relatively newer trend in AR, which works on the principle of advance projection technology that forecasts light onto real world surfaces and senses human interaction with the light. This process is carried out by distinguishing between the expected and altered projection [12].

Superimposition AR. Superimposition based AR works with object detection and recognition. It recognizes an object and then replaces it by superimposing a digital image over it [12].

4 Indoor Navigation with Augmented Reality

To navigate in an unfamiliar indoor setting with direction guides augmented in the real world to navigate from source location to destination, sample flow of implementation for on a smartphone device shown in Fig. 2 can be used. The flow consists of two parts- owner setup and visitor navigation.

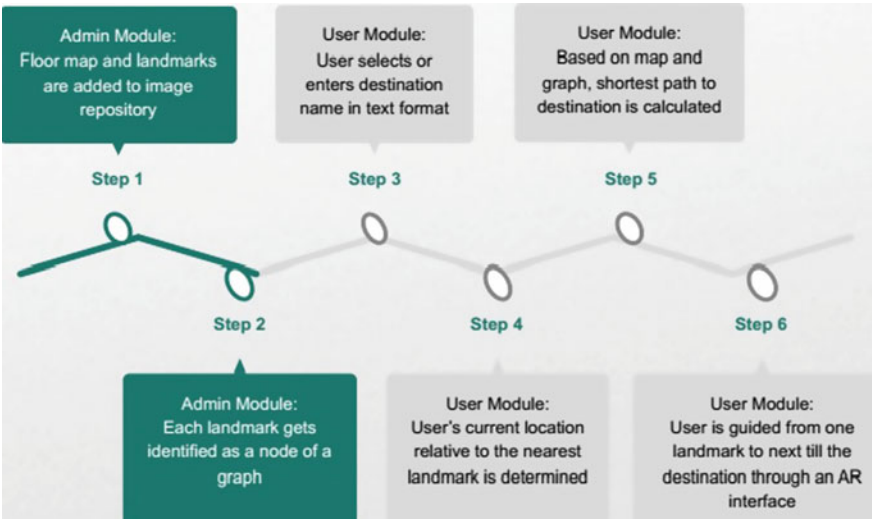

Fig. 2 Implementation of an indoor navigation system with arrows or direction guides augmented in the real world. Owner setup and Visitor navigation are referred to as Admin Module and User Module respectively

The owner, also referred to as the admin here, provides the floor map (or coordinates) and landmarks of the indoor structure to the system. Each landmark is identified as a node of a graph which is used for location identification with associated coordinates. To use the system for navigation, the visiting user captures his current location by getting a nearby landmark in his/her camera view. The system compares it to the existing stored landmark images and uses landmark detection algorithms to determine user's current location. The user then selects a destination from a list displayed by the system. Based on the navigation technique used and owner-visitor inputs, shortest path is calculated and arrows get augmented in the user's real-world view. For implementing the proposed system, some of the useful technologies and hardware are explored hereby.

Sensors like accelerometers, magnetometers, gyroscopes etc. most of which are available in modern smartphones, are required for such a system. Cameras are required to visually scan to collect data about the surrounding area to take this information, which determines where surrounding physical objects are located, and then formulates a digital model to determine appropriate output [12]. AR devices require significant computer processing power. The processing components utilized may include some of components like CPU, GPU, RAM, Bluetooth/Wifi microchip, GPS microchip, or more [13]. To develop AR, different popular software includes Unity, Vuforia, ARCore for Android based and ARKit for iOS based mobile equipment. According to ARCore documentation resource, it uses three main technologies to integrate virtual content with the real world as seen through your phone's camera—motion tracking, environmental understanding and light estimation [14]. In order

to identify and recognize landmarks for source detection in the indoor navigation system different machine learning features provided under MLKit can be combined and used [8, 15].

5 Inferences

Among the various navigation techniques surveyed, Wi-Fi fingerprinting, RFID etc. have an external hardware requirement such as Wi-Fi access points or beacons. Vision based navigation and VPS, on the other hand, can be implemented without these external hardware resources, though using them jointly will definitely improve accuracy of computer vision. The various augmented reality types, and implementation methods studied show the various possible implementations of this technology. AR can be implemented with head mounted displays as well as hand held devices like smartphones. Marker based AR is the easiest to implement but it restricts the experience to areas where markers are available. To make the user interaction more immersive, we can best try to implement markerless AR which is harder to implement than marker based but more flexible as required for navigation.

6 Conclusions

Indoor navigation is clearly implementable with smartphones in the present day, and possibly with lesser hassles in a few years. The future of AR is fairly good with the advancement in hardware, sensors and graphics. Both indoor navigation and AR are most likely to be found all across devices and applications. Using this technology, the power of smartphone cameras and computer vision can be combined indoor maps to reimagine walking navigation. Thus, the idea of development of an AR interface on smartphones for indoor navigation has merit in the form of a mobile application.

References

1. Le Dortz N, Gain F, Zetterberg P (2012) WiFi fingerprint indoor positioning system using probability distribution comparison. In: IEEE ICASSP 25–30 March
2. Athira SV, George M, Jose BR, Mathew J (2017) A global image descriptor based navigation system for indoor environment. 115:66–473
3. Sheinker A, Ginzburg B, Salomonski N, Frumkis L, Kaplan BZ, Moldwin MB (2016) *A method for indoor navigation based on magnetic beacons using smartphones and tablets.* 81:197–209
4. Gaudlitz E (2015) infsoftblog on infosoft.com [Online]. Available: https://www.infsoft.com/blog-en/articleid/40/indoor-navigation-using-wifi-as-a-positioning-technology
5. Infsoft Website [Online]. Available: https://www.infsoft.com/blog-en/articleid/40/indoor-navigation-using-wifi-as-a-positioning-technology
6. Infsoft Website [Online]. Available: https://www.infsoft.com/technology/sensors/rfid

7. Pearson J, Robinson S, Jones M (2017) Bookmark: appropriating existing infrastructure to facilitate scalable indoor navigation. J. Hum Comput Stud 103:22–34
8. Google Developers. (2018). Google I/O Keynote [Online]. Available: https://www.youtube.com/watch?v=ogfYd705cRs
9. Milgram P, Takemura H, Utsumi A, Kishino F (1994) Augmented reality: a class of displays on the reality-virtuality continuum. SPiE
10. Heilig ML (1961) Sensorama simulator. U.S. Patent 3 050 870A, Jan. 10, 1961
11. Lanier J (1992) Virtual reality: the promise of the future. Interact Learn Int 8(4):275–79
12. Reality Technologies Augmented Reality [Online]. Available: https://www.realitytechnologies.com/augmented-reality/
13. Augmented reality hardware functional requirements for industrial industry use case*s*. Digital Manufacturing and Design Innovation Institute (DMDII) 2016
14. ArCore Google (2018) Developers website [Online]. Available: https://developers.google.com/ar/discover/
15. Google Developers (2018) MLKit Documentation [Online]. Available:https://firebase.google.com/docs/ml-kit/

Survey Paper on New Approach to Location Recommendation Using Scalable Content-Aware Collaborative Filtering

Pooja Rajendra Pawale and Vidya Dhamdhere

Abstract The Location recommendation playing a important role for finding interesting places. Although recently researching he has advise places and provide information using socially and geographically, some of which have dealt with the problem of starting the new cold user. The Records of mobility shared on a social networks. Collaborative content-based filters based on explicit comments, but require a negative design sample for a improving performance. negative user preferences not observable in mobility records. However, In previous studies that sampling-based methods and this method does not work well. A Propose system based on implicit scalable comments Content-based collaborative filtering framework is used to avoid negative sampling and incorporate semantic based contents. Algorithm of Optimization is used to major in a linear fashion with the dimensions of the data and the dimensions of the features, dimensions of latent space is represent in a quadratic way. Also established relationship with factorization of the plate matrix plating. Personalized recommendation recommends the Point Of Interest routes by mining users travel records. Finally, evaluated ICCF framework with large-scale Location Based Social Network data set in which users have text and profiles.

Keywords Content-aware · Location recommendation · Social network · Implicit feedback · Weighted matrix factorization

1 Introduction

As we think about the title of this paper is related to Recommender System which is part of the Data mining technique. Recommendation systems it can be classify in two categories: collaborative and content-based filtering system. Content-based filtering system analyse the properties of articles and recommend articles which is similar to

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the user has preferred in the past. user profile is based on the properties of the elements that users like and using the profile to calculate the similarity with the new elements. We recommend location that are more similar to the user's profile. Recommender system, ignore the properties of the articles and base their recommendations on community preferences. Two users are considered as same because many elements is common. The recommendation systems main problem is cold start problem i.e. new articles or users is introducing the systems. In this study we focused on the problem of producing effective recommendations for new articles: the cold starting article. Collaborative filtering systems suffering from this problem because they depends on previous user ratings. Content-based approach, can still produce recommendation using article descriptions and are the default solution for cold-starting the article.

The cold start problem of the article is of great practical importance Portability due to two reasons. First, modern online the platforms have hundreds of new articles every day and actively recommending them is essential to keep users continuously busy. Secondly, collaborative filtering methods is the core of most recommendation engines since then tend to achieving the accuracy of the state of the art. However, to producing recommendations with the predicted accuracy and that items be qualified by a sufficient number of users. Having methods that producing precise recommendations for new article and Make effective recommendations on collaboration framework.

Propose system, provide a location recommendations using Implicit-feedback based Content-aware Collaborative Filtering framework. Avoid sampling negative positions by considering all positions not visited as negative and proposing a low weight configuration, with a classification, to the preference trust model. This sparse weighing and weighting configuration not only assigns a large amount of confidence to the visit and unvisit positions, but it includes different weighting schemes previously developed for location.

A. **Motivation**

In that part study of recommendation system, their application, which algorithm used for that and the different types of model, I decided to work on the Recommendation application which is used for e-commerce online shopping, location recommendation, product recommendation lot of work done on that application and that the technique used for that application is Recommendation system using traditional data mining algorithms.

Approaches to the state of the art to generate recommendations only positive evaluations are often based on the content aware collaborative filtering algorithm. However, they suffer from low accuracy.

- Improve the prediction accuracy using advanced content aware collaborative filtering technique.
- Providing location recommendations from positive examples is based on the implicit feedback.

2 Related Work

We need to study the previous papers of our domain which we are working and on the basis of study we can predict or generate the drawback and start working with the reference of previous papers.

In that section, we briefly review of Recommendations system and their different techniques and their related work.

X. Li, Y. Liu, X. Liu, describe the "Exploring the context of locations for personalized Location recommendations." In this paper, decouple the process of jointly learning latent representations of users and locations into two separated components: Skip-gram model used for learning location representations of latent, and C-WARP loss used for learning user representation of latent [1].

Dingming Wu, Shuyao Qi and Nikos Mamoulis describe that "Location Aware Keyword Query Suggestion Based on Document Proximity." We propose LKS framework and that framework provide keyword suggestion and this suggestions are relevant to user information and that time retrieve relevant documents from Near user locations [2].

R. Hong, Y. Ge, H. Li, Z. Wu, D. Lian, M. Wang, describe the "A relaxed ranking-based factor model for recommender system from implicit feedback." In this paper, recommendation of items use relaxed ranking-based algorithm with implicit feedback, and design smooth and scalable optimization method for model's parameter Estimation [3].

H. Xiong, D. Lian, N. J. Yuan, Y. Ge, X. Xie, describe the "collaborative filtering for implicit feedback for Sparse Bayesian." In this paper, we proposed a sparse Bayesian collaborative filtering algorithm best tailored to implicit feedback, And developed a scalable optimization algorithm for jointly learning latent factors and hyper parameters [4].

M.-Y. Kan, X. He, and T.-S. Chua, H. Zhang, describe the "online recommendation with implicit feedback Fast matrix factorization." In this paper, find out missing data using uniform weight model and also finding popularity of items or data using weight method [5].

J. M. Jose, F. Yuan, L. Chen, H. Yu, G. Guo, describe the "Lambda fm: factorization machines and learning optimal ranking with using lambda surrogates" describe use both FM and Ltr. The advantage of LTR and FM (Lambda FM) optimizing top–K items ranking. Implicit feedback is a exible in context aware collaborative filtering recommendations for incorporate contents [6].

Yiding Liu 1 TuanAnh Nguyen Pham 2 Gao Cong 3 Quan Yuan describe the An Experimental Evaluation of Point of interest Recommendation in Location based Social Networks-2017. In this paper, focus on point of interest recommendation model. and this model used for recommending point of interests and evaluate a aver all 12 state Point of interest since that evaluation finding many important things which is based on point of interest recommendations then utilize point of interest for finding various scenario [7].

Xueming Qian, Shuhui Jiang, IEEE and Yun Fu, Senior Member, IEEE" describe the "Personalized Travel Sequence Recommendation on Multi-Source Big Social Media." In this paper, recommended travel sequences and also personalized point of interests. In this system automatically mining user and travel preferences including cost, time and season. That system used user package and route package. most famous route find between route and user packages [8].

Huang Xu, Zhe Yang, Zhiwen Yu and Bin Guo describe the "Personalized Travel Package With Multi-POI Recommendation Based on Crowd sourced User Footprints." In this paper, user make travel Plans using travel package recommendation. Generate travel package based on heuristic travel route algorithm [9].

Amy Zhangy, Flavio du Pin Calmon_, Salman Salamatian_, Sandilya Bhamidipatiz, Branislav Kvetonx, Nadia Fawazz, Pedro Oliveira, Nina Taftk describe the "Managing your Private and Public Data: Bringing down Inference Attacks against your Privacy." Matrix factorization developing Effective parameter and efficient parameter [10].

3 Open Issue

Lots of work already done in location recommendation. Location recommendations applications and usages is very helpful for users. Achieving the same purpose which is mentioned use many of the approaches In another research, general location routes planed can not well meet users requirements. Point of interests recommendation recommend personalized and using users travel records mined by route.

The location-based matrix factorization is one of the famous method. Previously visiting Point Of Interests measure based on location co-occurrences. The similar users visiting records arrange ranked of Point Of Interests. Recently, static topic model is use to extract the travel topics from past traveling behaviors which can contribute to identify similar users. Travel preferences are not obtained accurately, because static topic model consider all travel records history of a user one document drawn from set of static topics, which is ignores the travel preference and topic evolution.

As my point of view when I studied the papers the issues are related to recommendation systems. The challenge is to addressing cold start problem from implicit feedback is based on the detection of recommendation between users and location with similar preference.

4 Proposed Approaches

As I studied then I want to propose content-aware collaborative filtering is propose the combination of content based recommendation filtering and collaborative filtering, firstly find nearby locations i.e. places, hotels and then to recommend to user based on

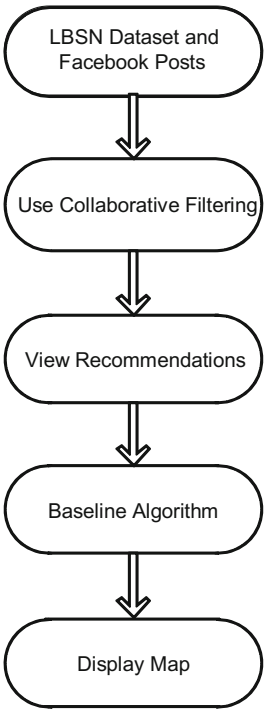
Table 1 Comparison table

Framework	Recall (%)	Precision (%)
ICCF	72	55
GRFM	59	45

implicit feedback and achieve the high accuracy and also remove cold-start problem in recommendation system.

In this system, Recommending interested places to users. Content-based collaboration filtering frameworks, design the basis of explicit feedback with favourite samples both positively and negatively. Such as Only the prefer samples implicitly providing in a positive way. Feedback data while it is not practical to treat all unvisited locations as negative, feeding the data on mobility together. user get recommendation interesting places in top-k recommendation. Users information and recommended places in this explicitly comments Frames require pseudo-negative drawings. From places not visited. User get recommendation of the most visited locations there is need the recommended locations, should be personalized to cold start user since different users may prefer different types of point of interests (Table 1).

Flow Diagram:



5 Experimental Dataset Result

i. Dataset For Collaborative Filters in Songs Dataset

In this dataset it consists of three attributes User ID, Song ID, Rating. That datasets, applied trees. random tree.In that dataset 2,000,000 instances and 3 attributes. The test mode is 10 fold cross validation. Then that dataset applied k-means algorithm and rule decision table.

KMeans algorithm:
Number of iteration: 4
Clusters sum of squared errors: 38769.5858
Initial starting points (random) K-means
Takes time to build model (full training data): 24.04s (Tables 2, 3, and 4)

ii. Restaurant and Consumer Data Dataset

Restaurant and consumer dataset it contains chefmozaccepts, chefmozcuisine and also include chefmozparking and chefmozhours4 this are 4 restaurants data sets including rating,user profile and user payment files. Chefmozaccepts data have 2 attributes Place ID and Rpayment.

User Rating file it incudes 5 attiributes UserID, PlaceID, Rating, Food_rating, Service_rating. Test mode is evaluate on training data. Rating final file applied four types of algorithm.M5P, Random forest, Random Tree Decision Stump.

In that dataset, applied k means classifier: No.of iteration is 3.

Table 2 Songs Dataset Result

Attribute	Full Data (2,000,000)	Cluster 0 (874,894)	Cluster 1 (1,125,106)
User ID	99,999	99,962	100,028
Song ID	67,989	68,126	67,882
Rating	3.45	1.87	4.69

Table 3 Clustered instances

0	0.874894 (44%)
1	1.1125106 (56%)

Table 4 Analysis of dataset using different algorithm

Algorithm	Correlation coefficient	Absolute mean error	Squared root mean error	Relatively absolute error (%)	Root relative squared error (%)	Total number of Instances	Time required for execution in seconds (S)
Decision stump	0.0082 –	1.3877	1.5532	99.9924	99.9965	908.010	1.11
ZeroR	−0.0039	1.3878	1.5533	100	100	908.010	0.14

Table 5 Restaurant and consumer dataset

Attribute	Full Data (1161)	Cluster 0 (746)	Cluster 1 (415)
User ID	U1106	U1061	U1135
Place ID	134.192	134.394	133.827
Rating	1.1998	1.6367	0.4145
Food _Rating	1.2153	1.6542	0.4265
Service_Rating	1.0904	1.5067	0.3422

Time required for execution in seconds 0.08 p/s

Table 6 Analysis of dataset using different algorithm

Algorithm	Correlation coefficient	Absolute mean error	Squared root mean error	Absolutely relative error	Root relative squared error	Total number of instances	Time required for execution in seconds (S)
M5P	0.730	0.3848	0.542	58.4003%	68.5116%	1161	2.48
Random forest	0.6248	0.4459 H	0.6302	67.6728%	79.6678%	1161	0.76
Random tree	0.5268	0.4614	0.7637	70.0405	96.5391	1161	0.01
Decision stump	0.6066	0.5342	0.6284	81.0762%	79.4436%	1161	0.01

Initial starting points is
Cluster 0: U1054,135041,2,2,2
Cluster 1: U1069,132851,1,0,0 (Tables 5 and 6).

6 Conclusion

In that Paper, we propose a content-aware collaborative filtering based on content based on implicit feedback set of data and develop the coordinates of the offspring for effective learning of parameters. We establish the close relationship of ICCF with matrix graphical factorization and shows that user functions really improve. So applying framework for recommending interesting locations in Location based social Network data set. The result of the ICCF framework are greater than five competing baseline algorithms. Including positions recommendation and factoring algorithms based on the ranking machine. user oriented scheme improving the performance of recommendation system.

References

1. Symeonidis P, Manolopoulos Y, Kefalas P (2016) A graph-based taxonomy of recommendation algorithms and systems in location based social networks. IEEE 28(3):604–622
2. Shou L, Chen K, Peng P, Chen G, Wu S (2016) KISS: knowing camera prototype system for recognizing and annotating places of Interests. IEEE Trans Knowl Data Eng 28(4):994–1006
3. Jiang S, Qian X, Mei T, Fu Y (2016) Personalized travel sequence recommendation on multi-source big social media. IEEE Trans Big Data 2(1):43–56
4. Chow CY, Zhang JD (2016) POI recommendation in LBSNs. In Proceedings of SIGSPATIAL, pp 26–33
5. Cheng AJ, Chen YY, Hsu WH (2015) Travel recommendation by mining people attributes and travel group types from community-contributed photos. IEEE Trans Multimedia 15(6):1283–1295, 17(3):409–419
6. Shen J, Fu Y, Jiang S, Qian X, Mei T (2015) Collaborative filtering for personalized point-of-interests recommendation. IEEE Trans Multimedia 17(6):907–918
7. Yang J, Pang Y, Zhang L, Hao Q Cai R, Wang X (2009) Generating location overviews with images and tags by mining user generated travelogues. In: Proceedings ACM, pp 801–8049
8. Cong G, Yuan Q, Ma Z, Sun A, Thalmann NM (2013) Time-aware POI recommendation. In: Proceedings of SIGIR, pp 363–372
9. Chow CY, Zhang JD (2015) Spatiotemporal sequential influence modeling for location recommendations: a gravity-based approach. Trans Intell Syst ACM 7(1):11

Square Microstrip Antenna with T-Shape Slots for Wide Band Response

Amit A. Deshmukh, Mansi Shah, C. Kudoo, V. Chaudhary and Shefali Pawar

Abstract Wide band designs of square microstrip antenna by employing four T-shape slots is proposed. The appropriate placement of proximity feed and T-shape slots modifies the modal current vectors at TM_{11} mode that along with its mutual coupling with diagonal TM_{10} mode yields wide band characteristics. The antenna yields impedance bandwidth of around 470 MHz (>40%) with radiation pattern in broadside direction along with peak gain close to 8 dBi. Further pair of T-shape slots cut square patch is presented. The additional slots maximize current vector on the surface along patch length which yields improved radiation pattern characteristics with impedance bandwidth of larger than 480 MHz (>43%). A rectangular slot cut variation shows broadside pattern and 8 dBi of maximum gain. Proposed designs are optimized in 900 MHz frequency band which will make them suitable in mobile and wireless communication designs in 800–1200 MHz spectrum.

Keywords Broadband microstrip antenna · T-shape slots · Rectangular slots · Higher order mode · Proximity feed

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1 Introduction

With numerous advantages like planarity in configuration and fabrication simplicity, microstrip antenna (MSA) finds varying applications in wireless communication applications like, mobile and personal communication systems [1, 2]. Earlier MSAs were regarded as narrow bandwidth (BW) elements when they were invented for first time in 1969, however over last three four decades many techniques have been evolved that has increased antenna BW. One of those techniques is use of parasitic elements which were coupled along length or height of the antenna [3]. However, these designs lose upon the low profile nature of MSA. Further in 1995, a new method of introducing slot in the patch was put forward which enhances MSA BW without increasing patch size [4]. Since then many configurations by employing slots of various shapes like, rectangular slots, modified U-slot, V-slot have been reported that has increased MSA BW [5–9]. An insight about functioning of slot cut MSA by providing detailed analysis was reported in [10] for slot cut rectangular MSA (RMSA). It has been clearly shown that slot modifies the frequency and modal current distributions at higher order modes and due to their mutual coupling with fundamental mode, enhances the BW. Here slot shape and its position related to the field distribution at higher order as well as fundamental mode is an important parameter since slot has to only affect the higher mode in frequency and impedance and not the lower order modes.

The excitation of various modes in MSA depends upon the position of feed point below the patch. Each resonant mode for given feed position are not observed since impedance matching at same is not realized. The TM_{11} mode frequency in RMSA or square MSA (SMSA) is lower than its TM_{02} or TM_{20} mode frequency. Hence tuning of TM_{11} mode frequency will require smaller slot length with reference to TM_{10} mode. In this paper with reference to excitation of TM_{11} mode, wide band SMSA designs with four T-shape slots is presented. The slots tune TM_{11} mode frequency to that of TM_{10} which yields impedance BW of above 470 MHz (>40%). The antenna shows pattern maximum in broadside with 8 dBi gain. Improvement in gain characteristics of T-slot design is obtained by introducing pair of rectangular slots. Pair of slots cut design offers better broadside gain response towards higher frequency spectrum in the VSWR BW. In proposed work, explanation about excitation of higher modes is discussed and with reference to same slot positions were selected. Thus as TM_{11} mode is chosen here against TM_{02} mode, slot dimensions required are smaller. This is the novelty in proposed T-slot designs against earlier reported slot cut wide band designs. The IE3D simulations were used first for studying proposed antennas. Further experimentation were performed using high end instruments like, 'ZVH–8' 'SMB 100A', 'FSC–6' inside the Antenna laboratory. The proposed antennas with BW of above 40% and gain of 8 dBi will be useful in mobile and personal communication systems in 800–1200 MHz frequency band.

2 Wide Band SMSA Using T-Shape Slots

A design of SMSA using proximity feed is given in Fig. 1a. As antennas are proposed to cover 800–1200 MHz range, SMSA dimensions are selected for $f_{TM10} = 1100$ MHz. For this frequency and air substrate thickness 'h_a' of 30 mm, SMSA side length (L_p) is optimized to be 100 mm. Proximity feed with length 'L_s' was placed below the patch with thickness of 'h_s' cm. Impedance graph showing variation in real and imaginary for two orientations of SMSA are given in Fig. 1b. Here the configuration where SMSA is rotated by 45° is referred to as modified SMSA. For SMSA two resonant peaks are observed. The current distributions at two modes were analyzed and they are due to TM_{10} and TM_{02} modes [3]. In modified SMSA, along with these two modes, additional mode is observed around 1700 MHz frequency. The current distribution at the same shows half wavelength variation along each length. Hence the mode observed is TM_{11}. This modal frequency is nearer to TM_{10} mode. This mode was not observed in SMSA since feed at that patch orientation lies nearer to minimum field point at TM_{11} mode. As spacing in between TM_{20} and TM_{10} mode is higher, larger slot will be required to tune frequency and yield wide band response. Therefore, here tuning of TM_{11} mode frequency is observed. For this vertical slot of length 'L_v' and width 'w_v' = 4 mm, are embedded on patch edge as given in Fig. 1c, d, and impedance plots for variation in length are given in Fig. 1e–g.

The length 'L_v' reduces TM_{11} mode frequency. But for 'L_v' > 25 mm, reduction in TM_{10} mode frequency is also observed. Hence to alter only TM_{11} mode frequency, slot length 'L_h' is introduced. This complete the T-shape slot design. Length 'L_h' largely reduces TM_{11} mode frequency and yields wider BW due to optimum spacing between TM_{10} and reduced TM_{11} mode frequency as provided in Fig. 1h. Respective measured and simulated BW are 475 MHz (43.5%) and 470 MHz (43.32%). The fabricated prototype, radiation pattern nearer to the band start and stop frequency and gain variation are shown in Figs. 2a–f and 3a. The pattern shows maxima along broadside direction with cross polarization level less than 10 dB. Maximum antenna gain is close to 8 dBi which reduces towards higher frequencies of BW due to contribution of vertical currents at modified TM_{11} mode.

To reduce gain variation along higher frequencies of the BW, current contribution at reduced frequency TM_{11} mode should be maximally optimized in horizontal direction. To realize this, horizontal slot of length 'l_s' is cut as shown in Fig. 1c. Slot orientation and position is selected such that it will only affect modified TM_{11} mode frequency. Impedance graph for same showing variations in TM_{10} and TM_{11} mode frequencies is given in Fig. 3b. Here slots marginally affect TM_{11} mode frequency. But it re-orients current contribution at same along horizontal direction as shown in Fig. 3c, d. The wider response is obtained for 'l_s' = 40 mm as provided in Fig. 3e. Respective measured and simulated BW are 499 MHz (45.23%) and 485 MHz (44%). Pattern in this design is broadside and due to rectangular slots, better gain characteristics towards higher frequencies of BW are observed as given in Fig. 3a. Thus new configuration of T-slot and rectangular slot cut SMSA for wide band response

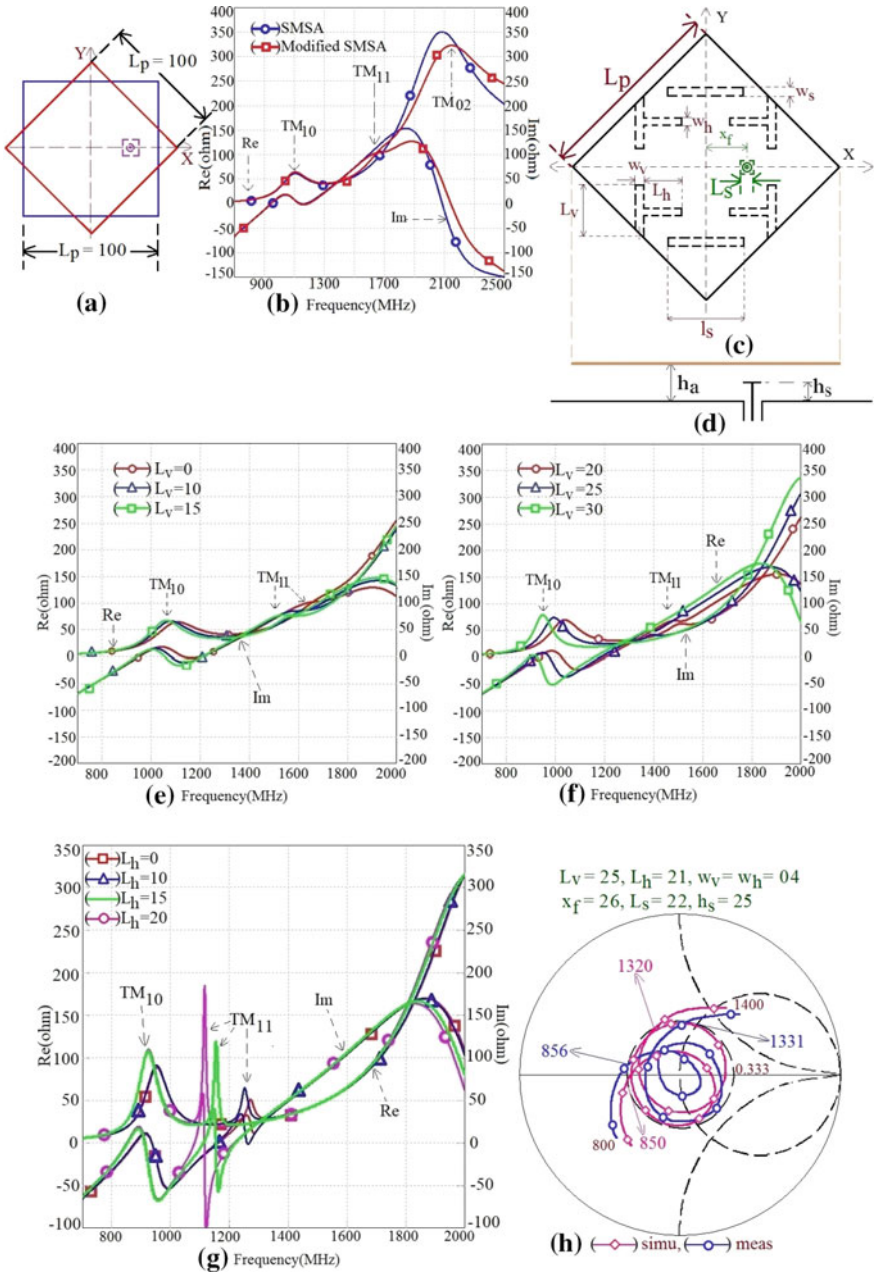

Fig. 1 **a** Two orientation of SMSA, its **b** impedance graphs, **c**, **d** SMSA with T-slot, its **e**–**g** resonance graph for T-slot length variation and its **h** optimum smith chart

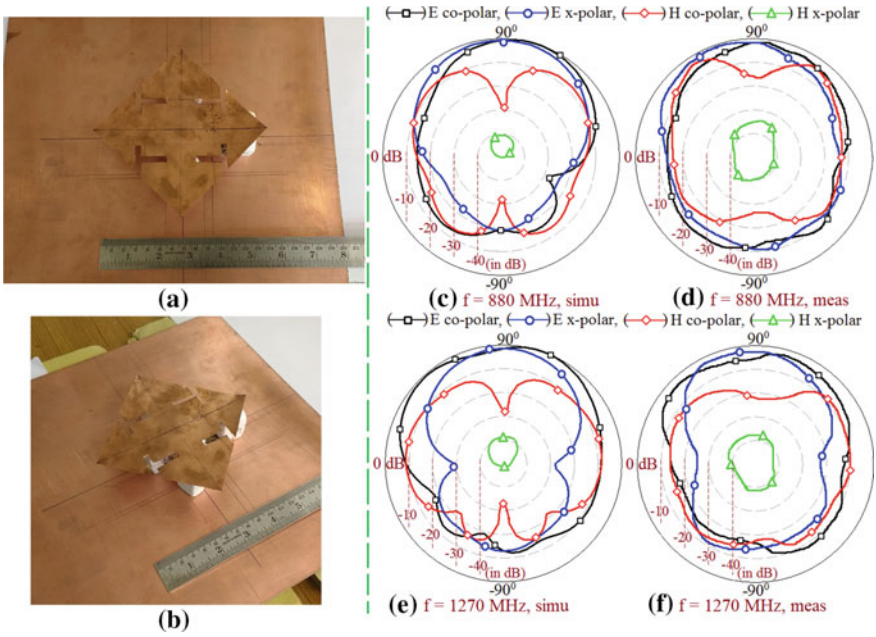

Fig. 2 **a**, **b** Fabricated prototype, **c–f** radiation pattern at band edge frequencies for T-slot cut SMSA

is the novelty in proposed paper. With BW of above 40% and gain of above 7 dBi, proposed antennas can find application in mobile band.

3 Conclusions

A wideband design of SMSA with T-shape slots is presented. The slot reduces and tunes frequency of TM_{11} mode and due to its optimum separation with TM_{10} mode yields wider BW. The antenna offers linear polarization with peak gain of 8 dBi. An improvement in gain characteristics of T-slot design is realized by embedding additional rectangular slots. These slots re-direct current distribution at TM_{11} mode and offers improved gain response specifically towards higher frequencies of VSWR BW. Addition of rectangular slots also adds to the marginal increment in BW. Thus novel configurations of T-slot cut SMSA design with its original explanation about antenna working are the novelties in present paper.

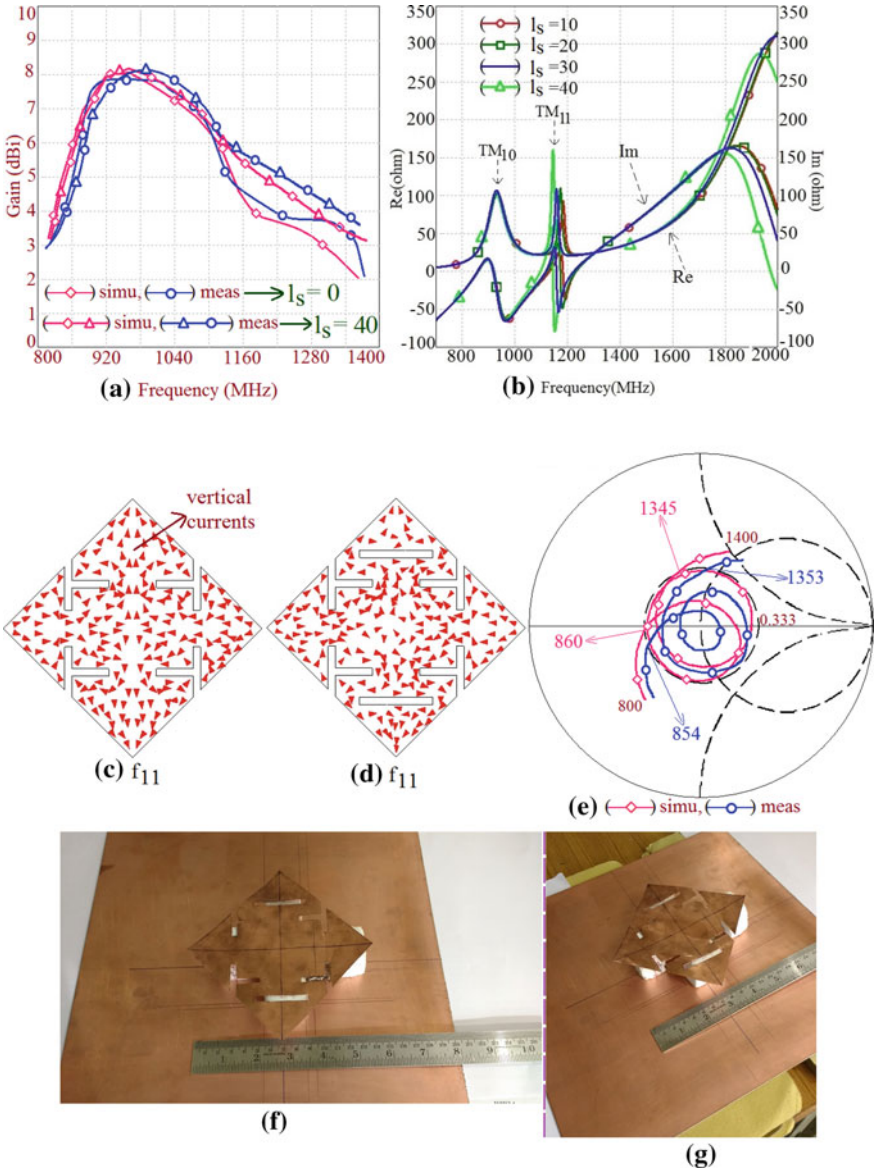

Fig. 3 **a** Gain variation over BW for T-slot ($l_s = 0$ mm) and T-slots and pair of rectangular slots ($l_s = 40$ mm) cut SMSA, **b** impedance graphs for length 'l_s' variation, current distribution at TM_{11} mode **c** without slot and **d** with slot, **e** optimum smith chart and **f** top and **g** 3D view of T-slots and pair of slots embedded proximity fed SMSA

References

1. Balanis CA (1997) Antenna theory, analysis and design. Wiley, New York
2. Bahl IJ, Bhartia P (1980) Microstrip antennas. Artech House
3. Kumar G, Ray KP (2003) Broadband microstrip antennas, 1st edn. Artech House, USA
4. Huynh T, Lee KF (1995) Single-Layer single-patch wideband microstrip antenna. Electron Lett 31(16):1310–1312
5. Ooi BL, Shen Q (2005) A novel e-shaped broadband microstrip patch antenna. Microwave Opt Technol Lett 27(5):348–352
6. Islam MT, Shakib MN, Misran N (2009) Multi-slotted microstrip patch antenna for wireless communication. Prog Electromagnet Res Lett 10:11–18
7. Neves ES, Heckler MVT, Schildberg R, da S Lacava JC, Cividanes L (2003) Single layer rectangular patch antenna with two pair of parallel slits. Microwave Opt Technol Lett 37(5):355–359
8. Wong KL (2002) Compact and broadband microstrip antennas, 1st edn. Wiley, New York
9. Lee HF, Chen W (1997) Advances in microstrip and printed antennas. Wiley, New York
10. Deshmukh AA, Ray KP (2013) Analysis Of Broadband & Psi (Ψ) shaped microstrip antennas. IEEE Antennas Propag Mag 55(2):107–123

Predicting Surface Air Temperature Using Convolutional Long Short-Term Memory Networks

Sanket Wagle, Saral Uttamani, Sasha Dsouza and Kailas Devadkar

Abstract Surface Air temperature prediction has been a long-standing challenge in the field of weather forecasting due to the number of variables that can influence the surface temperature of any area. In this paper, we aim to use convolutional Long Short-Term Memory (LSTM) Networks to create an accurate and reliable global surface air temperature model. LSTMs are a variation of recurrent memory networks that are able to learn long-term relationships and patterns in data with the use of dedicated recurrent gates. Since the data is provided to us in the form of spatiotemporal grid sequences, we use a convolutional LSTM layer in order to model the temporal and spatial relations. The model attempts to predict the next value of the surface air temperature for an area based on the historical grids given to it.

Keywords Surface air temperature · Prediction · Long short-term memory networks · Recurrent neural networks

1 Introduction

Weather forecasting systems can be classified into two categories:-numerical weather prediction (NWP) models or machine learning models. The numerical approach is based on predicting long-term forecasts by using various meteorological equations. However these methods fall short for predicting long term data since the inaccuracies add up over time. These problems can be solved via a machine learning approach. In

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essence, predicting surface air temperature is a sequence forecasting problem with the temporal sequence of past observations as the input and the sequence of a fixed number of predictions as the output. Even though it may seem trivial from a deep learning standpoint, such problems suffer from high dimensionality and a variety of hidden factors influencing the outcome.

Recent advances in deep learning, such as recurrent networks and Long ShortTerm Memory (LSTM) models, prove to be a suitable fit for such a problem. In this paper, we extend the Convolutional LSTM or ConvLSTM to a global scale to predict the surface air temperature for various base stations for a temporal resolution of 4 hours to a few days. By considering the global nature of the data as well as the knowledge of recurring temporal patterns we aim to create a model that can accurately predict the Surface air temperature globally and allow us to observe various trends caused by climate change and other human activities.

2 Related Work

Existing surface air temperature models try to approach the problem by using numerical weather predictions (NWPs) based on climatological equations. The Global Forecast System (GFS) by NOAA/NCEP [1] is a good example of such models. GFS provides deterministic and probabilistic weather predictions for up to 16 days. However for such NWP models, small errors in the predicition sequence add up over time and cause incorrect predictions.

As an effort to model these equations, machine learning and data mining methods have been proposed as a replacement. Soft computing serves to work for small datasets and can handle uncertainty to a varying degree [2]. Bayesian methods have also been used to model rainfall prediction to a reasonable accuracy [3]. However, these are heavily dependent on the availability of large datasets.

Other learning methods that have been used are linear regression, Support Vector Machines, and Neural Networks [4]. Deep learning especially has shown great promise as it allows efficient approximation of non-linear functions. Preliminary results have shown promising results for weather prediction. The most interesting approaches have implemented Recurrent Neural Networks to model the temporal features of the data [5]. However, Recurrent Neural Networks suffer from the exploding or vanishing gradient problem. Hence, it cannot model the long-term temporal patterns shown in weather observations.

In [6], LSTMs are used to predict the sea surface temperature around the coastal seas of China and show promising results in the application of LSTMs in weather prediction. LSTMs are a special case of recurrent neural networks created to combat the problem of a vanishing or exploding gradient by implementing gate mechanisms. However, using a fully connected LSTM (FC-LSTM) cannot scale to a fully global model due to the sheer size of such a model. An FC-LSTM also does not consider the spatial aspect of the observations. Hence, a convolutional LSTM structure can

be used instead to model the spatial as well as temporal relations in the data where it outperforms state of the art algorithms [7].

3 Methodology

3.1 Problem Statement

The goal of surface air temperature prediction is to accurately determine a fixed length of surface air temperature observations at a certain base station. In real applications, each base station measures the temperature approximately 2 m above the ground in a fixed time interval usually 4–6 h. The daily mean is also calculated as the mean of 24 hourly readings in a thermograph. This data is consolidated into a global grid consisting of the latitudes and longitudes of each base station.

To visualize this problem, consider observing a dynamic system represented by a $X \times Y$ grid correlating to X longitudes and Y latitudes. Inside each cell, there is a temperature observation T which corresponds to the surface air temperature at that location at that point of time. Thus, the data can be considered to be a collection of snapshots of this systems at intervals 1, 2, … n. Hence any observation can be represented as $\chi \in R^{X \times Y \times T}$ where R is the domain of the observed temperatures in the temporal sequence. The task given to the network is to predict the next N observations in the sequence.

3.2 Long Short-Term Memory Networks

To predict and model the temporal and spatial relations in data, we adopt LSTMs to do the job. This subsection introduces convolutional LSTMs. We choose to use convolutional LSTMs [7] where all inputs, cell outputs, hidden states and gates of the ConvLSTM are 3D tensors consisting of time, and the x and y axis. The ConvLSTM calculates the output value of a cell by considering the inputs as well as the memory vectors of its local neighbours. This is achieved by using a convolutional operator in the state-to-state and input-to-state transitions of the LSTM cells. The corresponding equations for a ConvLSTM are shown in Eq. (1) below.

$$\begin{aligned} i_t &= \sigma\left(W^i * H + b^i\right) \\ f_t &= \sigma\left(W^f * H + b^f\right) \\ c_t &= f_t \circ c_{t-1} + i_t \circ \tanh(W^c * H + b^c) \\ o_t &= \sigma\left(W^o * H + b^o\right) \\ h^{'} &= o_t \circ \tanh(c_t) \end{aligned} \tag{1}$$

where $*$ is the convolutional operator and $\circ$ is the Hadamard product.

3.3 Model Architecture

Our prediction target consists of a grid of latitudes and longitudes of the entire world along with a temperature observation for each cell in the grid. Hence, it is of the same shape as the input. As both the input and output cover the entire globe making it a closed system, it prevents us from using any "padding" in the convolutional layer since there is no external system that can be considered to take part. We have used a 1×1 convolutional LSTM layer to generate the prediction. The LSTM layer shifts a 1×1 grid over every time instance provided by the dataset and then transforms the input value in that cell into an output value along with the hidden memory state. Considering our dataset which consists of 2D snapshots with each cell value representing the temperature, the model can be considered as an LSTM that takes in 2D snapshots as inputs and produces the next 2D snapshot in the series effectively making it an LSTM that works on a 3D basis.

4 Experimental Results

We use the NCEP's NCAR dataset provided for surface air temperature [8]. The data contains values from 1948 to the present day with a resolution of 4 h consisting of grids of size 73 by 144 with each cell having a numeric value in Kelvin. Hence, each observation can be considered as a snapshot of the earth with each pixel representing the surface air temperature of that substation. Since Surface air temperature prediction is a sequence prediction problem, we need to determine the length of the observation. The more observations we consider, the better the accuracy of the model will be while increasing the computation. One way to increase the number of observations is to increase the batch size per epoch. This allows the model to be trained on a larger section of the data but increases the memory usage of the model. We must also ensure that the model should be able to generalize for a large group of temperature readings. Hence, we split the data into training and evaluation data to ensure that there is no overfitting of the model. Apart from this, there are still a lot of hyperparameters in our model that need to be decided. In our model we adopt the Adagrad optimization method to allow our learning rate to adjust to the features, increasing for rare ones and decreasing for common ones.

4.1 Results

The batch size is defined as the number of observations considered in each iteration of the model. Each model is trained in "epochs" where a certain section of the dataset whose size is decided by the batch size after which the model learns according to the errors it made. A larger batch size does allow the model to access a larger section of

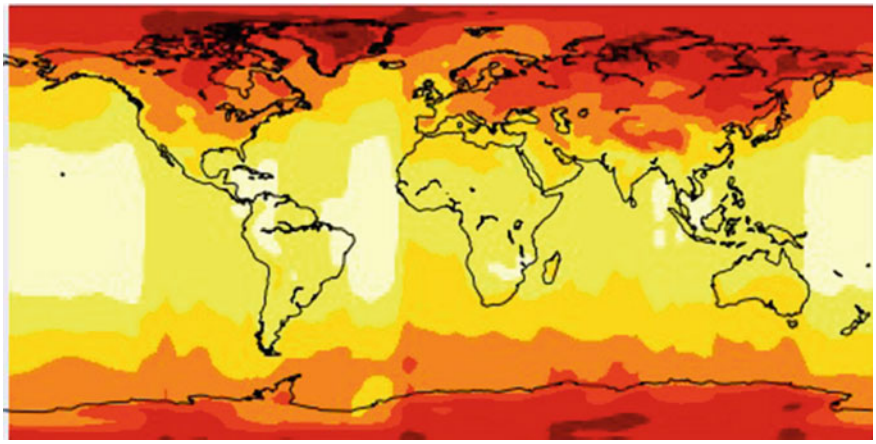

Fig. 1 The actual observed values

the database but at the same time causes a larger memory size on the model. Hence, a tradeoff value must be chosen between the accuracy of the model and the memory size of the model. Mean absolute error (MAE) measures the average magnitude of forecast error. It is a standard metric used to evaluate weather prediction models. A lower MAE value indicates a better model. We calculate the error as the difference between the normalized values of the forecast and observation. It is given by

$$MAE = \frac{1}{N} \sum_{i=1}^{N} \| F_i - O_i \| \tag{2}$$

where F_i is the actual value and O_i is the predicted value at i. We can compare the output given by our model prediction and the observed value via a heatmap in Figs. (1) and (2).

5 Conclusion

In this paper, we approach the problem of a global surface air temperature model from a machine learning perspective and propose a Convolutional LSTM based network to model the spatiotemporal relationships in the data to predict the future sequences. The proposed network utilizes a convolutional LSTM layer to learn a sequence of climatological snapshots of surface air temperatures and then attempts to predict the next few observations in the data. We evaluate the proposed model to find the appropriate parameters as well as verify the result against observed data.

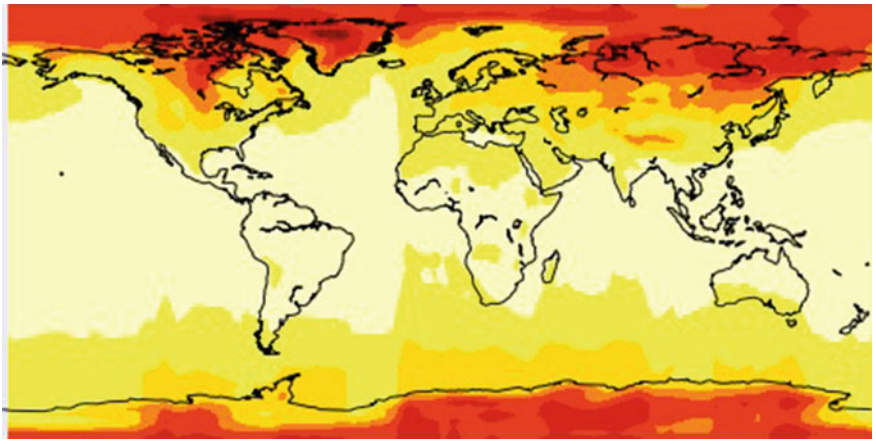

Fig. 2 The predicted values

Furthermore, the proposed network architecture is independent of the dataset given in this paper. The same architecture can be used to model a variety of climatological applications on a global scale. If the right dataset is provided it can be used to predict precipitation, humidity, air temperature and pressure.

References

1. NOAA/NCEP (2017) Global Forecast System (GFS) Atmospheric Model (2017)
2. Sharma A, Manoria M (2006) A weather forecasting system using concept of soft computing: A new approach. In: 2006 International conference on advanced computer communications, pp 353–356. https://doi.org/10.1109/ADCOM.2006.4289915
3. Nikam VB, Meshram B (2013) Modeling rainfall prediction using data mining method: a Bayesian approach. In: 2013 2013 fifth international conference on computational intelligence, modelling and simulation, pp 132–136. https://doi.org/10.1109/CIMSim.2013.29, http://ieeexplore.ieee.org/document/6663175/
4. Anandharajan T, Hariharan GA, Vignajeth KK, Jijendiran R, (2016) Weather monitoring using artificial intelligence. In: 2016 2nd international conference on computational intelligence and networks (CINE), pp 106–11. https://doi.org/10.1109/CINE.2016.26, http://ieeexplore.ieee.org/document/7556813/
5. Salman AG, Kanigoro B, Heryadi Y (2015) Weather forecasting using deep learning techniques. In: 2015 international conference on advanced computer science and information systems (ICACSIS), pp 281–285. https://doi.org/10.1109/ICACSIS.2015.7415154, http://ieeexplore.ieee.org/document/7415154/
6. Zhang Q, Wang H, Dong J, Zhong G, Sun X (2017) Prediction of sea surface temperature using long short-term memory. IEEE Geosci Remote Sens Lett 14(10):1745–1749. https://doi.org/10.1109/LGRS.2017.2733548
7. You J, Li X, Low M, Lobell D, Ermon S (2017) Deep Gaussian process for crop yield prediction based on remote sensing data. Association for the advancement of artificial intelligence, pp 4559–4565
8. Kalnay AE (1996) The NCEP/NCAR 40-year reanalysis project. Bull Amer Meteor Soc

Weather Data Analytics Using Hadoop with Map-Reduce

Priyanka Dinesh More, Sunita Nandgave and Megha Kadam

Abstract Big data describes a huge quantity of data which requires new technologies to make potential to get value from it by analysis and capturing method. In many aspects of life the weather is very critical for persons. For accurate analysis of weather, collecting, storing and processing a huge volume of weather data is needed. In agriculture sector, tourism sector and government agencies the weather forecasting has a lot of importance. A few knowledge of weather which is very helpful for human to prepare themselves for any unwanted condition of climate. In the analysis of weather conditions different some weather parameters plays an vital role such parameters are like temperature, pressure, wind speed and humidity etc. Big Data analyze the huge data-sets also it processes a large amount of data and process that data accurately. Weather analytics is the technology which shows the behavior of the environment for a particular given area. This paper presents the significant amount of data which loaded into Hadoop Distributed File System (HDFS), and it utilizes mapper and reducer function to process that data and final output will get in the form of average temperature of a particular city or location.

Keywords Big data · Hadoop · Map-Reduce · HDFS · Temperature · Weather data

1 Introduction

Analyzing a huge data sets is the method of big data which comprises a classes of data types. The big data maintain a significant amount of data and process them. It

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is conventional data analysis which can handle the structured data, but not unstructured data. In big data, it can process both unstructured and structured data. Big data contains various datasets which are in different dimensions having the ability to generally employed on software tools which manages, captures, processes the data accurately. Big data size varies from terabytes to several petabytes of data. Weather prognostication is the employment of technology to predict the behavior of the environment for a given area. It is essential for farmers, disasters, business agriculturist, etc. weather prediction is one of the most exciting and fascinating domain and plays a very important role in aerography. There are numerous conditions in an excellent implementation of weather forecasting for example in data mining methods, it cannot forecast weather in short-term efficiently [1].

Currently, the most popular Big Data handling technique is Map-Reduce. Map-Reduce is a technique which executes parallel and distributed algorithm across large data using number of clusters. The weather temperature will be analyzed very effectively and early with technique Hadoop Map-Reduce. When multi-cluster distributed network is set up then the data processing speed will increase. Therefore, there is a need of new platform for handling the big data. Using big data it helps to weather analysis. Thus, Hadoop is a much better for it, which contains clustered processing with high speed to analyze a huge datasets efficiently. We proposed in this paper, a system for analysis of weather average temperature of a particular city or area based on algorithm of Map-Reduce and Spatial CUSUM based algorithm is applied to find the changes in the climate which produces the output efficiently [2].

2 Hadoop

Hadoop is currently used model for processing of BigData. It is an open source software framework which supports large groups of data that are processes in distributed manner using programming models. Apache Hadoop has two components that are HDFS and MapReduce. HDFS is a Hadoop Distributed File System which manages large datasets. Also MapReduce is a programming model which processes a large amount of unstructured data in parallel way. It divides tasks into number of groups [3].

A. **Hadoop Distributed File System (HDFS)**

HDFS consists in master and slave architecture. A single NameNode is a component of HDFS cluster i.e. a master which handles file system. Also there are various DataNodes which are acts like slaves (Fig. 1) [4].

B. **Map-Reduce**

Map-Reduce is a programming software framework which is a currently used component of a Hadoop. Map-Reduce consists of map and reduce phases which divides the large chunks of data into a number of groups. It also processes a large datasets in

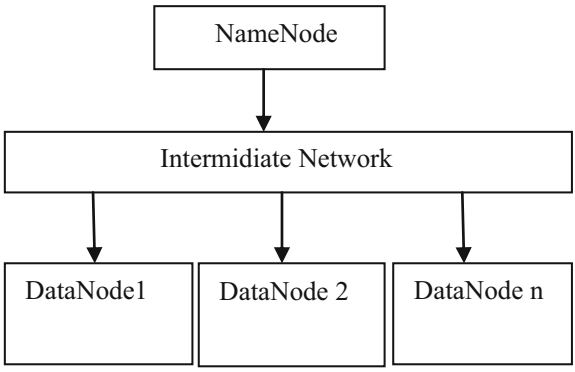

Fig. 1 HDFS architecture

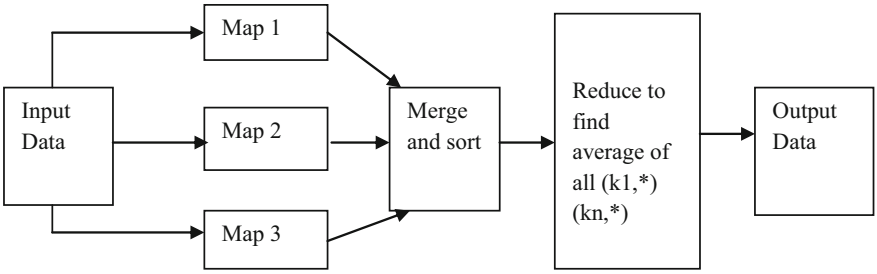

Fig. 2 Map-Reduce model

parallel using number of computers. Map-Reduce application will be work in three steps, that are map, shuffle, and reduce step. The mapper's job is to process the input data in map stage. In Hadoop file system the input data is in sort of file or directory and is collected. The reducer will take the output from the mapper as a input and merge that data (key-value pairs)with a small set of tuples (Fig. 2) [5].

3 Review of Literature

In [6] the authors proposed a system for Weather forecasting using a technique of data mining. Here, a method determination of the occurrence of rare patterns in weather is to be proposed. Different data mining steps like data collection, pre-processing, data cleaning, transformation and smoothing are applied. To proposed a system, various techniques of mining like Classification, Prediction, K-means clustering and Outlier analysis were used for weather data.

In [7] authors worked on the Building a platform using Hadoop for weather data analysis. For extraction and analysis, temperature and yearly precipitation were chosen as a parameter. The performance comparison using PIG and HIVE techniques

of a weather data is shown. The performance of HIVE is to be better in results than PIG. The proposed system, which has capability to scale better tool in Hadoop clusters.

In [8] authors developed a system for prediction of maximum and minimum temperature of particular area of particular year. Basic details of YARN and Map-Reduce was discussed for the implementation of their techniques.

Gayathri [9] worked on the survey of weather data by using data mining methods. Various kinds of forecasting that is Now casting, Short range, Medium range and Long range forecasting were discussed. weather parameters also a data mining methods were described along with the classification algorithm like Bayesian classification, Back propagation to forecast weather.

Ding and Yanhua [10], worked on detecting and analyzing urban regions with high impact of weather change on transport using the weather traffic correlation detection method. This proposed work fill up the gap in the analysis of the impact of weather to traffic from some locations to all road networks overall city.

Jayanthi [11] worked on Weather data analysis with the help of Spark—An In memory Computing framework. In the proposed work, a spark instance were created and i-python notebook is also created. After that weather data set is collected from weather sites and loaded into notebook. By creating data into number of partitions, the spark streaming is done also by distributed the partitions into a clusters and the highest average precipitation and average temperature values are executed for highest ten weather stations and displayed. By increasing the volume of data and iterations, the work can be extended.

Navadia [12] developed a Weather Prediction a Novel technique or a method for measuring and analyzing weather data. This work aims to predict the chances of rainfall by using hadoop tools. Here the proposed system used as a tool and by using Naive Bayes Algorithm which collects data from large volume of data as input and predicts the future rainfall.

4 Motivation of Work

Existing System processes only structured data, but not unstructured data. Also in existing system, processing of a huge data is a time consuming process Instead, there is no such system which can handle or process both structured and unstructured data also a semistructured data and faster processing of data. So it is important to add something more to existing mechanism. So that it motivates us to design a system which consists of Weather data Analytics using Hadoop with Map-Reduce [13].

5 Existing System

In the traditional system, the processing of millions of records is time consuming process. The existing climate change detection approaches, which are Segment neigh-

borhood, Pruned Exact Linear Time (PELT), Binary Segmentation method having results that is accuracy less than proposed method. The proposed system performance is well than other methods. The existing methods are discuss as follows [14]:

(A) **PELT Algorithm**—Pruned Exact Linear Time technique is applied to detect various changes in the large datasets. To minimize function of cost of a possible numbers and change points locations, the proposed method is used. It utilize a new method to determine the minimum of such cost function. Therefore, result gathered from PELT method has optimal number also a location of change points [15].

(B) **Binary Segmentation Algorithm**—This approach is used to analyze the difference in the many groups which are homogeneous in nature. The existing approach uses multiple comparison techniques to analyze different groups. A likeli-hood ratio test is proposed to find the variance among the groups.

(C) **Segment Neighborhoods**—To evaluate parameters of the model which are describe each segment neighborhood boundries, the segment neighborhood method is used. In the least squares and maximum likelihood estimation this method is used.

6 System Overview

In the analysis of diseases which are occur due to climate change, in that the Big Data plays a significant role. For such predictions, efficient data storage platforms and the effective change detection algorithms are required to determine the changes in the climate. In this paper, A scalable data processing framework with a novel change detection algorithm is used. The large volume of climate data is collected on Hadoop Distributed File System (HDFS) and Map-Reduce algorithm is proposed to calculate the average of climate parameters. In this paper, the Spatial CUSUM based climate change detection algorithm is proposed and it is used to monitor the changes in the climate of a particular area [16].

The proposed climate change detection method is shown in above Fig. 3. Hadoop with map-reduce the climatic weather data will be reduce by using reduce task. Here the map-reduce algorithm is applied to reduce the performance time that is the speed of processing a large volume of climate data is very fast. According to day, the weather climate data will be reduce in seasonal climate data by using map-redcue framework [17].

A. **Advantages**

- Hadoop is an open source software framework that stores data and can run applications on clusters of commodity hardware.
- Hadoop has the ability to handle and processes a huge set of structured and unstructured and semistructured data than the traditional data warehouse enterprise.

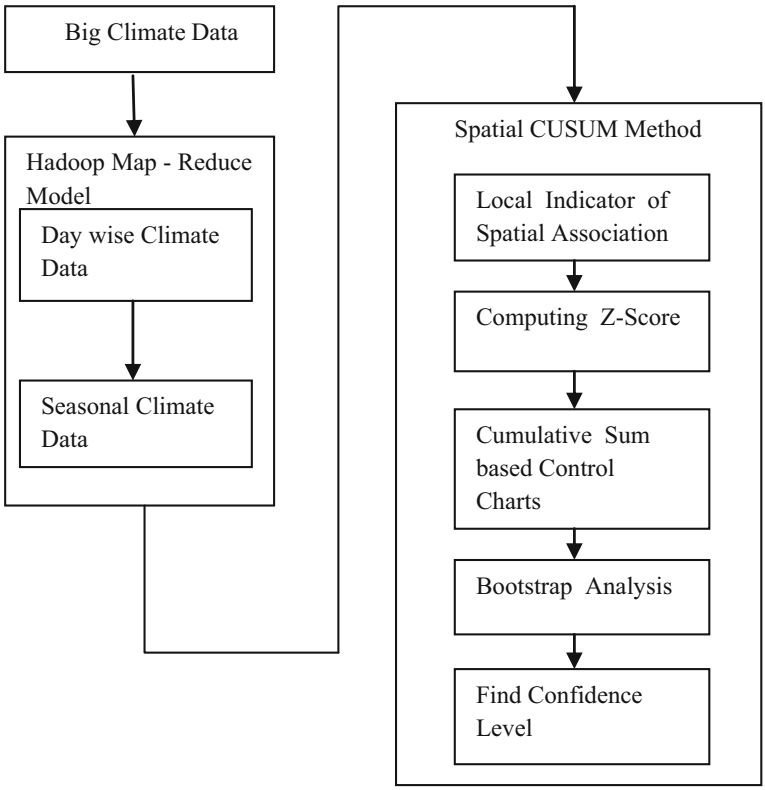

Fig. 3 System architecture

- Map-Reduce is a programming model helps to process huge data sets in distributed and parallel way.
- Proposed System provides mechanism for faster processing of large amount of data.

7 Experimental Results

In the proposed system, the method which is Spatial CUSUM based climate change detection algorithm is compared with existing CUSUM with Bootstrap method, PELT, Binary Segmentation and Segment Neighborhood methods. The performance of change detection techniques is to be analyzed with precision value. So, accuracy is calculated by following (Table 1) [17].

$$\text{Accuracy} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

Table 1 Results of various climate change detection methods

Climate parameters	Year	PELT	Bin-Seg	Seg-Neigh	CUSUM with BootStrap
Max Temp	Winter 2015	Yes	Yes	Yes	Yes
	Summer 2014	Yes	Yes	Yes	Yes
Min Temp	Winter 2013	Yes	Yes	No	Yes
	Summer 2013	Yes	Yes	Yes	Yes
Rainfall	Summer 2012	Yes	Yes	Yes	Yes
	Summer 2014	Yes	Yes	Yes	Yes

This results shows that Spatial CUSUM based climate change detection algorithm is performing well than all other methods. The method PELT, Binary Segmentation, Segment Neighborhood and CUSUM with Bootstrap finds changes in seasonal climate with accuracy 74.07, 77.77, 81.48, and 74.07 respectively which may be varies according to day.

8 Conclusion

Hadoop with Map-Reduce, the weather data can be analyzed effectively. Increasing amount of daily data is not possible to handle, process and analyze on single system thus there is a need of multiple node HDFS system. The distributed network which gives faster data processing. MapReduce is a framework which is parallel and distributed system across large dataset. This technology which will be applied to find huge datasets has the potential for significant enhancement to analyze weather.

References

1. Saranya S, Meyyappan T (2018) Proposing a new methodology for weather forecasting by using big data analytics. IEEE Int J Sci Technol 4(8):249–254
2. Jain H, Jain R (2017) Big data in weather forecasting: applications and challenges. In: International conference on big data analytics and computational Intelligence (ICBDACI)
3. Doreswamy, Gad I (2016) Big data techniques: Hadoop and Map-Reduce for weather forecasting. Int J Latest Trends Eng Technol 194–199 (Issue SACAIM 2016)
4. Chouksey P, Chauhan AB (2017) A review of weather data analytics using big data. Int J Adv Res Comput Commun Eng 6(1):130–152 (ISO 3297:2007 Certified)
5. Riyaz PA, Varghese SM (2015) Leveraging map reduce with Hadoop for weather data analytics. IOSR J Comput Engg (IOSR-JCE) 17(3):06–12, Ver. II
6. Shingne SV (2017) Weather forecasting using adaptive technique in data mining. Int J Recent Innov Trends Comput Commun (IJRITCC) 091–095
7. Dagade V, Lagali M, Avadhani S, Kalekar P (2015) Big data weather analytics using Hadoop. Int J Emerging Technol Comput Sci Electr 14(2)

8. Reddy B, Patil BA (2016) Weather prediction on big data using Hadoop Map Reduce technique. IJARCCE. ISSN: 2278-1021 5(6): 643–647
9. Gayathri A (2016) A survey on weather forecasting by using data mining. IJARCCE 5(2):298–300
10. Ye Ding, Yanhua Li (2016) Detecting and analyzing urban regions with high impact of weather change on transport. IEEE Trans Big Data
11. Jayanthi D, Sumathi G (2017) Weather data analysis using Spark—An In-memory computing framework. In: International conference on innovations in power and advanced computing technologies, IEEE-2017
12. Navadia S (2017) Weather prediction: a novel approach for measuring and analyzing weather data. IEEE International conference on I-SMAC
13. Ismail KA, Majid MA (2016) Big data prediction framework for weather temperature based on MapReduce algorithm. In: IEEE conference on open systems (ICOS) 7(1):244–304
14. Pandey AK (2017) Hadoop based weather prediction model for classification of weather data. IEEE-2017
15. Sreehari E, Velmurugan J, M. Venkatesan (2016) A survey paper on climate changes prediction using data mining. IJARCCE. ISSN: 2278-1021 5(2):294296
16. Anusha K, Rani U (2017) Big data techniques for efficient storage and processing of weather data. Int J Res Appl Sci Eng Technol (IJRASET) 5(VII)
17. Manogaran G (2017) Daphne Lopez Spatial Cumulative Sum algorithm with Big Data Analytics for climate change detection. Comput Electr Eng, Elsevier ltd 1–15

Recapitulating the Violence Detection Systems

Snehil G. Jaiswal and Sharad W. Mohod

Abstract Human behavior is the response to the status of internal and external stimuli. It comes out in the form physical actions and observable emotions which may be associated with individual or group of person. Significant contents from human behavior are pulled out for video surveillance, feature extraction and for creating human computer interface. The present research work explores the video surveillance for realization of violence detection system. A novel framework is introduced through which a raw video stream is processed; subsequently the framework decodes correct semantics relating to the violence detection from the received raw image. In this paper, exhaustive literature survey is carried out which discloses up to date technology in the field of video surveillance.

Keywords Video surveillance · Video indexing · Biometrics · Telehealth and Human-Computer interaction

1 Introduction

Video surveillance in broad sense is monitoring of human behavior, activities and other significant changing information coming out in response to internal and external stimuli. Surveillance broadly achieved using closed circuit cameras, interception of electronic signals or through other possible means. Surveillance proficiently used for intelligence gathering, prevention of crime, protection of process and many more. With the recent development in the field of electronics and fabrication technology, now a days IOTs are proved to be a preferable tool for gathering information.

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The present research work explores one of the applications of video surveillance for violence detection. Through the proposed system, the incoming video stream from connected close circuit camera or any offline video is processed. Per frame features and contents indicating violence is extracted for further processing. For identification of the violence, primarily human gestures and body motion which can be extended to emotion recognition from the face and movement of hand is used. Processing of mathematical algorithm on the data set extracted trough feature extraction can further be used for gait, proxemics and computer interface.

In the present paper, exhaustive literature survey is carried out which indicates the depth of the research work carried out so far on the basic of video surveillance for violence detection. In the subsequent section, the literature survey is carried out in two steps which explore the implementation and use of video surveillance and violence detection.

2 Reviewing Video Surveillance

A digital video surveillance system is a system which is capable of performing video recording, which as per application requirement, capable to compress, locally store and sent over the available communication channel. The proposed system in [1] disclosed an algorithmic approach which is applicable to the offline compress video signals for signal processing. Authors have suggested performing signal processing before encoding or adaptively changing the parameters of the encoding process to assure robust signal quality.

The approach utilized in [2] uncovers a novel visual analytics system which gives various views of information relating to a moving object in a video. It is video visual analytics system which can be helpful in searching video stream and identifying an object in a video stream. Using the proposed algorithmic approach, it is possible to search an event in a video as quickly at 5× fast forward speed instead of waiting for the event to occur [2].

A standard compliant video encoding scheme assuring to suppression of redundant temporal fluctuations in stable background areas is derived in [3]. New decision properties are set for intra and inner frames to reduce the share of temporal fluctuations, maintaining rate distortion performance. Authors are claiming to have precise object detection in compressed surveillance video stream—significant for surveillance, which may otherwise difficult to attain due to poor video quality due to lossy compression [3].

Effective use of action recognition and video summarization technique for identification of critical activity video stream from large surveillance video database is achieved via system developed in [4]. Through the proposed approach, new methodology for generation of coherent video summary which is based on clustering of identical activities is demonstrated. Authors calculated the appearance distance using Formula (1). Subsequent Fig. 1 depicts different stages in the process [4].

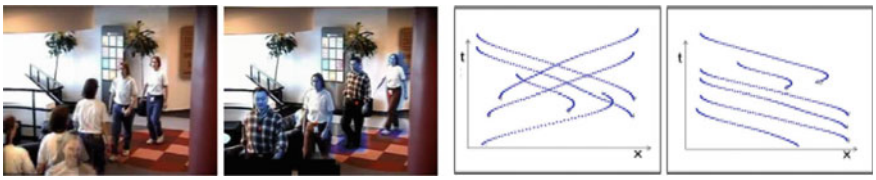

Fig. 1 Summary generated from one cluster and corresponding motion paths of objects

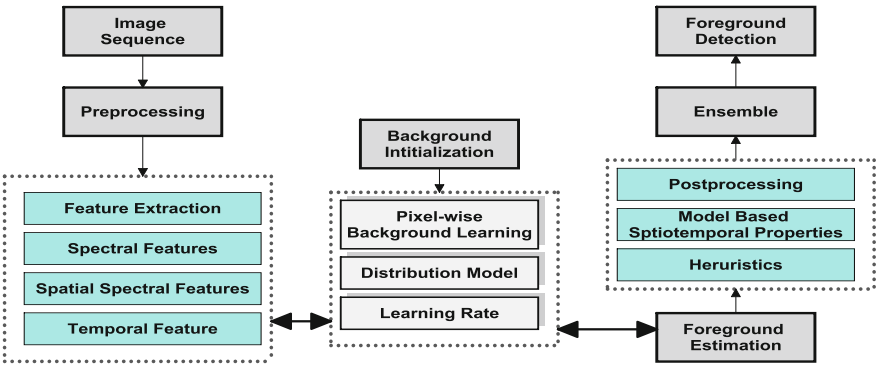

Fig. 2 Framework of pixel-wise background learning

$$Sdij = \frac{1}{2N}\left(\sum_k \left|S_k^i - \tilde{S}_k^j\right| + \sum_k \left|S_k^j - \tilde{S}_k^i\right|\right) \tag{1}$$

A systematic algorithm which learns the input sequence by multilayered background model to overcome the limitations of the pixel wise recursive filter based learning algorithm caused by multiple foreground in public area surveillance is executed in [5]. In the proposed algorithm, regions are clustered using spatiotemporal structured with spectral similarity by comparing inputs and layers. Authors further uses the pixel-wise learning algorithm based on the following Eq. (2). Figure 2 demonstrates the framework of pixel-wise background learning [5].

$$\theta(t) = (1 - \eta(t)) \cdot \theta(t-1) + \eta(t) \cdot \nabla(\mathrm{x(t)}; \theta(t-1)) \tag{2}$$

Limin Liu et al. came up with novel video encoding framework for compression and transmission of surveillance videos addressing to complexity and efficiency. Author introduces 'light' encoder characteristics which makes proposed algorithm prominent for surveillance video compression. The compression is based on Wyner Ziv coding principles [6].

Video summarization based smart video surveillance system is introduced in [7] that characterizes large content of the video data to assist in scrutinizing silent events in the surveillance video. The said process optimizes the gap between large amount

of video data generated and the amount of video content to be manually inspected. Subsequently, to optimize the search delay, authors proposed to convert content based video retrieval into content based image retrieval [7].

Double background based coding scheme for surveillance system to optimize the number of bits required to optimize high quality background image is proposed in [8]. In this technique hierarchical background image construction algorithm is introduced in which background image is dynamically updated by blocks of background regions. Subsequently, prediction residual between original background and reconstructed background is encoded into data stream, effectively reducing cost per bit.

A means for data security in surveillance cameras using novel coprime blurred pair model is introduced in [9]. In this approach, spatial encryption scheme is preferred instead of completely encrypting the video stream. To implement this, original video stream is blurred using separate kernels into public stream and private stream [9].

3 Summarizing Violence Detection

Violence detection method for surveillance video system is proposed in [10]. Authors structured the algorithm in which the object region of interest is extracted from the frame and filtering is performed using morphology filter to suppress the noise signal. Next, the total global approach is estimated with total variation. Finally, violence is detected in surveillance video using Motion Co-occurrence Feature [10].

Dong Wang et al. reveal an approach for violence detection in still images. Authors used Bag of Words image classification tool to bifurcate violence and non violence images from the input database of 2000 sample images. Four different feature representations are tested on BoW model to come up with the robust architecture. Subsequent Fig. 3 indicates the pipeline of bag of words model [11].

Pedestrian violence detection system based on optical flow energy characteristics is revealed in [12]. The proposed system claimed to be overcoming the shortcomings of traditional behavior detection system which was based on analyzing structure and characteristics of human being. In the novel algorithm the corner joints are detected using Shi-Tomasi corner detection algorithm followed by calculating optical

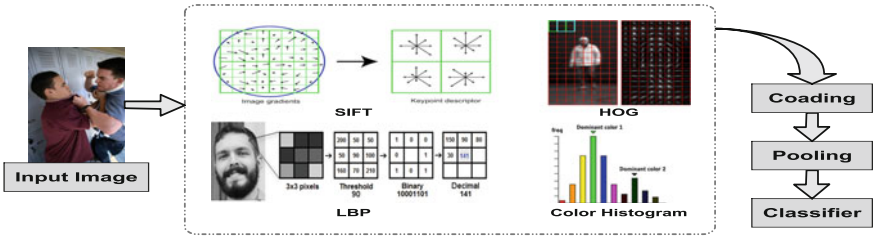

Fig. 3 Framework of pixel-wise background learning

flow parameters using Lucas-Kanade pyramid optical flow algorithm and finally the violence parameters are detected using histogram of newly computed optical flow parameters [12].

A novel algorithm for violence detection which is based on spatio temporal features and optical flow is implemented in [13]. The proposed algorithm uses physical contact detection algorithm which extracts the frames having violence activity. System further uses 3D spatio temporal interest point detector and optical flow meter to get optimized performance [13]. Tahira Khalil et al. provides a technique to detect violent content from the cartoon videos. In this technique different low level visual features are evaluated for violence detection in cartoon videos using dataset having contents of violent and non violent frames. These features are used for violence detection and objectionable element detection [14]. Piyush Vashistha et al. discovers violence detection system to detect violence and generate an alert signal. The proposed system is based on object tracking and behavior understanding for detecting violence. Feature is extracted based on speed, direction, centroid and dimensions. These features are used for tracking an object in video frame [15].

Based on Lagrangian theory, a technique for automated detection of violent contents in the video stream is discovered in [16]. It uses a novel feature of lagrangian direction field based on spatio temporal model and uses appearance, background compensation and long term motion information. Additionally bag of word procedure is employed ensure spatial and temporal scales [16].

The system in [17] unwraps an idea of Motion Weber Local Descriptor (WLD) through which it is possible to come up with an algorithm for effective violence detection. In this approach first, considering drawbacks of the well-known WLD, authors have proposed improved WLD, that is IWLD, and then proposed to extend the IWLD by adding a temporal component to the appearance descriptor to obtain MoIWLD. MoIWLD implicitly captures local motion information together low-level image appearance information. In the next phase, a modified sparse model has been proposed to learn a dictionary for classification. Based on this structure a classification scheme is proposed which is having learned dictionary [17].

Liang Ye et al. proposed automatic physical bullying detection system implemented using movement sensors. The proposed system is implemented using extraction of information from acceleration, gyro data and an instance based classifier. To check the robustness of the proposed system, eight kids with activities having three of them bullying and five performing normal acts are considered. Authors have claimed that by using the algorithm it is possible to achieve around 80% of accuracy [18].

4 Proposed Violence Detection System

In the proposed work, initially, surveillance video data is acquired using various cameras. The quality of the video collected through cameras suffers different noises, to have better results, preprocessing operations are performed on raw input video

sequence, which enhances the overall quality of the video signals further this helps to extract and analyze precise and maximum information from the data stream. Subsequently, essential discriminative information is extracted using feature extraction technique and the outcome is fed to the classifier unit. Classifier unit, bifurcate the essential information contents indicating violence. By observing normal activity sequences, minimal threshold can be determined to distinguish the violent behavior sequences from the normal activities.

5 Conclusion

In this paper, processing of video streams receiving through different surveillance systems by different novel techniques by distinct authors and researchers are summarized. The discussion is extended by disclosing violence detection schemes and system implemented by different authors are studied. Subsequently, the proposed system is discussed. The proposed system is configured around acquisition, preprocessing, feature extraction and classification. This paper is unable to describe more details of the individual methods and their comparison, which is planned to be dealt with in more details in next survey papers.

References

1. Aslam S, Babick A (2009) Robust surveillance on compressed video: uniform performance from high to low bitrates. In: 6th IEEE conference on advanced video and signal based surveillance. https://doi.org/10.1109/AVSS.2009.38
2. Meghdadi AH (2013) Interactive exploration of surveillance video through action shot summarization and trajectory visualization. IEEE Trans Vis Comput Graph 19(12)
3. Kong L, Dai R (2017) Object detection based video compression for wireless surveillance system. IEEE MultiMedia 24(2)
4. Pritch Y, Ratovitch S, Hendel A, Peleg S (2009) Clustered synopsis of surveillance video. In: Sixth IEEE international conference on advanced video and signal based surveillance. https://doi.org/10.1109/avss.2009.53
5. Park D, Byun H (2009) Object-wise multilayer background ordering for public area surveillance. In: Sixth IEEE international conference on advanced video and signal based surveillance. https://doi.org/10.1109/avss.2009.33
6. Liu L, Li Z, Delp EJ (2009) Efficient and low-complexity surveillance video compression using backward-channel aware Wyner–Ziv video coding. In: IEEE transactions on circuits and systems for video technology, vol 19, issue 4
7. Thomas SS, Gupta S, Subramanian V (2017) Smart surveillance based on video summerization. In: IEEE region 10 symposium (TENSYMP). https://doi.org/10.1109/TENCONSpring.2017.8070003
8. Li H, Ding W, Shi Y, Yin W (2018) A double background based coding scheme for surveillance videos. In: Data compression conference. https://doi.org/10.1109/dcc.2018.00073
9. Thorpe X, Li F, Li Z, Yu Z, Saunders D, Yu J (2013) A Coprime Blur scheme for data security in video surveillance. In: IEEE transactions on pattern analysis and machine intelligence, vol 35, issue 12

10. Ha J, Park J, Paik J (2018) Violence detection for video surveillance system using irregular motion information. In: International conference on electronics, information and communication. https://doi.org/10.23919/elinfocom.2018.8330609
11. Wang D, Zhang Z, Wang W, Wang L, Tan T (2012) Baseline results for violence detection in still images. In: Ninth international conference on advanced video and signal based surveillance. https://doi.org/10.1109/avss.2012.16
12. Guo Z, Wu F, Cai C (2017) Pedestrian violence detection system based on optical flow energy characteristics. In: 4th international conference on system and informatic (ICSAI). https://doi.org/10.1109/icsai.2017.8248479
13. Lyu Y, Yang Y (2015) Violence detection algorithm based on local spatio–temporal features and optical flow. In: International conference on industrial informatics-computing technology, intelligent technology. https://doi.org/10.1109/iciicii.2015.157
14. Khalil T, Bangesh JI, Adnan A (2016) Low level vision temporal features for violence detection in cartoon video. In: 6th internal conference on innovative computing technology. https://doi.org/10.1109/intech2016.784511
15. Vashisth P, Bhatnagar C, Khan MA (2018) An architecture to identify violence in video surveillance system using ViF and LBP. In: Fourth international conference on recent advances in information technology (RAIT). https://doi.org/10.1109/rait.2018.8389027
16. Senst T, Sikora T (2017) Crowd violence detection using global motion compensated lagrangian features and scale sensitive video level representation. In: IEEE transactions on information forensics and security, vol 12, issue 12
17. Zhang T, Jia W, He X, Yang J (2017) Discriminative dictionary learning with motion weber local descriptor for violence detection. In: IEEE transactions on circuits and systems for video technology, vol 27, issue 3
18. Ye L, Ferdinando H, Alasaarela E (2015) An instance-based physical violence detection algorithm for school bullying prevention. In: International wireless communication and mobile computing conference (IWCMC). https://doi.org/10.1109/iwcmc.2015.7289284

Spartan-6 FPGA Implementation of AES Algorithm

Anil Gopal Sawant, Vilas N. Nitnaware and Anupama A. Deshpande

Abstract Due to advancement of Information and Technology, Artificial Intelligence and Internet of things, Space Technology and E-Commerce world that changes the life of human being as because of that it is possible to interact with people by electronic means to everybody, every time, everywhere. It is possible to have seamless fabric of electronic connection with the help of electronic devices. The data which transmitted ceaselessly through electronic media which provides more assurance on cryptography to secure the data and communication. AES algorithm design is Implemented in VHDL and Simulated and Synthesized in Integrated Environment synthesis Xilinx 14.2 version software, then after actual result of AES Operation is validated on hardware in the form of Spartan 6 FPGA. From the work completed in this paper it is observed that AES Algorithm which designed and Implemented with less FPGA Hardware, Less Power consumption and Better Throughput of the Cryptosystem. Hence AES Algorithm which implemented on Spartan-6 FPGA can Give the possibility of portability, applications Compatibility and Improvement of security levels.

Keywords Cryptography · Internet of things · Artificial intelligence · FPGA · Block cipher

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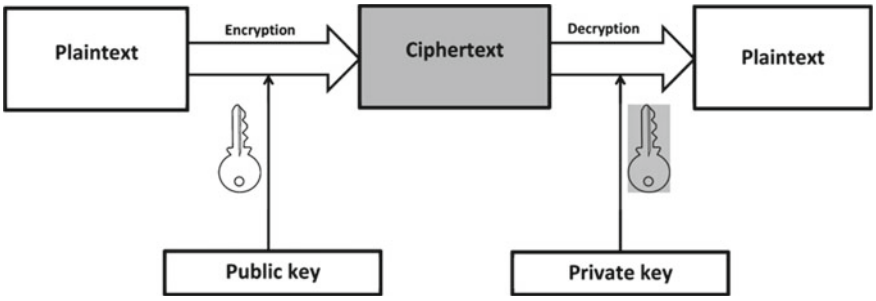

Fig. 1 Block diagram

1 Introduction

In an age of technological advancements, security and privacy [1] plays an prime role in daily life. Newer Technology like Artificial Intelligence which gives the scope to Electronic devices which can interact, communicate with each other, can take their own decision which gives possibility to connect every other electronic devices which can generate huge amount of data at tremendous speed that makes our world as possible as connected together that actually creates overall growth in every possible sector like Aviation, Mass Transit, Maritime, Rail, Roadways, Automotive industry, Smart Grid, Oil and Gas, Smart home, Wearables, Smart Cities, Industrial applications, Infrastructure Management, Energy Management, Smart Farming and so on [4]. Hence it is prime importance to provide secure connection and data itself. cryptography to guarantee the data confidentiality, data integrity and data authenticity, Data Security and data Privacy which became prime need of today's electronic environment [3]. Advanced Encryption Standard is basically a block cipher algorithm which nowadays used everywhere for encryption and Decryption purpose and provided supports for variety of real time applications [2]. The length of data blocks is fixed to be 128 bits and key length may varies which is of 10 rounds, 12 rounds and 14 rounds for 128 bits, 192, and 256 bits respectively [2]. It is found that AES provided enough security as well as more faster than other Cryptographic algorithms such as DES (Fig. 1).

2 Software and Hardware Design Aspect

Spartan 6 FPGA Board is used which is having 512 MB DDR SDRAM and SPI flash. Xilinx ISE is Software which is basically used for simulation and synthesis purpose. Putty software open source is used to like communication port where output from Spartan 6 FPGA can be transferred to PC (Fig. 2).

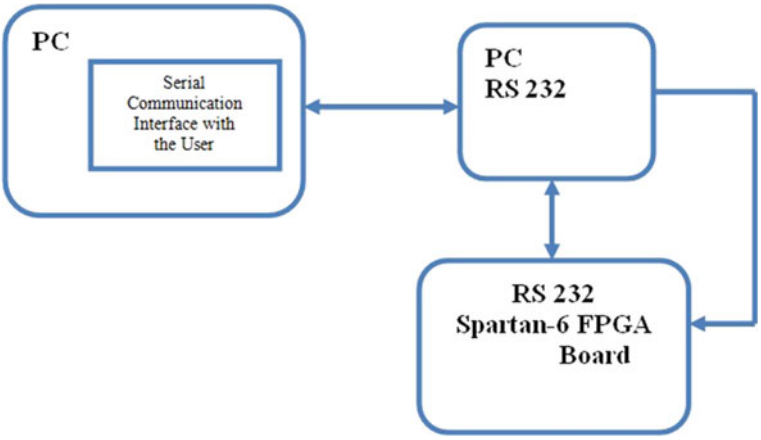

Fig. 2 Interfacing diagram PC and Spartan 6 FPGA

3 Encryption and Decryption Design Process of AES Algorithm

This Paper Proposed kind of different Methodology in which sequences of Encryption process as well as Decryption process for AES Algorithm as shown in the Fig. 3. The decryption algorithm is the reverse of its corresponding process from encryption algorithm [1, 3]. Four processes are used namely Add round, Mix column, Shift row, Substitute byte [2, 4]. And these four process repeats in the form of several rounds to provide adequate security.

4 Simulated Testing Results for AES Algorithm Design Process

4.1 Testing of Encryption Process

4.1.1 Add Round Key

In this process normally column of state matrix Xored with corresponding round key (Fig. 4).

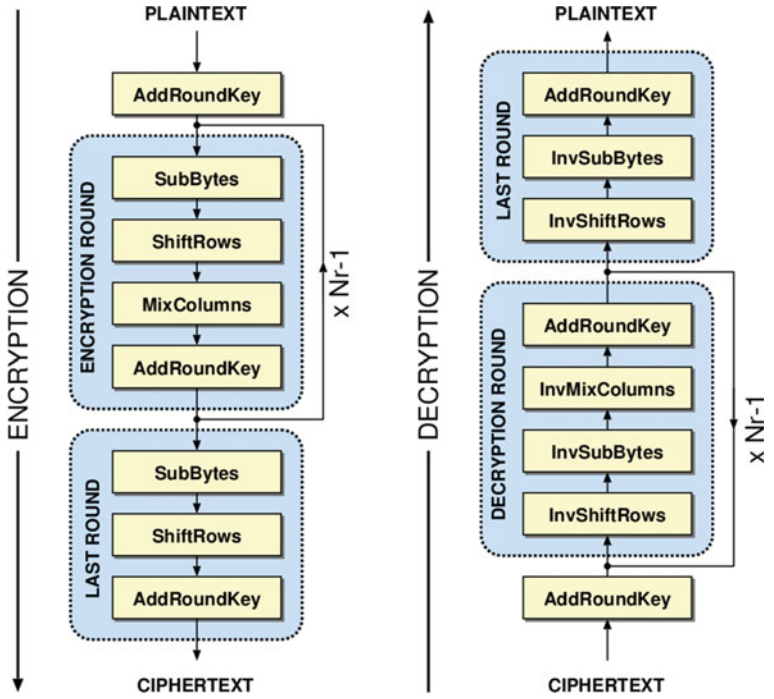

Fig. 3 Encryption and decryption of AES Algorithm

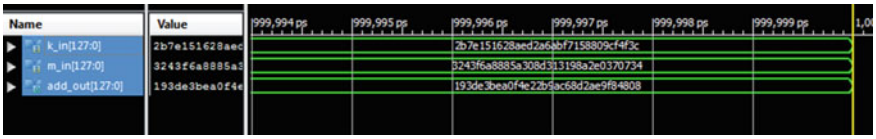

Fig. 4 Simulated output for Add Round key encryption

4.1.2 Sub-Byte

In this process byte substitution is normally happened using substitution table (S-box) independently operates on state bytes (Fig. 5).

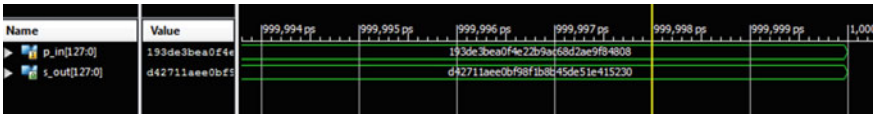

Fig. 5 Simulated output for Sub-Byte encryption

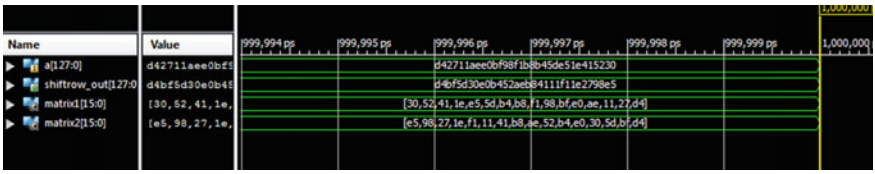

Fig. 6 Simulated output for Shift Row encryption

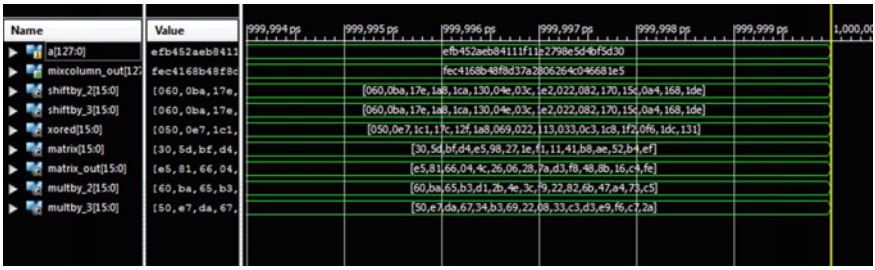

Fig. 7 Simulated output for Mix Column encryption

4.1.3 Shift Row

The transformation is called Shift Rows performs in encryption, in which rows are cyclic shifting to the left (Fig. 6).

4.1.4 Mix Column

The Mix Columns multiplies the rows of the constant matrix by a column in the state (Fig. 7).

4.2 Testing of Decryption Process

Testing of Encryption Processes which is similar to Decryption process implemented with Inverse form. Yet again, the 10th iteration just ignores the Inverse Mix Columns transformation.

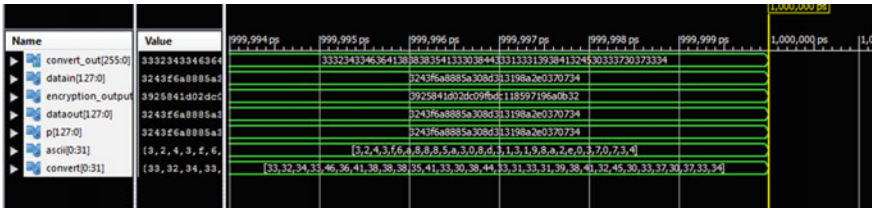

Fig. 8 Final simulated AES output

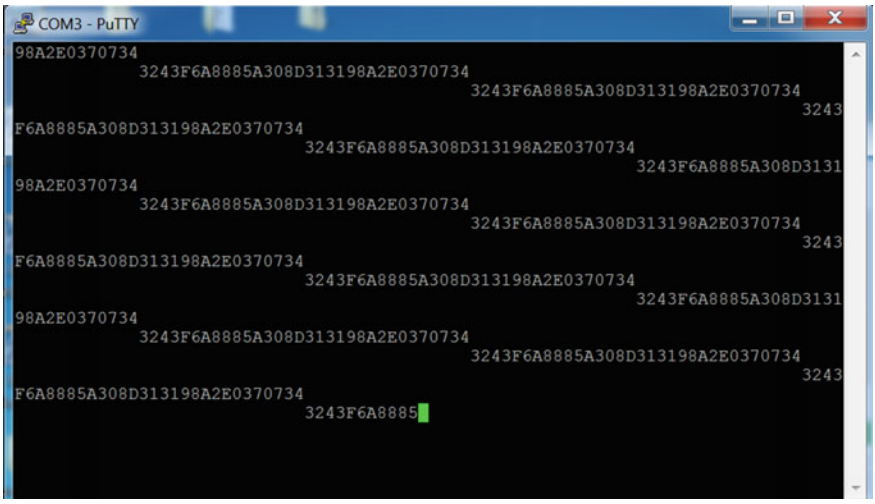

Fig. 9 Final FPGA output on Putty

Table 1 Power consumption report

Parameters	Power (mW)	Logic power (mW)	Signal power (mW)
1	0.05/0. 16	0. 03/0. 11	0.02/0. 06

5 Results and Discussion

The Proposed system has given some experimental results are as follows. Final Result of AES Algorithm Implemented by Integrating all Encryption and Decryption of subsequent design processes. This result shows the simulated and synthesized in Integrated Environment synthesis Xilinx 14.2 version then after actual result of AES Operation is validated on hardware in the form of Spartan 6 FPGA which is displayed on Putty (Figs. 8 and 9; Tables 1, 2 and 3).

Table 2 FPGA hardware utilization report

2	Parameter	Utilization
2.1	FFs	27/69
2.2	LUTs	83/159
2.3	Total Ram's: 1. 16 × 8-Bit Ram 2. 256 × 8-Bit Ram	432 32 400
2.4	Total multiplexers	2744
2.5	Number of LUT's Per CLB Slices	4
2.6	Number of adder stages per CLB Slice	4
2.7	Number of slices per CLB	2

Table 3 Total memory usage

3	Total memory usage	341296 Kb

6 Conclusion

After studying for various security algorithms we concluded on AES 128 bit algorithm which is widely used for data security purpose in various application. Multiple steps are performed in encryption and decryption. We can have performed key generation operation for encryption and decryption. We have concluded with match of encrypted 128 bit with decrypted 128 bit data theoretically as well as practically. We have also tried for more security purpose with an extra key xor-ing at last step of encryption and first step of decryption. We have done 128 Bit AES Encryption and Decryption of data with VHDL coding and implementation using Spartan-6 FPGA board.

From the work completed in this paper it is observed that Power consumption by FPGA is very less and FPGA Hardware utilization is also very less hence This AES algorithm actually developed with better Throughput, Hardware Utilization with respect to Security.

References

1. FIPS 197 (2001) Advanced Encryption Standard (AES). Federal Information Processing Standard, National Institute of Standards and Technologies, U.S. Department of Commerce
2. Bouillaguet C, Derbez P, Dunkelman O, Fouque PA, Keller N, Rijmen V (2012) Low-data complexity attacks on AES. In: IEEE transactions on information theory, vol 58, issue no 11, pp 7002–7017
3. Cheng H, Ding Q (2012) Overview of the block cipher. In: 2nd international conference on instrumentation & measurement, computer, communication and control
4. Bajaj RD, Gokhale U (2016) Design and simulation of AES algorithm for cryptography. Int J Eng Sci 6(6). https://doi.org/10.4010/2016.1524. ISSN 2321 3361 © IJESC

Improved Method for Noise Detection by DBSCAN and Angle Based Outlier Factor in High Dimensional Datasets

Sarita Tripathy and Laxman Sahoo

Abstract Various data mining methods are used to detect outliers from different databases. It is essential to detect outliers in different kinds of real time application areas, such as the health care sector and insurance, marketing, banks and finance et c. The proposed method in this paper is a new outlier detection method from a high dimensional data sets which combines the angle based outlier detection (ABOD) with the classical density based clustering method DBSCAN. The algorithm consists of three stages in which the first stage consists of applying of the PCA on the data set which will result in a subset of attributes, to this subset of attributes the dbscan algorithm is applied which results in detection of a set of outliers. In the third and final stage ABOD is applied to the set of outliers. Experimental analysis conducted state that the result improves the detection accuracy and decreases the number of false positives.

Keywords DBSCAN · Clustering · Outlier detection · Principal component analysis · ABOD

1 Introduction

The data which deviates from the normal data in a large set of data are known as outliers. The outliers are the observations which have a higher integrated squared error than a threshold. The detection of this type of inconsistent data is required for many applications in real life, which includes detection of crimes, fraudulent transaction detection, intrusion detection in the network, in stock market, data analysis in hospitals, etc. The types of outliers can be classified into 3 classes namely.

Outliers as points consisting of multidimensional data. Outliers which are contextual consisting of sequence of data which are discrete and are dependency oriented,

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time-series etc. Attributes which are contextual and behavioral are used for defining each instance to a particular context. Outliers which are collective which does not consider individual data but a collection of data. In general any outlier detection method creates a normal pattern and after that assigns an outlier score to the data points which is based on how much it is deviated from the pattern which is normal. Some of the models are, models based on extreme values, models based on probability, models which are linear, models based on proximity, models based on information theory, models based on high dimensional data etc. Both uni-variate and multivariate data can be checked for outlier on the basis of whether they are categorical or continuous. In data which are uni-variate features like shape, center, distribution of data and relative position are considered. In bi-variate data use of prediction can be done by using correlation and regression, also multiple regressions can be done using multivariate data. Estimations used in statistics such as standard deviation and also the mean are highly affected due to the points which lie away from the centre of the data set. Poisson and Gaussian distribution are statistical methods when applied to large data set consumes more time. The next section of this paper gives the summary of various outlier detection methods. Section 3 describes about the PCA algorithm. In Sect. 4 DBSCAN algorithm is described, Sect. 5 describes about the Angle based outlier detection, Sect. 6 consists of the algorithm which is proposed in this paper, In Sect. 7 the experimental analysis is presented finally Sect. 8 draws the conclusions and future work.

2 Literture Survey

The noise present in a database is cleaned with the help of outlier detection methods. Four common types of approaches are used for outlier detection based on: Distribution, Clustering, and Distance and Density-based. The method which is based on distribution consists of development of models based on statistics from a given data set, which checks whether the behavior is normal or abnormal. This type model takes into consideration the spread of data points in a data set, it presents a method known as the active outlier method (AO). The active learning technique is invoked in AO method which is a selective sampling based mechanism. However, multidimensional scenarios are not applicable to this approach, the reason being knowledge about the spread of data is needed in advance and another reason is that they are univariate in nature. Further, the sample which is chosen may or may not be matching with the law of distribution.

Another method proposed by [1] which considers clustering of data points as the basis in which the clusters of small size are considered as outliers. But, if the clusters are separated by large distances, then in such situations every cluster is considered to be an outlier. Hence, approach of clustering by itself is not enough to detect outliers appropriately. Another method proposed by [2] which considers clustering of data points as the basis in which the clusters of small size are considered as outliers. But, if the clusters are separated by large distances, then in such situations every cluster

is considered to be an outlier. Hence, approach of clustering by itself is not enough to detect outliers appropriately A method presented in [3] takes distance between the data points as the basis, in which O is taken which is a point in a dataset and is considered as a noise if there are less than M points present, with distance equal to d from the point O. The determination of M and d is the greatest drawback of this approach. An improved method is proposed by [4] and is based on measurement of distance between the kth nearest neighbor and the point O. A more extended approach given by [5] is computation of value of outlier for each of the point which is equal to the sum of distances from K nearest neighbour. Rough set of neighbor is used to detect NED and the selection of appropriate parameters makes it more efficient. Method which takes density as the basis was presented in [6]. In this method a factor is assigned to each of the data points which is called (LOF) which measures the degree of an object being an outlier. A hybrid approach for outlier detection was proposed by [7] (HAOD) it is a method in which clustering and distance methods are combined.

3 Principal Component Analysis

It is a method which takes statistics of the data set and uses orthogonal method of transformation and transforms an observation into a variable set which are then mapped with set of variables known as principal components. The number of unique observation is equal to the original number of variables or original number minus one. Out of the number of principal components obtained after applying the method the component having highest variance is the first component and each of the components followed by it has the variance with the restriction that they are orthogonal to the feature those precede tithe result comprises of vectors which are uncorrelated to one another on the basis of orthogonally. This method is generally a tool to explore predictive modelling. Mostly it can be used for visualizing distances which are genetically related and how the population are related. The process consists of decomposition of eign value of correlation based matrix or decomposing of the matrix after normalization for each of the attribute in the matrix. The result is obtained generally by getting the value of weight associated with each of the original variable which is standardized and it should be multiplied with the value of the component. Also this method is used in reduction of dimension of the data-set. The dimension of the data-set is reduced while the variance is still preserved. Taking an instance if we keep the first two principal components it finds the components in the two dimensional plane where the distribution of high dimensional data set is the most, where as if two different directions in the data set are chosen at random, then the clusters may spread apart and most likely to overlap with one another and cannot be distinguished.

3.1 Effect of PCA on Noisy Data

When the data set is noisy PCA is most advantageous as it is more easier if the variance spreads over the few components rather than over the whole set of components, so comparatively the noise effect becomes less as the signal-to-noise-ratio of the first few components higher. This effect of concentrating much of the signal on the first few components can be achieved by PCA's dimensionality reduction feature the latter principal components may be dominated by noise, and so they can be discarded without great loss.

4 DBSCAN

It is a density based algorithm. It forms clusters by grouping the data points which are having dense neighboring data points. Sensitivity to noise is less for DBSCAN and it can also handle datasets which are high dimensional [8]. Core point is one which has number of surrounding points greater than the MinPts in the range of points of Eps-neighborhood. A border point is one which is not a core point and is in other points Eps-neighborhood which are core points. A point is known as a noise point if it is neither a core point nor a border point. The three different types of points are shown in Fig. 1.

The algorithm checks for number of data points in EPS-neighborhood of each point, in the EPS-neighborhood of a point p the count of points is greater than MinPts then a cluster is created where the set of points p is the core point.

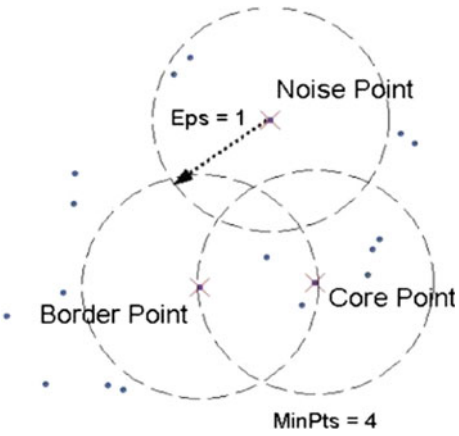

Fig. 1 Different points of DBSCAN

5 Anglle Based Outlier Detection

The methods of outlier detection which is distance based is not suitable for data sets with very high dimensions. For this an angle based method is being developed which is a total different approach. In this method both distance and angle in between the vectors comes into picture. The basic technique followed in this approach is, the angle between vectors vary highly, the value of the variance for angles at the border will become smaller. Most pair of points will be small as large number of points is grouped in a particular direction. The angle spectrum for the border points will be smaller and variance is high. These values of angle and variance are known as angle-based outlier factor which is described in divergence of directions of objects. Suppose for a point the spectrum of observed angle is broad then it can be concluded that the point is covered in all directions by other points and hence it is a point inside the cluster, on the other hand if the spectrum of angle is small that means other points are placed in one direction.

Hence, points with small angles are considered as outliers as shown in Fig. 2 (Fig. 3).

The variance of the angels between the difference vectors of the point A is calculated with respect to all other points present in the dataset D and in which the points are being weighted by the distance of the points. The calculation is done as follows:

6 Proposed Algorithm

Input: Data set D.
Output: Outlier points.
Step1: PCA is applied to the dataset, and low dimensional dataset l is obtained.
Step2: DBSCAN is applied to the low dimensional dataset to get the noise point's n1.
Step3: let the noise points be taken as cluster 0 and each of the other points are taken as cluster1.
Step4: For each point in the noise set n1 ABOF calculated.
Step5: ABOF is obtained and the points having high ABOF are removed from the noise set n1 and added cluster1.
Output: The set n1.

7 Result Analysis

An experimental analysis was performed by us for measuring the efficiency of the proposed algorithm. The analysis is done on Lung Cancer data set which is obtained from the UCI repository, it has in total 32 instances and 56 attributes. The efficiency

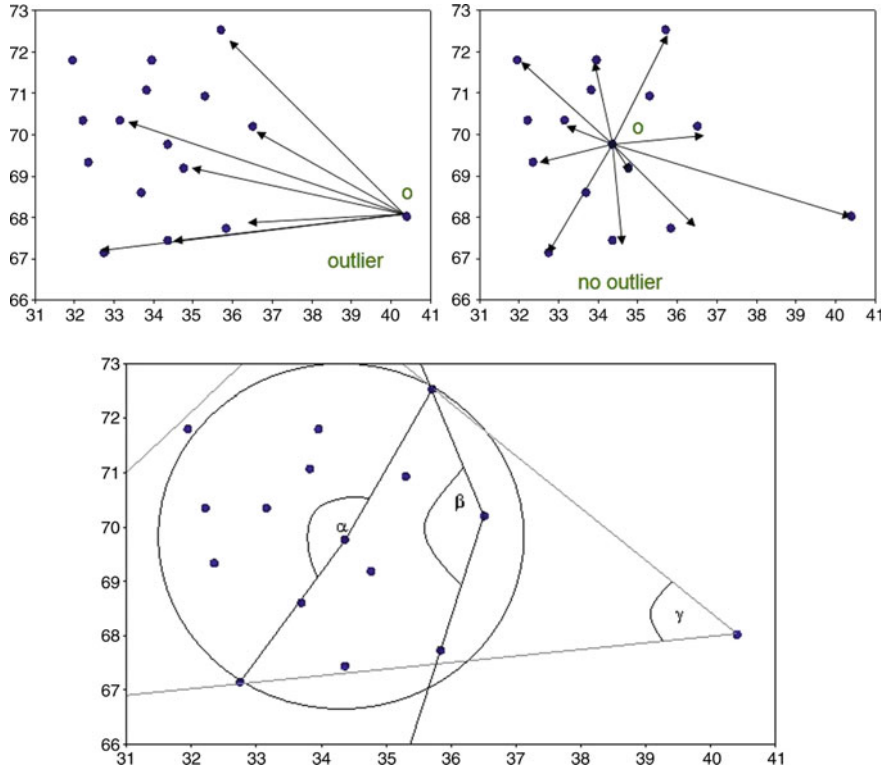

Fig. 2 Points with small angles

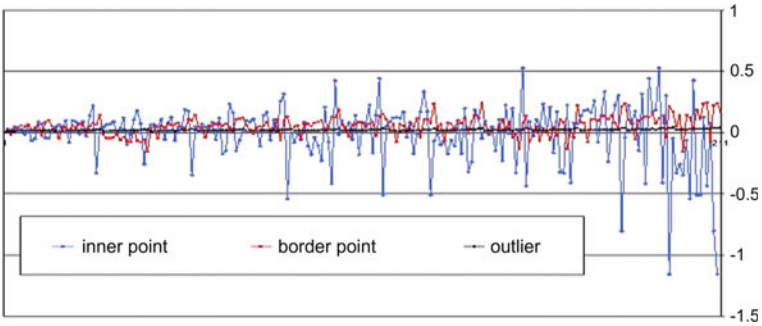

Fig. 3 Various type of points

Table 1 Comparion of performance metrics

Algorithm	Eps	Minimum points	Accuracy
FBOD	0.4	0.4	0.7500
ABOD	0.4	0.4	0.7778
SOD	0.4	0.4	0.8750
Proposed algorithm	0.4	0.4	0.9848

of proposed algorithm when applied to the Lung cancer dataset can be judged by the result as shown in Table 1.

The precision, recall and F1 score for the algorithms is obtained. We can use precision as a measure for evaluating the correctness of the algorithm, more the precision lesser is the false positive and also lesser accuracy means higher the false positive. On the other hand the recall will measure the integrity or sensitivity of the algorithm, with the increase in recall the false negative becomes lesser and as the recall decreases latter increases. The F1 score is calculated by the combination of recall and precision, more the F1 score means better is the model used.

The Precision and Recall are defined as follows:

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

$$\text{Recall} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

The F1 Score is defined as:

$$\text{F1 Score} = 2.\frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}}$$

The Table 2 shows the three measures for the two models and it can be noted that the accuracy obtained from the proposed method is higher.

Table 2 The three measures for the two models

Algorithm	Precision	Recall	F-measure
FBOD	0.5	0.5	0.5
ABOD	0.33	0.67	0.4422
SOD	1	0.66	0.7951
Proposed algorithm	0.833	1	0.9088

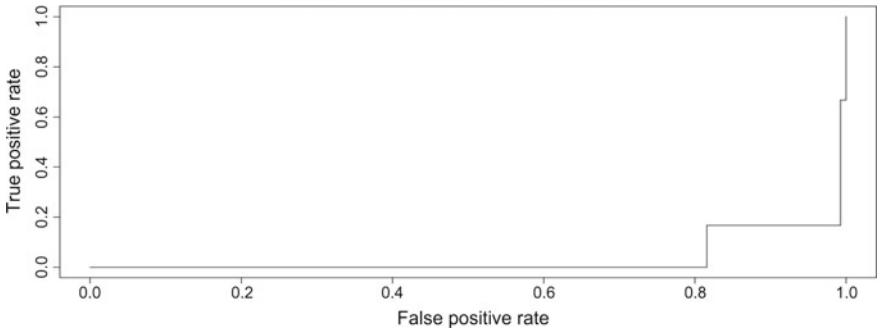

Fig. 4 Roc curve with SOD

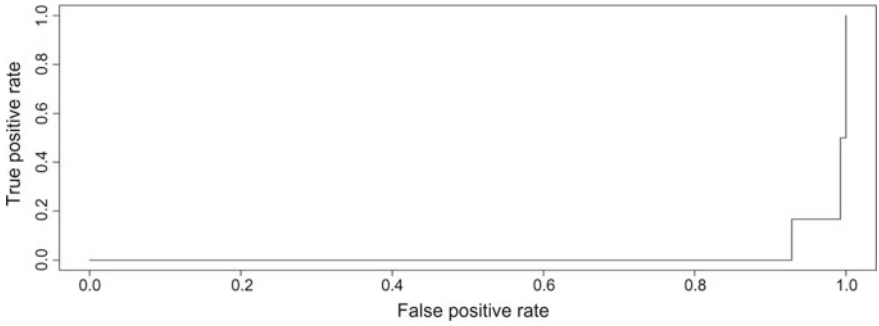

Fig. 5 Roc curve with proposed algorithm

The ROC Curves as shown in the Figs. 4 and 5 shown gives the area under curve for both the algorithms SOD and the proposed algorithm.

8 Conclusion

A new method based on the hybridization of DBSCAN and ABOD is proposed in this paper which is more efficient as it minimizes the error of DBSCAN algorithm, as evident from the experimental output the proposed algorithm improves the accuracy. The parameters those are required to be selected are (i) Minimum points and (ii) Epsilon. From the experimental analysis it is concluded that higher accuracy is obtained. The accuracy can further be increased by introducing techniques such as bagging and random forest. Future work will consist of finding out a method for automatic selection of the optimal parameters and introduction of the above methods for further increasing the accuracy.

References

1. Jain AK, Murthy MNN, Flynn PJ (1999) Data clustering: a review. ACM Comput Surv 31(3):264–323
2. Ramaswamy S, Rastogi R, Kyueok S (2000) Efficient algorithms for mining outliers from large datasets. In: SIGMOD Conference
3. Winter T, Mallory S, Allen T, Rosenberry D (2000) The use of principal component analysis for interpreting ground water hydrographs. Groundwater 38(2):234–246
4. Breunig MM, Kriegel H-P, Ng RT, Sander J (2000) LOF: identifying density-based local outliers. In: Proceedings of 2000 ACM SIGMOD international conference on management of data (SIGMOD '00), ACM, New York, NY, USA, pp 93–104
5. Angiulli F, Pizzuti C, (2002) Fast Outlier Detection in High Dimensional Spaces. In: Elomaa T, Mannila H, Toivonen H (eds) Principles of Data Mining and Knowledge Discovery, PKDD, (2002). Lecture notes in computer science (Lecture notes in artificial intelligence), vol 2431. Springer, Berlin, Heidelberg
6. Papadimetriou S, Kitawaga H, Gibbons PB, Falout-sos C (2003) LOCI: fast outlier detection using the local correlation integral. In: Proceeding of 19th international conference on data engineering, Bangalore, India, pp 315–328
7. Angiulli F, Basta S, Pizzuti C (2006) Distance-based detection and prediction of outliers. IEEE Trans Knowl Data Eng 18:145–160
8. Khan K, Rehman SU (2014) DBSCAN: past, present and future. In: 2014 Fifth international information and web echnologies (ICADIWT), Bangalore, pp 232–238

Specular Reflection Detection and Substitution: A Key for Accurate Medical Image Analysis

Pratik Oak and Brijesh Iyer

Abstract The quality of any image depends on the specifications of capturing devices. However, external factors also affect the appearance of an image. The disturbance created in image due to reflections from the surface is a major issue with respect to image quality reduction. These reflected regions appearing in image are called as specular reflections (SR). This problem is common in all types of images and it disturbs the image interpretation. Thus, the removal of SR pixels is one of the most important pre-processing steps for accurate image analysis. Several techniques are suggested in the literature to address this issue. The paper reports an in-depth review of various categories and issues of SR detection and the probable solution to overcome it. Experimental analysis proves that Kittler minimum error threshold selection method can be applied on input image as a preprocessing method for SR detection and analysis. Increase in Jaccard Index (JC) justifies the performance of proposed solution.

Keywords Specular reflections (SR) · Jaccard index · Diagnostic accuracy

1 Introduction

Extraction of information from an image is useful to acquire its internal properties. The analysis of extracted information helps to initiate the modifications in image attributes as per the requirement of specific application. The preliminary stage of information extraction is to observe the illumination directed from surface. The illumination parameters of an image can be categorized as reflectance, shadow effect, movement of object, camera miss focuses etc. The reflection is a major disturbance affecting the quality of information retrieval. Any reflection induced in an image can

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Fig. 1 Example of SR affected cervix image with cropped SR region

be considered of two types: 1. Specular reflection and 2. Diffuse reflection. When a ray of light strikes the surface of an illumination source, part of ray gets immediately reflected from interface between surface and air owing to their different refractive indices. If this reflection is from single direction. This phenomenon is called as specular reflections (SR) and if it is reflected from multiple directions, it is called as diffuse reflections [1]. Most of the images get affected by specular reflections (SR).

Medical Image analysis is one of the growing fields of research. The most prominent factor affecting the accuracy of this analysis is the quality of an input image. The SR produced during capturing of medical images is major obstacle in this process. Thus, replacement of these SR pixels keeping the underlying image characteristics intact, is a must before any further medical image analysis. Removal of these reflections from the captured images is a prevalent challenge for the medical image processing. SR is a bright spot on an image which contains maximum part as a white intensity. It is prominent in medical images like cervix image, endoscopic image, cardiographic image, angiogram etc. Figure 1 shows the example of cervix image affected by SRs. This SR region can be easily seen with open eyes (shown as black box). The cropped SR region is also shown in the adjacent image.

Handful contributions are made in the literature to address the issue of SR removal. These contributions majorly focus on accurate detection of SR pixels and its proper replacement in original image.

In 2011, A. Artusi et al. presented a detailed review on specularity removal technologies suggested by various principles. Authors compared various methods based on dichromatic reflection model (DRM). Theoretical description was given for each category of DRM. They analyzed the significance and demerits of each model to brief the respective application domains. They also compared few state-of-art systems related to SR detection. Brief discussion about single and multiple image analysis is also included in the same review. Authors focused on hardware aspect of SR detection and removal methodologies. The paper also added visual comparison of state-of-art methods [2].

In 2017, H. Khan et al. reported a survey on highlight detection in color and spectral images. Authors covered the methods related to single and multiple images

and analyzed various state-of-art methods with respect to strengths and assumptions. This survey provides a wide look on highlight detection and removal issue in color and spectral images [3].

The paper reports a review on the working principle of SR detection methods. The SR detection techniques can be broadly classified as use of dichromatic reflection model (DRM) principle, use of Kernel as a filter, using thresholding technique and considering SR as a classification or segmentation problem. The paper is arranged in same fashion. Section 2 to 5 concludes with table of comparison between various contributions of respective category and enlists objective (OQA) and subjective i.e. visual quality assessment (SQA) measures used by researchers. All these major categories are reviewed in further sections separately and common analysis is done in Sect. 6. The possible solution to remove the research gaps is explained in Sect. 7 based on detail review. The paper is concluded in Sect. 8.

2 SR Detection Using Principle of Dichromatic Reflection Model (DRM)

Any radiation is composed of reflections from interface and surface body. The DRM works on the principle of same characteristic of radiation or reflection [2]. The major objective is to separate this combination i.e. to get diffuse and specular reflections separated. Many researchers focused on same principle and suggested various methods of SR detection.

K. Yoon et al. proposed speedy detection of SR pixels in 2006. They calculated value of specularity invariant pixels and their ratio to separate diffuse components. However, this method is applicable in texture images and has limited accuracy due to approximation in normalization process [4].

In 2011, O. Meslouhi et al. suggested another method based on DRM. The method works on chromatic characteristics of highlighted areas. The experimentation is carried out on uniform and textured colposcopic images. The method is independent of any arbitrary threshold value [5].

The technique proposed by Ali et al. separates specular component from diffused component using factorization of non-negative matrix. The reflection function of skin is scaled with respect to changes in density and distribution functions of skin. This assumption made in scaling gave promising results in SR detection or separation [6].

J. Suo et al. applied DRM concept as signal separation problem for SR detection and removal [7]. However, the method suggested by them is incapable of differentiating the pixels with same hue and different saturation. It is also unable to incorporate smooth change in color.

Tao et al. [8] proposed a new measure called line consistency for depth estimation of SR region. Colors from multiple light sources are easily estimated by this method. However, it fails to separate saturated specularity.

Table 1 State of the art SR detection techniques based on principle of DRM

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Yoon et al. [4]	General purpose images	Ratio of specularity invariant pixels	Runtime	Yes	Useful for texture images	Limited accuracy due to normalization process
Meslouhi et al. [5]	Colposcopy	Chromatic characteristics of bright areas	Expert grading	Yes	Independent of arbitrary selection of threshold	Occurrence of darkness in few in-painted areas
Ali et al. [6]	Dermatology	Non-negative matrix factorization and skin scaling function	–	Yes	Useful for skin lesion classification in further stages 96.77% accuracy	Need to test the applicability of method on other image modality
J. Suo et.al. [7]	General purpose images	DRM as signal separation problem	PSNR	Yes	High efficiency and good speed	Undifferentiating pixels having same H and different S
Tao et al. [8]		Line consistency for depth estimation	RMSE & Runtime	Yes	Efficient SR detection from multiple light sources	Unable to separate saturated specularity
Asiedu et al. [9]	Colposcopy	Finite element analysis	–	Yes	Tested of hardware real time processing	Testing is required for other image modalities

(continued)

Table 1 (continued)

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Wang et al. [10]	Natural images	Polarization imaging Energy minimization function	Normalized standard deviation	Yes	Stable for camera noise	Improper detection of SR region induced from multiple light sources
Lamprinou et al. [11]	Laproscopy	Use of filter based on differentiation to separate SR and diffuse components	Mean error	Yes	Non-blind inpainting is efficient	Database dependent quality of output Complex system

In 2017, Asiedu et al. [9] designed a new model to generate specular free image. The authors worked on colposcopy images and used the principle of finite element analysis for accurate SR detection. The model is tested on hardware platform to check the compatibility and feasibility on real time processing.

Wang et al. [10] presented the method using minimization of global energy in polarization imaging. Color constraints are consider through polarization information and color distortion is reduced at maximum scale to achieve significant accuracy. The method is robust with respect to consistency of accuracy in detection of camera noise.

Lamprinou et al. [11] suggested a method recently in 2018 to remove glare present in laproscopic images. Authors promoted the use of forward and backward derivatives of non-stationary signals to act as a filter. The backward derivative is proposed to remove abrupt changes in images. Different cost functions are designed to optimization and system stability. The major cause of concern is database dependency of the method and computational complexity.

Table 1 summarizes state-of-art methods of SR detection based on DRM principle.

3 SR Detection Using Kernel as a Filter

Another approach suggested by few researchers is to use a kernel or mask as a filter to detect SR pixels present in image. This kernel is referred as structuring element (SE).

Lange [12] extracted green component of an image to get high glare to background ratio and treated it as a feature image. Morphological top hat filters are used to detect SR pixels from extracted feature image. Watershed segmentation is used to find the complete boundary of glare region. The method suffers from drawback of accurate selection of structuring element in morphological processing.

Sun and Sang [13] also suggested using kernel as a filter on image. Xue et al. [14] followed similar approach to use structuring element in top hat transform on intensity image (I) of cervigrams.

Yao et al. [15] worked on gastroscopic images to automatically extract SR pixels. Authors promoted the use of IS histogram (Intensity-Saturation histograms) from HSI color plane. Templates of various shapes like triangular, rectangular and anti-sector are applied on input images to perform template matching and detect appropriate SR region. The work achieved 71.9% true positive rate with area under curve (AUC) 0.869. Ulcer can also get detected accurately without any confusion with intensity values. Though authors proposed triangular template as a best for SR detection, the shape of the template may get change for each image modality.

Tchoulack et al. [16] proposed a FPGA based architecture on SR removal from endoscopic images. Histogram decomposition is done on each channel of RGB to compare the intensity levels. Specular mask is designed based on histogram intensity observations and smoothing filter is applied to detect accurate SR pixels. The performance of hardware is tested and reported as faster system. However, size of specular mask is a vital factor in maintaining the accuracy of SR detection.

Das et al. [17] suggested another way of using kernel for SR detection. Author worked on colposcopy images collected from hospitals. Simplest procedure of logical ANDing between white pixels of RGB color planes is proposed as SR pixels. Dilation followed by region filling is applied to get final replacement of SR pixels. K-means clustering is used to get accurate region of interest (ROI) from colposcopic images. Though the method is simple and easy to implement, its generalized behavior on various database is still a problem due to dependency on size and shape of the kernel.

In 2018, Kudwa et al. [18] proposed a unique way of focusing on SR pixels. Authors combined a feature image from saturation component of HSI plane, green component of RGB plane and lightness channel of CIE plane. The standard deviation filter is applied on feature image and dilation is performed to detect SR pixels from it.

Table 2 gives brief in sequence of above explained methods related to use of kernel for SR detection. This category suffers from the drawback of dependency of size and shape of kernel with respect to input database.

Table 2 SR detection state-of-art methods based on use of kernel as a filter

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Lange et al. [12]	Colposcopy	Green channel as feature image Top-hat transform	–	Yes	Easy to implement	Accuracy may vary with size of SE
Sun and Sang et al. [13]	Colposcopy	Top-hat transform on I image Gabor wavelet multiscale morphology	–	Yes	Independent of arbitrary selection of threshold	Improper detection of SR in local image and smooth changes in color
Xue et al. [14]	Cervicography	RGB to HSI OTSU's thresholding top hat transform	Mean	Yes	Ease of implementation automatic ROI extraction	Variation in size of structuring element affects the accuracy
Yao et.al. [15]	Gastroscopy	IS histogram Template matching	Area Under Curve (AUC)	Yes	Triangular template is best to detect SR region	Shape of template varies with images
Tchoulack et al. [16]	Endoscopy	Histogram decomposition and specular masking	–	Yes	Faster hardware design	Size of specular mask may vary with different database

(continued)

Table 2 (continued)

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Das et al. [17]	Colposcopy	Logical ANDing of white pixels from RGB planes Dilation and filling	Expert grading	Yes	Accurate ROI extraction using k-mean clustering	Inferior accuracy in detection of less bright SR pixels
Kudwa et al. [18]	Colposcopy	Feature image formation from RGB planes Deviation filter and dilation	Sensitivity and Jaccord index	Yes	96.75% sensitivity excellent detection of accurate SR and less non-SR pixels	Non-detection of low intensity high contrast SR pixels

4 SR Detection Using Image Thresholding

SR pixels always have bright intensities. Thus, some researchers proposed the use of various constants as a threshold on input image to get SR pixels. Most of the thresholds are applied on Intensity (I) and Saturation (S) images of HSI plane. Table 3 summarizes the SR detection techniques based on thresholding.

Zimmerman et al. [19] first introduced the selection of constant as a threshold on image. Authors suggested working in HSI color plane and proposed a multiplying factor of 0.4 and 0.6 to be multiplied with maximum intensity of intensity (I) and saturation (S) images respectively. Pixels less than threshold in S image and greater than threshold in I image are extracted. The magnitude of gradient image is considered as SR region. The constants suggested by Zimmerman et al. do not suitable for any database.

Shen et al. [20] promoted the threshold as specular degree of an image. Using this threshold, authors separated SR and diffuse pixels without any segmentation algorithm.

Alsaleh et al. [21] proposed three combinations of multiplication factors i.e. 0.5 & 0.17, 0.7 & 0.07 and 0.8 & 0.19 for I and S image respectively. The experimentation was carried out on various types of database. However, these constants need to be selected differently for each image modality.

Guo et al. [22] suggested performing binarization of intensity image using arbitrary selection of threshold. The accuracy of the said method is limited due to non-consideration of saturation parameter of an image. Authors worked on endoscopic images to get SR suppression using contouring.

A work on images having characters is carried out by Jiao et al. [23]. They promoted the use of two images captured from different angle to extract and merge specular free regions of these images. An algorithm based on image stitching is

Table 3 Thresholding based SR detection state-of-art methods

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Zimmerman et al. [19]	Colposcopy	Thresholding gradient image magnitude	Expert Grading	Yes	Ease of design	Threshold should get varied with respect to database
Shen et al. [20]	General purpose images	Subtracting minimum value of RGB plane from each pixle	Runtime	Yes	No use of segmentation less complex	Small changes in intensity must be interpreted by the system
Alsaleh et al. [21]	Cervicography	Thresholding on S and I image to get SR pixels	–	Yes	Less detection of non-SR pixels improves the efficiency	Arbitrary constants must be suitable for any database
Guo et.al. [22]	Endoscopy	Binarization of image using single threshold	–	Yes	Ease of design	Less accuracy due to non-consideration of S component
Jiao et al. [23]	Text images	Image stitching	OCR Accuracy	Yes	No need of hardware for complete CAD system	Need of two images captured from different angle incorporate difficulty in database generation
Digiovanni et al. [24]	Colposcopy	Thresholding on intensity image	Histogram comparison of G plane image	Yes	Ease of design	Low performance due to non-consideration of S component

proposed in the work to avoid the need of special hardware for generating SR free image.

Digiovanni et al. [24] followed similar approach to apply thresholding on intensity image and experimented on colposcopy images. The technique proposed by them suffers from the trade-off of ease of implementation and less accuracy of SR detection.

The arbitrary selection of constants in the state-of-art methods of SR detection affects the accuracy.

5 SR Detection Using Image Segmentation or Classification of SR Pixels

Another approach suggested by few researchers is to consider SR detection as a classification problem and identify image pixels as SR and non-SR pixels. The use of segmentation on same line of approach is also promoted in the literature. Classification and segmentation based techniques work on input image pixel labeling and to separate the pixel based on its features.

In 1996, Hokland et al. [25] proposed the use of markov random field (MRF) to estimate the spread function and noise variance from input simulated images. The SR pixels get detected based on these models and they are restored separately using stochastic relaxation. Iterative de-convolution algorithm is used to remove the noisy components from image. The technique based on MRF proved to be better than wiener filter and it protects the occurrence of ringing effects.

Stoyanov and Yang [26] suggested temporal registration of non-rigid surface motion to recover chromatic information of SR saturated region. The registration is used to separate the specular and diffuse reflections. Authors applied this technique in robot assisted surgery. However, they have not considered the reflectance from noise and complex components.

The SR detection in facial images is promoted by Levine and Bhattacharyya [27]. Region based segmentation is used to separate specular and shadow regions with initial consideration of seed pixel. Support vector machine (SVM) classifier is used based on features of these expected separations. The SR detected pixels are replaced by mean of non-SR neighboring pixels and inpainting method called as 'illumination compensation'. Authors justified the significance of the method for accurate detection of facial reflections.

Lee et al. reported a similar approach to treat the SR detection problem as a two label classification [28]. Authors suggested using perceptron neural network classifier to identify any pixel from an image as SR or non-SR pixel. Removal of these detected SR pixels is made by spatial smoothing filter. In advantage of working on single frame, this method is inefficient to detect SR pixels in gum areas of tooth. Thus, overall accuracy of the technique limits the usage.

Toshiaki Tsuji proposed assessment of variance in luminance component of an image to detect the SR region [29]. This method is effective to detect SR generated from various illumination sources. It removes the SR in original image but produces new SR with less intensity somewhere in other region. Author nullified this drawback of his own method by introducing the use of combination of flickering information of two images [30]. This method is composed of principle of reflection model, use of threshold for luminance of variance and segmentation of SR pixels using flickering information.

Doerschner et al. worked on different aspects for SR detection [31]. Authors worked on 36 videos or movies and using the concept of image velocity using spatio-temporal filters. These filters are applied on sequence of frames. Histogram of each

frame is computed to classify the specular or diffuse region. This method is also suitable for 3D images and also predicts subjective perception.

The use of chaotic clonal selection algorithm is proposed by Akbar et al. [32]. The algorithm is an iterative calculation of threshold based on segmentation. An approach based on Walsh-Hadamard kernel is applied on the segmented image to get SR removal. The patch based coherency sensitive hashing algorithm is suggested for this SR in-painting using kernel. The complete SR removal process is compared with state-of-art methods and proved the significance of the same. The segmentation algorithm is also found effective than PSO through experimentation undertook by the authors.

Shah et al. worked on specularity removal of images of roads [33]. Authors considered the limitations of state-of-art methods applied on illuminant invariant images. The effect of wrong assumptions which rarely observed in road images is explained by the authors. They proposed a segmentation method using graph-cut algorithm to detect the SR patches from any road image. In-painting is done by morphological image processing. The quantitative step up of the SR removal method is explained with different performance measures and running time.

The state-of-art methods explained in this section are summarized in Table 4. The necessity of the every time training is a major demerit of using this classification principle.

Table 4 State-of-art methods based on SR detection as a classifier or segmentation problem

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Hokland et al. [25]	Simulated ultrasonic image	Restoring SR pixels by stochastic relaxation and iterative de-convolution algorithm	–	Yes	Restoration better than Wiener filtering does not produce ringing effect	Multiple target echoes affects standard envelope imaging estimation of accuracy number of regions is most sensitive to accuracy
Stoyanov and Yang [26]	3D laproscopy	Temporal registration of non-rigid surface motion	Luminance histogram	Yes	Used in robot assisted laproscopy surgery	Noise and complex reflectance components are not considered

(continued)

Table 4 (continued)

Contribution	Image modality	Methodology	OQA	SQA	Merits	Remark
Levine et al. [27]	Facial images	Region growing illumination component in-painting	Accuracy	Yes	No need of any camera specification	Improper selection of seed pixel is most vulnerable
Lee et.al. [28]	Tooth images	Perceptron Neural Network (PNN) spatial smoothing filtering	Luminance histogram	Yes	Simple design using line intensity profile	Inaccurate SR detection in gum areas
Tsuji et al. [29 and 30]	General purpose images	Estimation based on luminance variance combination of flickering information	Luminance histogram	Yes	Effective separation of SR from AC and DC luminance	Occurrence of new SR in same image needs two images at a time for feature extraction
Akbar et al. [32]	General purpose images	Chaotic clonal selection algorithm coherence sensitive hashing	Mean Square Error (MSE)	Yes	Effective against state-of-art classification algorithms	Need of every time training

6 Performance Analysis of SR Detection Techniques and Research Gaps

Quantitative analysis of any image processing algorithm can be carried out by comparison with original images. These original images need to be captured with proper illumination. Most of the reported literature for automatic SR detection (reviewed in Sects. 2–5) considered medical images under experimentation. However, it is not practically possible to get ground truth images in medical imaging. Thus, researchers preferred to have subjective quality assessment of their respective proposed SR detection and removal techniques. Table 1, 2, 3 and 4 enlists various objective assessment measures promoted by researchers. Most of the reported work is validated by using expert grading and mathematical quality attributes.

Table 5 Summary of SR detection state-of-art methods

Sr. No.	Category	Merits	Research Gaps
1	Use of DRM	Separation of specular and diffuse components without any segmentation technique	Incapable of handling smooth changes in intensity and less identification of saturated specularity
2	Use of kernel as a filter	Excellent of detecting ROI of any shape	Size and shape of kernel limits the usage or difficult to choose
3	Thresholding	Simplest system design and less complex	Arbitrary selection of constant must vary with respect to database
4	Classification or segmentation	Capability of work on complex scenes	Need of every time training affects the overall usage

The state-of-art methodologies for SR detection and removal are overviewed in Sects. 2–5. All methods are categorized in four groups based on working principles. Summary of this review is given in Table 5.

All the categories explained in above sections provides explanation for the state-of-art methods of SR detection. Each category has some pros and cons. However, complete removal of specular reflections is must before any further image analysis. Thus, from the detail study of these categories proposed by various researchers, we suggest a possible way out to design a complete automatic system independent of database and image modality for detection and replacement of SR pixels occurring in an image.

7 Use of Automatic Threshold Selection Technique Before State-of-Art SR Detection

As discussed in above sections, most of the researchers proposed the use of arbitrary constants as a threshold and various image processing algorithms. However, these suggested threshold values are outcome of experimentation undertook for specific image modality. To fill the research gap and design a complete automatic SR detection system, we suggest to apply an automatic threshold selection algorithm on input image before applying state-of-art SR detection techniques. Thus, threshold will vary automatically as per the input image modality and other characteristics and can be passed forward to SR detection algorithm.

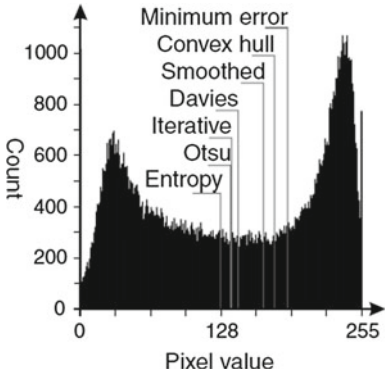

Fig. 2 Comparison of automatic thresholding techniques [35]

7.1 Survey of State-of-Art Automatic Threshold Selection Techniques

The automatic thresholding techniques can be broadly classified in five groups according to the information content, viz. histogram based, clustering based, entropy based, object attribute based and statistical relation based. In histogram shape-based methods, the major intensity, decimation in intensity range and non-linear nature of the smoothed histogram get analyzed. The method works on input image histogram to calculate the optimum threshold. In clustering-based methods, input image grey level pixels are divided in two parts as background and foreground pixels. Entropy-based methods use regional entropy, cross entropy of the foreground and background regions, original and binary image, etc. Object attribute-based methods focus on similarity between the gray-level and its black and white version. The statistic relation based methods use higher-order moments and/or correlation between pixels for threshold selection [34].

The reported techniques of automatic thresholding, principally depends on the calculation of either bi-modal distribution or multi-modal thresholding. To get SR pixels, which are always bright, bi-modal distribution is adequate and histogram based approach may be preferred for the same. A review on automatic threshold selection techniques based on histograms is given in Table 6.

Donald Bailey compared adaptive thresholding techniques given in Table 6 for performance analysis. As shown in Fig. 2, author concluded that Kittler's minimum error method is best for automatic selection of threshold [35].

Sezgin and Sankur [34] compared the performance of thresholding techniques using five quality measures viz. misclassification error (ME), edge mismatch (EMM), relative foreground area error (RAE), modified Hausdorff distance (MHD) and region non-uniformity (NU). They calculated average score of each technique and rank of individual quality measure and concluded with Kittler and Kapura as best adaptive thresholding techniques.

Table 6 Survey of automatic threshold selection techniques

Contribution	Criteria function	Significance	Remarks
Bailey DG [35]	Histogram represented as combination of Gaussian mixture of different modes	Approximation of histogram is scale dependant (Ţ) for number of mode selection	Computationally complex
Riddler TW [36]	Starts with mean of histogram Updates the threshold as average of lower mean and upper mean of histogram Stops if lower and upper threshold difference is zero	Simple and speedy Detected threshold is useful for foreground separation	SR intensities are always brighter Not suitable for SR detection
Otsu N [37]	Minimizing intra-class variance between two regions of histogram (left and right)	Best suitable for histograms with clear valley between the modes	Not suitable for histograms where object and b/g are not well separated
Kapur JN et al [38]	Maximization of entropy between two regions	Works on actual information extraction of two modes	SR detection does not required to know average information of lower intensity pixel region
Kittler and Illingworth [39]	Minimum error thresholding with respect to std. deviation of both sub-histograms	Moderate threshold selection Good for proper foreground detection	Some changes in partitioning required for high intensity threshold selection
Davies ER [40]	Geometric mean of difference between histogram point and peaks on either side	Global valley approach for detecting valley regions in histogram	Cervigrams not necessarily have valleys. SR region is generally uniform with respect to higher intensities
Patra S et al [41]	Calculated energy of pixel over 3 * 3 neighborhood	Proposed energy curve which behaves similar to histogram with valleys and peaks	Applicable for spatial contextual information not appropriate for multi-level histogram

Above discussion of literature related to automatic threshold selection promotes the significance of Kittler method due to its minimum error consideration. Thus, it may be applied on previously discussed state-of-art SR detection techniques to increase in the accuracy of algorithms.

7.2 *Qualitative Analysis of Applying Kittler Method on State-of-Art SR Detection Techniques*

We have experimented on 10 non-medical images collected from internet. State-of-art SR detection techniques viz. Zimmerman et al. [19] and Alsaleh et al. [21] are chosen based on the popularity. Kittler method of automatic threshold selection [39] is applied on these two techniques to replace arbitrary constants suggested in [19] and [21]. Figure 3 shows the comparative analysis of SR detection using original method and combination with Kittler method.

The SR pixels can be seen visually in original image. It can be easily observed from Fig. 3 that there is reduction in detection of non-SR pixels. The appropriate method of SR detection will produce sizable increase in the accuracy.

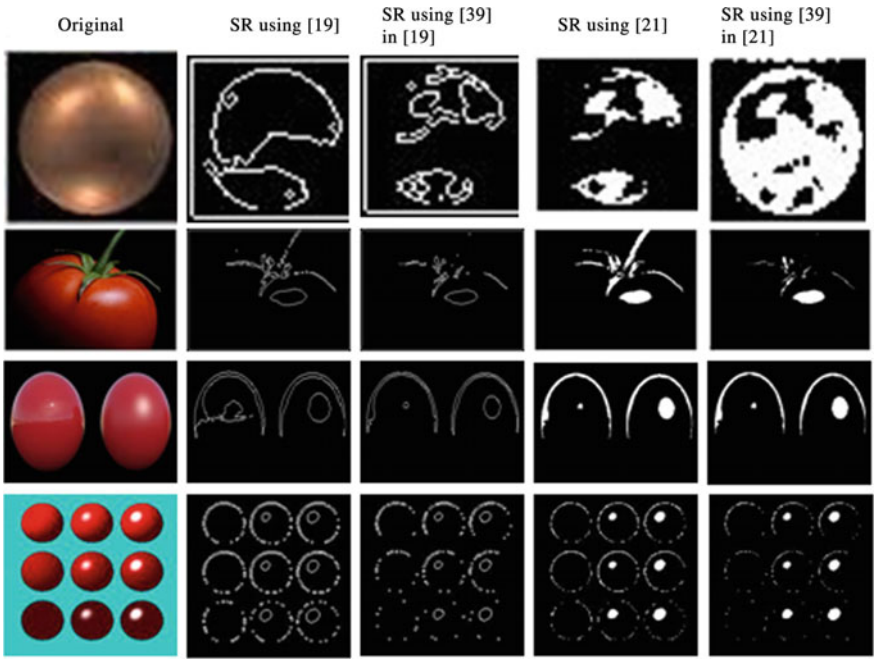

Fig. 3 Comparison of use of Kittler automatic thresholding technique on state-of-art SR detection methods

Table 7 Quantitative analysis of Kittler automatic threshold selection techniques on state-of-art SR detection methods

Image	Zimmerman et al. [19]	Use of Kittler[39] on [19]	Alsaleh et al. [21]	Use of Kittler [39] on [21]
1	0.4698	0.4916	0.5053	0.74
2	0.1569	0.18	0.1609	0.21
3	0.1294	0.1645	0.1496	0.1622
4	0.1716	0.2482	0.1320	0.1998

7.3 Quantitative Analysis of Applying Kittler Method on State-of-Art SR Detection Techniques

Kudwa et al. [18] proposed using Jaccard Index (JC) to measure the quality of SR detection method. Accurate detection of SR pixels and less detection of non-SR pixels increases the value of JC. Table 7 compares the JC of SR detection using [19] and [21] with the addition of Kittler method in [39]. This JC is calculated for manually marked SR pixels and actual detected SR pixels.

Use of Kittler method shows increase in the value of JC. It justifies that more SR and less non-SR pixels are detected with the use of automatic thresholding.

8 Conclusion

The state-of-art methods of SR detection in the input image are reported in this paper. The methods are categorized with respect to working principle and compared through various aspects of performance analysis. The research gaps from study of these categories are also reported. To avail completely error free image for appropriate analysis, a fully automatic and database independent system of SR removal is the need of the hour. This can be achieved with the help of automatic threshold calculation. A detail survey of such automatic calculation of threshold is elaborated in Sect. 7. From the overall review and the experimental analysis, it can be inffred that Kittler minimum error threshold selection method canbe applied on input image before use of state-of-art SR detection principles. The proposed solution increases the Jaccard Index (JC) which demonstrates accurate detection of SR pixels and less detection of non-SR pixels. Perfect SR free image can be used for automatic diagnosis through computer aided system stages like feature extraction, classification etc.

References

1. Barrow H, Tanenbaum J (1978) Recovering intrinsic scene characteristics from images. Comput Vis Syst 3–26
2. Artusi A et al (2011) A survey of specularity removal methods. Comput Graph Forum 30(8):2208–2230
3. Khan HA et al (2017) Analytical survey of highlight detection in color and spectral images. In: Bianco S et al (eds) Computational color imaging, CCIW, Lecture notes in computer science, vol 10213. Springer, Cham
4. Yoon KJ et al (2006) Fast separation of reflection components using a specularity-invariant image representation. In: Proceedings of IEEE international conference on image processing, pp 973–976
5. Meslouhi O, Kardouchi M, Allali H, Gadi T, Benkaddour Y (2011) Automatic detection and inpainting of specular reflections for colposcopic images. Cent Eur J Comput Sci 1(3):341–354
6. Madooei A et al (2015) Detecting specular highlights in dermatological images. In: IEEE international conference on image processing (ICIP), Quebec, pp 4357–4360
7. Suo J et al (2016) Fast and high quality highlight removal from a single image. IEEE Trans Image Process 25(11):5441–5454
8. Tao MW et al (2016) Depth estimation and specular removal for glossy surfaces using point and line consistency with light-field cameras. IEEE Trans Pattern Anal Mach Intell 38(6):1155–1169
9. Asiedu M et al (2017) Low cost, speculum free, automated cervical cancer screening: bringing expert colposcopy assessment to community health. Ann Glob Health 83(1):193–207
10. Wang F et al (2017) Specularity removal: a global energy minimization approach based on polarization imaging. Comput Vis Image Underst 1–9
11. Lamprinou N et al (2018) Fast detection and removal of glare in gray scale laparoscopic images. In: Proceedings of the 13th international joint conference on computer vision, imaging and computer graphics theory and applications, vol 4, pp 206–212
12. Lange H (2005) Automatic glare removal in reflectance imagery of the uterine cervix. Medical Imaging: Image Processing. https://doi.org/10.1117/12.596012
13. Sun K, Sang N (2007) Enhancement of vascular angiogram by multiscale morphology. In: 2007 1st international conference on bioinformatics and biomedical engineering, Wuhan, pp 1311–1313
14. Xue Z et al (2007) Comparative performance analysis of cervix ROI extraction and specular reflection removal algorithms for uterine cervix image analysis. In: Proceedings of SPIE 6512, Medical Imaging: Image Processing, 65124I. https://doi.org/10.1117/12.709588
15. Yao R et al (2010) Specular reflection detection on gastroscopic images. In: 4th international conference on bioinformatics and biomedical engineering, Chengdu, pp 1–4
16. Tchoulack S et al (2008) A video stream processor for real-time detection and correction of specular reflections in endoscopic images. In: Joint 6th international IEEE northeast workshop on circuits and systems and TAISA conference, Montreal, QC, pp 49–52
17. Das A et al (2011) Elimination of specular reflection and identification of ROI: the first step in automated detection of cervical cancer using digital colposcopy. In: IEEE international conference on imaging systems and techniques, Penang, pp 237–241
18. Kudva et al (2017) Detection of specular reflection & segmentation of cervix region in uterine cervix images for cervical cancer screening. IRBM 38:281–291
19. Zimmerman G, Greenspan H (2006) Automatic detection of specular reflections in uterine cervix images. In: Proceedings of SPIE, vol 6144, Medical Imaging: Image Processing, 61446E. https://doi.org/10.1117/12.653089
20. Shen HL, Cai QY (2009) Simple and efficient method for specularity removal in an image. Appl Opt 48(14):2711–2719
21. Alsaleh SM et al (2015) Automatic and robust single-camera specular highlight removal in cardiac images. In: 37th annual international IEEE conference of engineering in medicine and biology society (EMBC), Milan, pp 675–678

22. Guo J et al (2016) A specular reflection suppression method for endoscopic images. In: IEEE 2nd international conference on multimedia big data, Taipei, pp 125–128
23. Jiao J et al (2016) Highlight removal for camera captured documents based on image stitching. In: IEEE 13th international conference of signal processing, Chengdu, pp 849–853
24. Digiovanni S et al (2016) Healthcare system: a digital green filter for smart health early cervical cancer diagnosis. In: IEEE 2nd international forum on research and technologies for society and industry leveraging a better tomorrow (RTSI), Bologna, pp 1–6
25. Hokland J et al (1996) Markov models of specular and diffuse scattering in restoration of medical ultrasound images. IEEE Trans Ultrason Ferroelectr Freq Control 43(4)
26. Stoyanov D, Yang GZ (2005) Removing specular reflection components for robotic assisted laparoscopic surgery. In: IEEE international conference on image processing, Genova, pp III–632
27. Levine MD, Bhattacharyya J (2005) Detecting and removing specularities in facial images. Comput Vis Image Underst 100:330–356
28. Lee S-T, Yoon T-H, Kim K-S, Kim K-D, Park W (2010) Removal of specular reflections in tooth color image by perceptron neural nets. In: 2nd international conference on signal processing systems (ICSPS), pp 285–289
29. Tsuji T (2010) Removal of specular reflection light on high-speed vision system. In: Proceedings of IEEE international conference on robotics automation, pp 1542–1547
30. Tsuji T (2011) "An image-correction method for specular reflection removal using a high-speed stroboscope", IECON 2011. In: 37th annual conference of the IEEE industrial electronics society, Melbourne, VIC, pp 4498–4503
31. Doerschner K et al (2011) Rapid classification of specular and diffuse reflection from image velocities. Pattern Recogn 44:1874–1884
32. Akbar H, Herman NS (2016) Removal of highlights in dichromatic reflection objects using segmentation and inpainting. In: 2016 international conference on robotics, automation and sciences (ICORAS), Melaka, pp 1–4
33. Shah F, Shah P, Dubey R (2016) Specularity removal for robust road detection. IEEE region conference (TENCON), Singapore, pp 1853–1858
34. Sezgin M, Sankur B (2004) Survey over image thresholding techniques and quantitative performance evaluation. J Electron Imaging 13(1):146–165
35. Bailey DG (2011) Histogram operations. In: Design for embedded image processing on FPGAs, vol 1. Wiley-IEEE Press, pp 352
36. Ridler TW, Calvard S (1978) Picture thresholding using an iterative selection method. IEEE Trans Syst Man Cybern 8(8)
37. Otsu, N. (1979). A threshold selection method from gray-level histograms. IEEE Trans. Sys. Man. Cyber. 9(1): 62–66. https://doi.org/109/TSMC.1979.4310076
38. Kapur JN et al (1985) A new method for grey level picture thresholding using Entropy of the histogram. IEEE Trans Comput Vis Graph Image Process 29:273–285
39. Kittler J, Illingworth J (1986) Minimum error thresholding. IEEE J Pattern Recogn 19(1):41–47
40. Davies ER (2008) Stable bi-level and multi-level thresholding of images using a new global transformation. IET Comput Vision Spec Issue Vis Inf Eng 2(2):60–74
41. Patra S et al (2014) A novel context sensitive multilevel thresholding for image segmentation. Elsevier Appl Soft Comput 23:122–127

Significant Improvement in Classification Performance Metrics by Ensemble Approach

Meenakshi A. Thalor, Veena Bhende and Amrapali Chavan

Abstract Today most of real time applications are source of big data and classification process over huge amount of this data is a challenge. The training of a single classifier with such type of large amount of data causes plasticity–stability problem. A single classifier is not able to preserve large amount of knowledge when it starts to learn new knowledge. This paper gives the introduction about the ensemble and techniques to generate ensemble which shows that how one can maintain stability between bias and variance to improve classification performance. Various classification performance metrics are elaborated and effect of ensemble size on different evaluation measures is also demonstrated.

Keywords Base classifiers · Classification · Classification performance metrics · Ensemble · Evaluation measures

1 Ensemble Based Learning

Sometimes the data on which one wants to perform learning is so huge that it's not possible to process or analyze such vast amount of data by one classifier. This huge amount of data can be analyze by partitioning data into smaller chunks and pass smaller chunks to multiple classifiers(ensemble) rather than one classifier. Once the learning over different chunk of data is done or model is ready the unseen data can be passes to different classifiers for classification. Each classifier will predict the class of unseen data then by using different voting approaches one can combine the outcome and come to a final class conclusion. The Ensemble based classification [1] achieved by grouping the classifiers by some way then individual predictions of each classifier is combined to classify unseen data.

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2 Components of Ensemble

In order to do the classification using an ensemble approach, first one has to consider following elements of ensemble.

2.1 Training Set

For supervised learning, the basic requirement is a training dataset. A labeled training dataset consists of instances and their corresponding class variable. An instance is feature value vector which can be represented in a variety of languages. Generally set of instances are represented by X which consist of n attributes $X = \{x_1, \ldots, x_i, \ldots, x_n\}$ and Y to represent the class label or the target attribute.

2.2 Base Classifier

The base classifier is a classification algorithm that attains a training data and makes a model that specifies the association between the input variables and the class variables.

2.3 Diversity Generator

The main element which is responsible for creating the different classifiers is called diversity generator. In order to create diverse classifiers in ensemble various techniques are proposed in literature [2, 3] as mentioned below:

a. Using diverse training sets
b. Using diverse feature subsets
c. Using diverse classifier models
d. Using diverse combination schemes.

2.4 Combiner

The purpose of combiner is to join the prediction outcome of the various classifiers. The outcome of an ensemble depends on the selection of appropriate rule to unite the decision of each classifier. Voting rule is applied at the final step of ensemble system.

3 Ensemble Generation Methods

Ensemble is combination of set of diverse classifiers, which collectively do decision making and predict the label for unseen data. Generation of classifiers in ensemble [4–7] can take place in different ways. Ensemble can be generated in sequence, in parallel or in layered form. Following are the state of art ensemble learning approaches.

3.1 Bagging

The quality of classification model is assessed by two independent parameters i.e. bias and variance. A trade-off always exists in between a classifier's ability to minimize bias and variance. To minimize variance one of the best approaches is bagging where training data is divided into different subset using sampling and multiple independent classifiers are generated. These independent classifiers collectively predict the target class for unknown label. Bagging also known as Bootstrap Aggregating which is one of initial ensemble based approach to combine classifiers by providing the different set of inputs using sampling with replacement, finally the prediction of unlabeled data is given by all classifiers using majority voting approach which guarantee the decrease in variance and errors will be ignored.

Bagging creates set of classifiers in parallel and gives fast learning. The motivation behind bagging [8] is to reduce variance by considering different bags of original training data and construct a different classifier for each bag.

3.2 Boosting

The boosting [8] method creates a set of classifiers horizontally where initially uniform weight is assigned to each example of training set and a classifier is generated. The weight of every example is updated afterward; the weight coefficient of correctly classified instances get decrease and weight coefficient of incorrectly classified instances remain same. In every iteration, this weight updation is first performed and a new classifier is generated so that new classifier can focus on incorrectly classified examples. The motivation behind boosting is to increase the prediction power of classifiers by giving more weightage to incorrectly classified instances and reduce difference between model's predictions and true targets (bias).

3.3 Stack Generalization

Stacked Generalization is also known as Stacking or Blending in literature. Stacking is an ensemble forming and learning technique which combine models of different type unlike bagging and boosting. The process of stacking is explained as follows:

1. Divide the available entire training set into two separate sets.
2. Generate several base classifiers by proving training on the first part of training set.
3. Test all generated base learners on the second part of training set.
4. Using the correct predictions from step 3 and make a new and different train-ing set for providing training to next level of learner.

3.4 Mixture of Experts

The mixture of experts is an ensemble learning process where the generalization performance is improved by dividing the main task into subtasks and allocating these different subtasks to different experts. The main aim of mixture of expert is provide concurrent training to all different experts and using a gating network. The purpose of gating network is assign "probability" to each participant expert depending on the current input. During training phase, this probability value represent the probability of a pattern appears in the training set of an expert. During testing phase, this probability value specifies the comparative expert's contribution to the ensemble.

4 Classification Performance Metrics

The performance of any classification model/tool is measured by using some metrics. For experimental purpose and comparative analysis, different evaluation measures [9] as explained below are considered.

4.1 Confusion Matrix

A confusion matrix is a matrix that is generally used to depict the performance of a classifier on test data for which the true values are prior available as shown in Fig. 1.

		Predicted Outcome	
		Positive	Negative
Actual Outcome	Positive	TP	FN
	Negative	FP	TN

Fig. 1 Confusion matrix

4.2 Accuracy

It is the proportion of amount of correct classified predictions out of the total number of predictions as given in Eq. (1). The best accuracy value is 1.0, while the worst value is 0.0. It can also be calculated by 1—ERR.

$$Accuracy = \frac{TP + TN}{TP + FN + FP + TN} \tag{1}$$

4.3 Error Rate

Error rate (ERR) is calculated as the amount of all incorrect predictions divided by number of examples in the dataset as given by Eq. (2). The best error rate value is 0.0, while the worst value is 1.0.

$$\text{Error rate} = 1 - \text{Accuracy} \tag{2}$$

4.4 Precision

It is a measure of exactness as given in Eq. (3), which states how many positive examples are actually labeled correctly out of total positive prediction. The best value of precision is 1.0, while the worst value of precision is 0.0.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{3}$$

4.5 Recall

It is a measure of completeness as given in Eq. (4), which states how many positive examples are actually labeled correctly. The best sensitivity value is 1.0, while the worst value is 0.0.

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{4}$$

4.6 F-Measure

This evaluation measure is used to evaluate the balance between Recall and Precision as given in Eq. (5). Here β is a coefficient and its value varies from 0 to 1 to vary the importance of precision versus recall.

$$\text{F} - \text{Measure} = \frac{(1 + \beta)^2 \cdot \text{Kecall.Precision}}{\beta^2.\text{Recall} + \text{Precision}} \tag{5}$$

4.7 G-Mean

It is the ratio between positive accuracy and negative accuracy as given in Eq. (6).

It is calculated to measure the stable performance of a model between the classes.

$$\text{G} - \text{mean} = \sqrt{\frac{\text{TP}}{\text{TP} + \text{FN}} \times \frac{\text{TN}}{\text{TN} + \text{FP}}} \tag{6}$$

5 Experimental Results

Experimental results are carried out on ensemble generated through bagging approach where Reliance intraday dataset with 5251 instances and naïve bayes as base classifier is considered. Using diverse training sets, diversity is introduced in ensemble and precision, recall, accuracy, f measure and g-mean are evaluated using different ensemble size. Figure 2 shows the effect of ensemble size on classification performance metrics. Results show that the performance of all above mentioned evaluation measures are less when size of ensemble is less. The performance of considered evaluation measures are better and stable when the ensemble size is not too less or not too more. This shows that classification performance metrics can be improved with use of ensemble but need to maintain a balance different evaluation measures for that the ensemble size should not be too less or too high.

6 Conclusion

This paper gives a detail description of ensemble learning, basic components of ensemble, approaches to combine the decision of each classifier in ensemble and

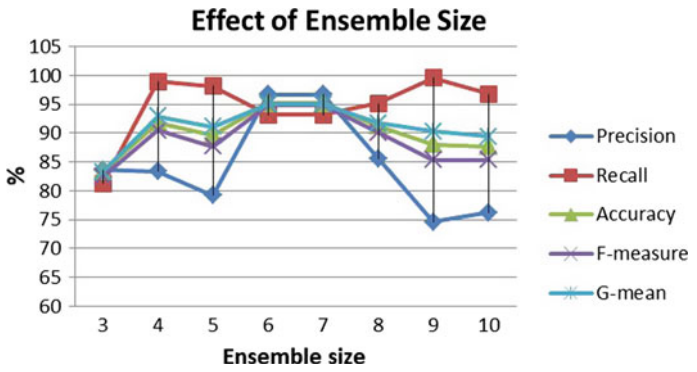

Fig. 2 Effect of ensemble size on performance of classification

methods to generate different types of ensemble. Based on review, conclusion is that the bagging approach to design an ensemble is effective one as reduce the variance whereas boosting improves the model perform by considering misclassified instances. One can make use of hybrid approach which is combination of boosting and bagging to take the advantage of both approaches. For optimal performance one has to maintain a balance between different evaluation measures for that the ensemble size should not be too less or too high.

References

1. Polikar R (2006) Ensemble based systems in decision making. IEEE Circuits Syst Mag 6(3):21–45
2. Polikar R (2007) Bootstrap-inspired techniques in computational intelligence. IEEE Signal Process Mag 59–72
3. Rokach L (2010) Ensemble-based classifiers. Artif Intell Rev 33(1):1–39
4. Thalor MA, Patil ST (2014) Review of ensemble based classification algorithms for non-stationary and imbalanced data. IOSR J Comput Eng 16(1):103–107
5. Thalor MA, Patil ST (2016) Learning on high frequency stock market data using misclassified instances in ensemble. Int J Adv Comput Sci Appl 7(5):283–288
6. Thalor MA, Patil ST (2016) Incremental learning on non-stationary data stream using ensemble approach. Int J Electr Comput Eng 6(4):1811–1817
7. Thalor MA, Patil ST (2016) Learning framework for non-stationary and imbalanced data stream. Int J Eng Technol 8(5):1942–1945
8. Galar M, Fernandez A, Barrenechea E, Bustince H, Herrera F (2012) A review on ensembles for the class imbalance problem: bagging-, boosting-, and hybrid-based approaches. IEEE Trans Syst Man Cybern 42(4):463–484
9. Davis J, Goadrich M (2006) The relationship between Precision-Recall and ROC curves. In: Proceedings of the 23rd International Conference on Machine learning, pp 233–240

Improvement in Satellite Images by Amalgam of Brovey and PCA Algorithm with Artificial Neural Network

Kavita Joshi, Dilip D. Shah and Anupama A. Deshpande

Abstract Image processing is playing a major role in almost all the field to renovate the original images. Image processing includes image capturing, then pre-processing, segmenting, extraction of features and classification. Authors are proposing a method of fusion of the panchromatic and hyperspectral images and then classification using ANN. After pre-processing of satellite image, Segmentation of image have been carried out using fusion techniques incorporating brovey and Principal component analysis which is proven to present best results in terms of enhancement. Authors have achieved accuracy of 95.1% with processing delay of 43.79 ms for 1600 blocks training in NN.

Keywords Neural network · Satellite image · Classification · Fusion · Principal component analysis · Brovey

1 Introduction

Research in image processing has emerged as a trending area for analysis of images. Various methods have been evolved for different stages during processing of images. Different tools are also armed for processing purpose [1]. Processing of images contains acquiring the image, removing the unwanted noise, enhancing the specific area of interest, extracting the features and finally classification to get the exact knowledge of requirement under interest [2]. Now a days a wide range of applications has been extracted from remote sensing data. It includes drought conditions assessment,

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water resources availability, land cover, forest cover, estimation of crop [3, 4]. There are various sources for acquisition of the satellite images. The images are researched to zone out forest cover, mountains, river, farming area and various other parameters depending on requirement [4], Satellite images are available in hyperspectral, Multispectral, panchromatic and variety of ways. As compare to multispectral image, hyperspectral image contains more sensitive information which depicts more precise information within the specific area. Sources of hyperspectral satellite image includes Spectrometer (AIS), AVIRIS, CASI, HyperCAM and Hymap [5].

The bands available in the images pertain color and shape information. Next step after acquisition of image includes image preprocessing. Gaussian noise mostly gets noticed in the satellite images. The noise fee image can be obtain by various filtering. The noise free image is further subjected to enhancement block wherein hidden areas under test are enhanced because of which segmentation process can be performed in more better way. While dealing with satellite and aircraft images utmost care need to be taken related to spatial and spectral resolutions of the images. To achieve this target, authors had implemented the hybridization of Brovey and Principal component analysis methods.

Laplacian and Gaussian is applied for enhancing the fused image. The image is further processed for segmentation wherein only regions of interest are extracted. Color map and shape map is implemented for feature extraction. There is a wide scope to classify the satellite images in a variety of ways [6]. Here the image classification is carried out by using feed forward back propagation neural network.

The goal of proposed work is to categorize each crop type from the remotely sensed image pixel using artificial neural network. Based on the experimentation some interesting observation had been evolved as shown in concluding part of this paper.

2 Literature Review

Assessing the crop when it grows gradually is vital in order to predict end products. Authors researched vegetation index based on normalized difference for achieving it [7]. Spectral mixture analysis had proven its potential to produce land cover map where multispectral data is extracted from landSAT and that data is preprocessed and re-sampled for classification wherein three algorithms were implemented namely supervised, unsupervised and object based classification [8].This study presented a new fusion approach that integrates the advantages of both spatial information and spectral information to reduce the color distortion of fusion results [9]. Texture based weed classification had been done by using different pattern such as binary, ternary and directional, yielding better results [10].

Combination of Histogram, analysis using discriminant, which is linear and stepwise and SVM had been employed for differentiating crops from unwanted species [11]. Different approach is adopted in this research for classification and segmentation. Hyper-spectral data taken from compact airborne spectrographic imager and

height information taken from Light detection and ranging (LiDAR) were combined which provided good accuracy of classification [12] on the basis of the predefined classes new objects are classified [13]. Various image processing based algorithms uses segmentation algorithm. The Concept of LCM class reference parcel (LPIS) is suggested which provides parcel based information, eliminating the use of segmentation algorithm [14].

Authors use different combinations of spectral bands derived from landSAT 8, then all were analyzed into digital environment ARCGIS 10 and vegetation indices had been calculated by using NDVI, NDBR [15]. Researchers proposed an order strategy utilizing Bayesian procedures for grouping of high-goals satellite pictures [16]. Image analysis based on object, instead of pixel is employed, where phenology of crop and multi spectral data with more spatial resolution is used which leads to accuracy of 93% [17].

3 Neural Network Based Classification on Satellite Images

In present work authors have used the following panchromatic image and Hyperspectral image as shown in Figs. 1 and 2.

Band separation is done. Four bands are obtained namely red, green, blue and grey as shown in Figs. 3, 4, 5 and 6.

Brovey Implementation: Implementation of Brovey method is achieved. The result is as shown in Fig. 7.

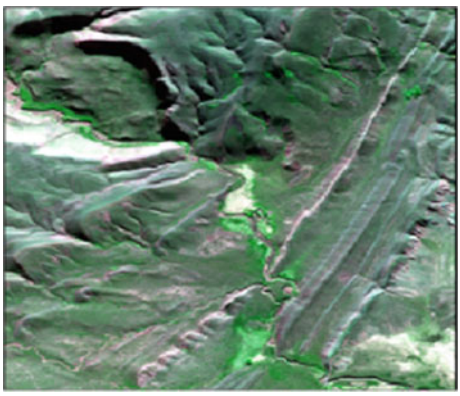


Fig. 1 Panchromatic image

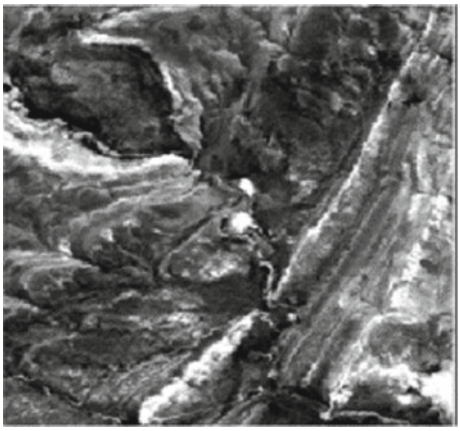


Fig. 2 Hyperspectral image

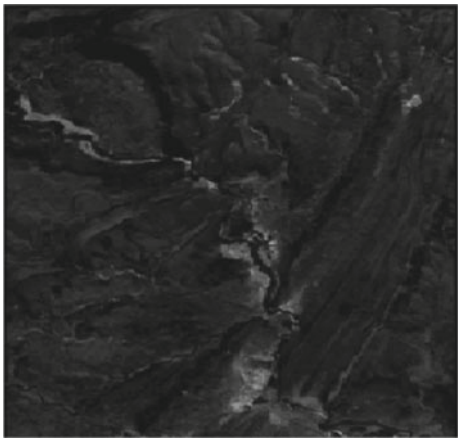


Fig. 3 Band 1

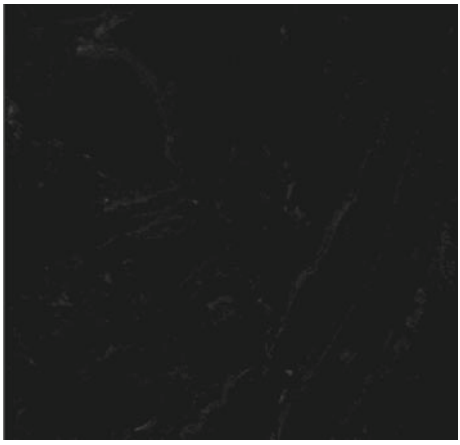


Fig. 4 Band 2

Fig. 5 Band 3

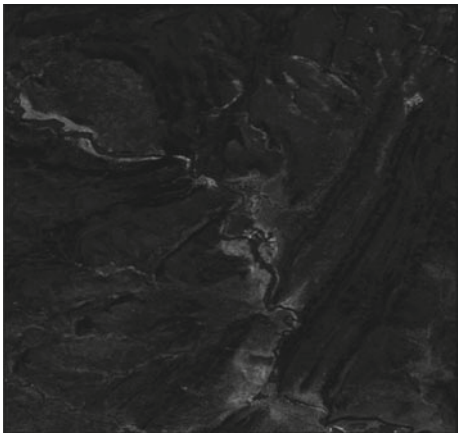


Fig. 6 Band 4

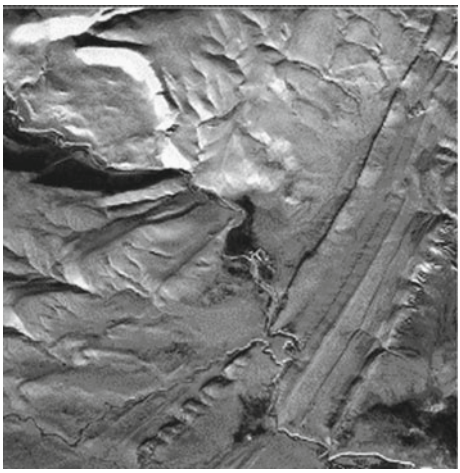
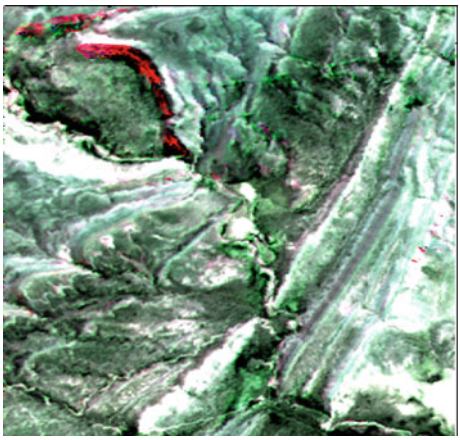


Fig. 7 Brovey image



4 Brovey and PCA Fusion Technique

The images obtained from aircrafts and satellites are not enriched both with the spectral and spatial resolutions. These images are hyperspectral, multispectral and panchromatic. The hyperspectral and multispectral images have better spectral resolution but have the drawback of less spatial resolution. Considerably panchromatic images are rich in spatial resolution but having scarcity of high spectral resolution. In order to achieve both the flavors of spatial and spectral resolution, the amalgam of both the images obtained from aircraft and satellite is achieved by using the Eq. (1),

$$Fused = \frac{(k * P * M)}{\sum M} \tag{1}$$

where, k represents the scaling constant. Author used the scaling factor as four as 4 bands, typically red, green, blue and panchromatic are taken into account for this research. Challenges in achieving the fusion occurs while adding spatial details to each band of MS images. To overcome this situation principal component analysis (PCA) is used. The information common to all bands is collected by the first principal component in PCA. Then the first band gets replaced with PAN image in the process of fusion This delivers a typical fused image as shown in Fig. 8. Fused image is now enriched with shape and color information.

5 Classification Based on Neural Network

The image obtained from fusion is further subjected to filtering and enhancement of image is achieved with the help of filtering process. In this study and implementation, authors used Laplacian and Gaussian filtering for enhancing fused image. After completing all these processes the classification of image is accomplished. Accord-

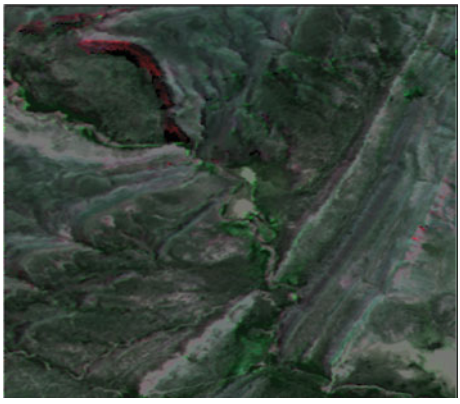


Fig. 8 Fused image

ing to various researcher's implementation survey, there are numerous methods of classification of image. Supervised and unsupervised classification are two basics methods comes under the category of classification. In this paper, implementation of the supervised classification has been achieved. Neural network is proven to be the most oftenly used classification method. Pattern Net, cascaded feed forward BP Network is used where 25 images are taken for training. Individually each image is alienated into 64 blocks. The identification of distinct farming area and within the distinct area, specific crop types identification was the objective of this research. Based on the input image taken, total 1600 sets are available for training of neural net classifier. The constitution of neural network comprised of 278 neurons at input layer, 1600 neurons in the hidden layer and 3 neurons in the output layer for particular current research.

The neural network which is designed with optimized composition is trained and tested. The tested results has proven accuracy of 95.1% as discussed in result analysis while considering various test images. Figure 9 shows the results after classification. According to classifier result the orange plantation area (red) is 30.72%, teak (green) 33.91%, others (blue) 35.35%.

6 Results and Analysis

The neural network which is designed with optimized composition is trained by using 1600 blocks and in order to estimate accuracy the same network is tested for same number of blocks of the images. Similarly the delay needed for classification is also evaluated. The results after evaluation of accuracy is depicted in Table 1.

Table 1 Accuracy versus number of blocks trained and delay comparison

Number of blocks trained	Accuracy (%) of Neural network	Delay (ms) (NN)
80	82	16.2
160	87	17.3
320	89	19.7
480	89.6	21
640	91.8	23.3
800	92	26
960	93.4	30
1120	94	34.8
1280	94.6	39.5
1440	95	43.77
1600	95.1	43.79

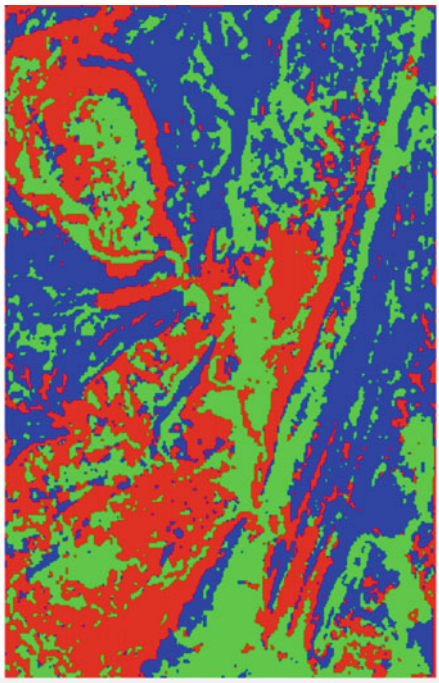


Fig. 9 Classification result

Linear inclination in accuracy of neural network classifier had been observed after increasing the training blocks and soaks near 95.1% as per the results shown in Table 1.

It also shows the delay occurred. The delay is evaluated between the instance of applying the image as an input to the classifier and the instance at which the output is obtained after classification.

As detected from the table, high delay of classification using neural network is initially observed for less number of blocks, but comparatively lessens as the number of blocks increase, because of the specialty of the neural network to trains itself once it is evaluated continuously, From the observed results, it is imminent that neural network outperforms when applied to crop region classification.

7 Conclusion

Thus neural network achieves better crop classification. From final results, we observe that the performance of neural networks is better in terms of delay and accuracy of the system. As the NN has error correcting capabilities, the overall accuracy improve, while the one shot training of the classifier plays main role for reduction in delay. Author has achieved accuracy of 95.1% with processing delay of 43.79 ms for 1600 blocks training in NN.

References

1. Polke A, Joshi K (2018) Leaf disease detection based on machine learning. In: International Conference on ISMAC in Computational Vision and Bio-Engineering (ISMAC—CVB 2018) and Springer—Lecture Notes in Computational Vision and Biomechanics, 16–17 May
2. Aware A, Joshi K (2015) Wavelet based crop detection and automatic spraying of herbicides. Int J Innov Adv Comput Sci 4(2)
3. Herbei M et al (2016) Classification of land and crops based on satellite images Landsat 8: case study SD Timisoara. Bull UASVM series Agric 73(1):29–34 (2016)
4. Richards JA (2013) Remote sensing digital image analysis, 5th edn. Springer, Berlin, 496 pp
5. Vorovencii I (2009) The hyperspectral sensors used in satellite and aerial remote sensing. Forest Management Dept., Bull Transilvania Univ Brasov 2(51):Series II
6. Schmedtmann J, Campagnolo ML (2015) Reliable crop identification with satellite imagery in the context of common agriculture policy subsidy control. 9325–9346
7. Singha M et al (2016) An object-based paddy rice classification using multi-spectral data and crop phenology in Assam, Northeast India. Remote Sens 8:1–20
8. Dhumal RK, Rajendra Y, Kale KV (2013) Classification of crops from remotely sensed images: an overview. Int J Eng Res Appl (IJERA) 3(3):758–761. ISSN: 2248-9622
9. Joshi K, Shah (2018) Hybrid of the fuzzy C means and the thresholding method to segment the image in identification of cotton bug. 13(10):7466–7471
10. Ahmed F, Kabir H, Bhuyan S, Bari H, Hossain E (2014) Automated weed classification with local pattern-based texture descriptors. Int Arab J Inf Technol 11(1)
11. Siddiqi MH, Lee S, Lee Y-K (2010) Efficient algorithm for real-time specific weed leaf classification system. J Commun Comput. ISSN 1548-7709, USA
12. Venkat A (2015) Supervised classification of agricultural crops. A case study in Vellore, India, Tufts University, School
13. Aware A, Joshi K (2016) Crop and weed detection based on texture and size features and automatic spraying of herbicides. Int J Adv Res Comput Sci Softw Eng 6(1)
14. Singha M et al (2015) An object-based paddy rice classification using multi-spectral data and crop phenology in Assam, Northeast India. Remote Sens. 8:1–20
15. Herbei M, Sala F (2016) Classification of land and crops based on satellite images Landsat 8: case study SD Timisoara. 73(1):29–34 (2016)
16. Aksoy S (2006) Spatial techniques for image classification. In: Chen CH (ed) Signal and image processing for remote sensing. CRC Press, pp 491–513
17. Almendros-Jiménez JM et al (2013) A framework for ocean satellite image classification based on ontologies. IEEE J Sel Top Appl Earth Obs Remote Sens 6(2):1048–1063

BotHook: A Supervised Machine Learning Approach for Botnet Detection Using DNS Query Data

Anuradha D. Biradar and B. Padmavathi

Abstract As of late, botnets are the most radical of all digital assaults and turning into the key issue in distributed computing. Botnets are the system of various traded off PCs or potentially cell phones. These gadgets are contaminated with pernicious code by bot ace and controlled as gatherings. The aggressors utilize these botnets for criminal exercises, for example, Distributed disavowal of administration, click misrepresentation, phishing, spamming, sniffing traffic and spreading new malware. The primary issue is how to identify these botnets? It turns out to be all the more intriguing for the analysts identified with digital security? This rouses us to compose a survey on botnets, its engineering and identification procedures. By checking DNS asks for, one can identify the presence of bots and botnets. Along these lines, We proposes a botnet discovery demonstrate dependent on machine learning using DNS query data and increment its adequacy utilizing machine learning systems.

Keywords Domain name service · Botnet detection · Machine learning · Bot

1 Introduction

A botnet is an intelligent gathering of web associated gadgets, for example, PCs, cell phones or IOT gadgets, every one of which is running at least one bots. A bot is a robotized program that keeps running over the Internet. Bot is emerge from word "Robot". Systems of bots controlled by a bot master. Bot master is a person who plan and control the botnet. Botnets can be utilized to perform distinctive assignments, for example, Distributed denial-of-service attack, transmit malware, send spams, steal sensitive data, phishing assaults. The primary distinction among botnet and different kinds of malware is the utilization of the C&C servers, which causes the

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botmaster to deal with the fevered gadgets remotely. The exploration by Stevanovic, et al. expressed that 40% of PC machines in globe are a piece of botnets. Symantec expressed that all things considered, 42 billion spam messages multi day around the globe were caused by botnets. Today the Internet is very subject to the DNS. Domain Name Service (DNS) is an important service on web which permits the resolution of host names, or domain names to IP address and IP address to domain names. For instance, when customer gets to a website page it initially send a demand to the DNS framework to discover the IP address of a web server, DNS gives IP address of a web server then the customer utilizes the IP address to get to the web server and load the asked for site page. In that capacity, most approved applications use DNS services while making solicitation to get to organize benefits over web. In same way bots of botnets additionally use DNS services as legitimate applications. Bots send demand to DNS to discover the IP address of Command and Control server and when they have an IP address, they get to the Command and Control server. They get directions and downloads refreshed bot code. To evade the scanning and detecting of Command and Control servers, the bot master is always showing signs of change the names and IP address of Command and Control servers. For changing names and IP address they use predefined methods, for example, Domain generation algorithms (DGA), or Fast flux (FF). Every time the name and IP address of Command and Control servers are continually pushed to DNS framework. Bots are additionally furnished with the capacity to consequently produce names of C&C servers utilizing these procedures. So bot can discover IP address of Command and Control server via naturally producing their hostnames to query the DNS service. Consequently monitoring and analyzing DNS query data can tell the presence of malevolent exercises in checked system, since a portion of the DNS query data might be produced by botnets. This paper analyzes and assesses the viability of the botnet detection strategy utilizing DNS query data dependent on machine learning methods, for example, KNN, Decision Tree, Naive Bayes, Random Forest and SVM.

2 Related Work

Due to the strong improvement of botnets and the data security hazards that they may reason, the identification of botnets in the systems is a best analysts topic. In this segment, we quickly survey the related work on Botnet Detection and their diverse systems.

We proposed machine learning based botnet identification demonstrate utilizing DNS query data and ascertain its viability utilizing machine learning systems. The given outcomes on DGA botnet and FF botnet datasets result that a large portion of the machine learning systems utilized in model accomplished the general grouping precision more than 85%, compare than random forest algorithm gives the 90.80% of order exactness [1].

They made an establishment for an anomaly based intrusion detection framework to expand network security and to help limit human inclusion and blunder.

They utilized network traffic for caught as connection logs, which are produced by network checking structure called Bro. They look at the exhibitions of various managed learning approaches, including Logistic Regression (LR), Naive Bayes (NB), Support Vector Machine (SVM), Random Forest (RF) and Neural Networks (NN) at anomaly detection by utilizing proposed structure. They said that Random Forest gives us the best execution for anomaly detection. To test every single calculation's capacity to sum up to concealed bot types, the executed a hand crafted Leave-One-Out Cross Validation (LOBO-CV) [2].

In this they proposed a methodology for distinguishing the call backs dependent on the randomness of domain names. This mean to distinguish progressively produced domain names from monstrous DNS queries to recognize DGA bots. A Domain Generation Algorithm is a procedure for concealing the call backs of bots by changing the domain name of a command and control server. Along these lines, they proposed a methodology for estimating the randomness of domain names by utilizing lexical analysis. This methodology depends on two perceptions: (1) there are noticeable contrasts in the strings of dynamically generated domain names and human-produced domain names, and (2) the strings of dynamically generated domain names show the randomness since conflicts with already registered domain names must be avoided [3].

They displayed BotScoop approach for the identification of DGA based botnets. In proposed system, discovery depends on the DNS traffic examination and it makes bunches as per the likeness in the query behavior. BotScoop proficiently distinguish DGA based botnet patterns and recognize their command and control server domain with it's corresponding IP address [4].

They exhibit a novel stealthy and robust botnet. They investigate the nature of email-based P2P-like botnet, analysing the construction C&C system, evaluating the evasion ability against horizontal correlation algorithm, and discussing malware data concept drift and possible defense strategies [5].

In this, they present their current research on estimating the new bots previously they dispatch their assault dependent on real world data. They propose a rich arrangement of highlights of system traffic utilizing CONIFA structure to catch regularities in Command and Control correspondence channels and malicious traffic. They show a study of applying the approach to a popular botnet toolkit Zeus [6].

In this, they select six sorts of extraordinary features of botnet domain querying traffic dependent on the profound investigations of the DNS log. After that three classifiers are take up so as to select malicious domains from the DNS traffic utilizing those highlights. In this paper, they profoundly considered the qualities of the Rustock CN resolution traffic and select six sorts of highlights as the contribution of four famous classifiers to identify the similar botnet domain names [7].

This paper traces the chances and difficulties for recognizing botnet network acitivity and presents the survey of the most unmistakable contemporary botnet identification techniques dependent on MLAs [8].

3 Botnet Detection Using Machine Learning

3.1 Introduction to Machine Learning

It is a branch of artificial intelligence(AI) which helps to learn automatically from data to improve from experience without being explicitly programmed. Machine learning is more of an evolved from AI, Which makes great use of Statistics, Pattern recognition and knowledge discovery and data mining. Following are 3 categories of machine learning technique: supervised learning, unsupervised learning and semi-supervised learning. Supervised learning is a set of data that contains both the inputs and the desired outputs. In opposite side unsupervised learning take a set of data that contains only inputs, and find structure in the data. In the case of semi-supervised learning algorithms, some of the training examples are missing the desired output. So in this paper, we only examine the effectiveness of supervised learning techniques in the botnet detection.

3.1.1 KNN

kNN (K-Nearest neighbor) is supervised machine learning algorithm. The working of KNN is classify new object with the help of its k nearest neighbors, where, k is a predefined positive integer.

1. Load the training and test data
2. Choose the value of K
3. For each point in test data:
   - find the Euclidean distance to all training data points
   - store the Euclidean distances in a list and sort it
   - choose the first k points
   - assign a class to the test point based on the majority of classes present in the chosen points
4. End.

3.1.2 Naïve Bayes

Naïve Bayes is a conditional probability model that demonstrate

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Above condition gives the essential portrayal of the Bayes' hypothesis. Here A, B are two events.

P(A|B): the conditional probability that event A happens, given that B has happened. This is otherwise called the posterior probability.
P(A) and P(B): Probability of A, B without respect of one another.
P(B|A): Conditional probability that event B happens, given that A has happened.

3.1.3 Random Forest

Random Forest algorithm is a supervised classification algorithm. There are two phases in Random Forest calculation, one is random forest creation, the other is to make an prediction from the random forest classifier made in the primary stage.

Random Forest pseudocode:

1. Arbitrarily select "k" highlights from aggregate "m" highlights. Where k << m.
2. Among the "k" highlights, ascertain the hub "d" utilizing the best part point.
3. Split the node into daughter nodes using the best split.
4. Rehash 1–3 stages until "l" number of hubs has been come to.
5. Build forest by rehashing stages 1–4 for "n" number occasions to make "n" number of trees.

3.1.4 Decision Tree

Decision tree is a prediction model that is a mapping from perceptions of a thing, or a marvel to the decisions about estimation of things, or wonders. Decision tree makes models that permit the order of an item by making a set of decision rules. These principles are extracted dependent on the set of characteristics of the training data. In a decision tree, leaves represent to classes and every child node in the tree and its branches represent a combination of features that lead to classification. Along these lines, grouping an article will start with checking the estimation of the root node, and after that proceeding descending under the tree branches relating to those qualities. This procedure is performed over and over for every node until the point that it can't go any further and touch the leaf node. For the best model, the choice to choose the root node and sub-node while building the decision tree depends on the Information Gain (IG) and Gini Impurity estimations. The decision tree calculation utilized for analyses in this paper is C4.5 [1, 9].

3.1.5 SVM

Support vector machine is Supervised machine learning algorithm which can be utilized for both regression and classification. In this algorithm, system plots every data item as point in n-dimensional space with the estimation of a particular coordinate. After that classification by finding the hyper-plane that separate the two classes

exceptionally well. Support Vectors are essentially the co-ordinates of individual observation. Support vectors are essentially the best segregates the two classes. SVM is a standout amongst other realized methods in pattern classification and image classification. It is intended to separate of a lot of preparing pictures two distinct classes, (x1, y1), (x2, y2), …, (xn, yn) where xi in Rd, d-dimensional element space, and yi in $\{-1, +1\}$, the class name, with i = 1…n [1]. SVM assembles the ideal isolating hyper planes dependent on a piece work (K). All images, of which feature vector lies on one side of the hyper plane, are have a place with class − 1 and the others are have a place with class + 1.

4 Proposed Work

Based on existing strategy we select the Support Vector Machine (SVM) calculation for the best accuracy result. The model is based on the investigation in Section I that bots of botnets routinely send lookup queries to the DNS framework to discover IP address of C&C servers utilizing consequently produced domain names (Fig. 1).

The detection model is implemented in two stages:

(a) the training stage and
(b) the detection stage.

During training stage, the DNS query data is gathered, and after that domain names in DNS queries are separated. Next, the arrangement of domain names is pre-processed to extricate the features for the training [1]. In the training stage, SVM machine learning calculations are utilized to learn the classifiers. Through the evaluation procedure, the machine learning algorithm that gives the most noteworthy in general classification accuracy will be chosen for use in the proposed detection model. During the detection phase of the model, the DNS queries are observed and went through the way toward separating the domain names, pre-processing, and classifying using the classifier delivered from the training stage to decide whether a domain name is legitimate, or a botnet domain name. The pre-processing step for every domain name in the training and detection stage is the same [1].

Howerver, this step is done in the offline mode for all the domain names of the training dataset in the training stage while it is done for each domain name extricated from the DNS queries on the fly in the detection phase [1].

5 Experimental Result

Number of tools are available to do clustering, out of which, we used WEKA tool, one reason being its popularity and other being usability.

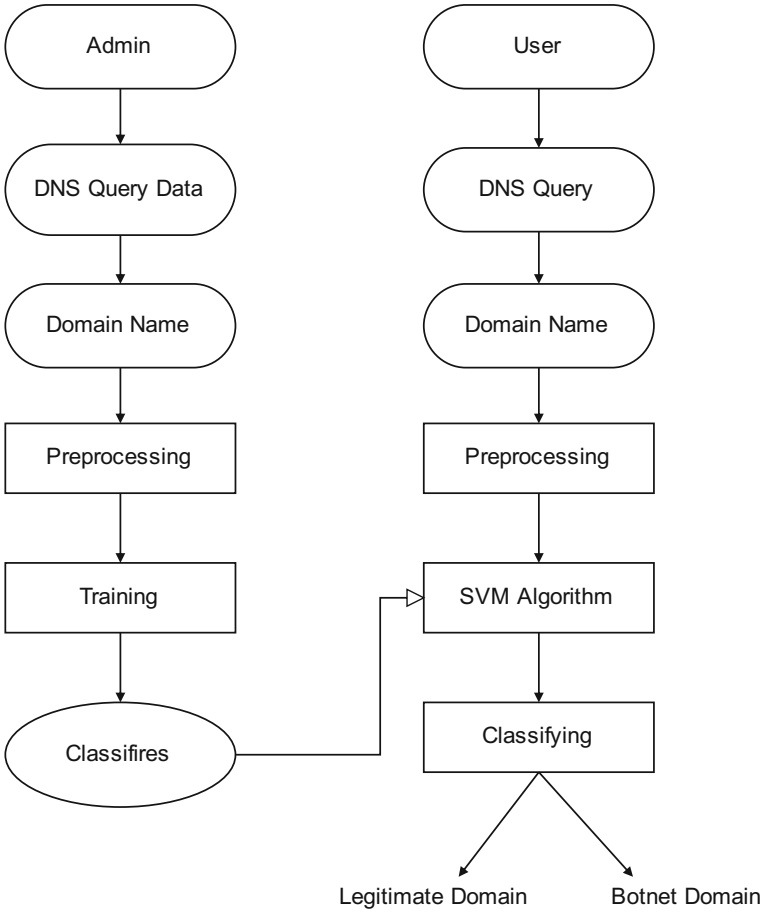

Fig. 1 Proposed botnet detection model dependent on machine learning using Domain Name Service (DNS) query data

WEKA tool

Weka stands for Waikato Environment for Knowledge Analysis. It is a machine learning programming written in java and created at University of Waikato, New Zealand. It contains a gathering of machine learning algorithms that can be used for real world problems. It contains tools for

1. Pre-processing
2. Classification
3. Clustering
4. Regression
5. Association
6. Visualization.

Table 1 Classification performance of the detection model using training set

Machine learning Algorithms	PPV	FPR	TPR	ACC	F1
KNN (k = 13)	88.50	10.60	91.00	90.10	90.20
C4.5	88.10	11.10	90.20	89.10	89.10
RF (30 trees)	90.60	9.30	89.00	90.50	90.50
Naïve Bayes	82.10	17.30	90.00	84.30	85.40
SVM	92.50	9.45	91.20	91.80	91.80

These algorithms can be applied directly to a dataset or called from own java code [10]. We have used DGA dataset [11] and applied Machine learning algorithm. The classification measures used in our experiments incorporate PPV (Positive predictive value), FPR (False positive rate), TPR (True positive rate), ACC (Accuracy) and (F1 measure). Where, TP (True Positives) is the number of records lebeled "bad" that are classified correctly, TN (True Negatives) is the number of records labeled "good" that are classified correctly, FP (False Positives) is the number of records lebeled "good" that are misclassified to "bad" and FN (False Negatives) is the number of records labeled "bad" that are wrongly classified as "good" [1] (Table 1).

6 Conclusion

In this paper we proposed adequacy of the botnet detection model dependent on machine learning strategies using DNS query data. Trial result demonstrate that Support vector machine (SVM) calculation gives best outcome among other Machine Learning calculation. In the future, we continue to test the proposed model with larger datasets and analyze the effects of the domain name features on the detection accuracy, as well as research and propose new features to improve the detection accuracy of the proposed model.

References

1. Hoang XD, Nguyen QC (2018) Botnet detection based on machine learning techniques using DNS query data. Future Internet 10:43
2. Abraham B, Mandyay A, Bapaty R, Alaliz F, Brown DE, Veeraraghavan M (2018) A comparison of machine learning approaches to detect botnet traffic. IEEE
3. Satoh A, Nakamura Y, Nobayashi D, Ikenaga T (2018) Estimating the randomness of domain names for DGA bot callbacks. IEEE Commun Lett 22(7)
4. Khehra G, Sofat S (2018) BotScoop: scalable detection of DGA based botnets using DNS traffic. In: 9th ICCCNT 2018, 10–12 July 2018, IISC, Bengaluru, India
5. Wang Z, Qin M, Chen M, Jia C, Ma Y (2018) A learning evasive email-based P2P-like botnet. China Commun

6. Azab A, Alazab M, Aiash M (2016) Machine learning based botnet identification traffic. 2016 IEEE TrustCom/BigDataSE/ISPA
7. Miller S, Busby-Earle C (2016) The role of machine learning in botnet detection. 2016 IEEE, the 11th International Conference for Internet Technology and Secured Transactions (ICITST)
8. Jin J, Yan Z, Geng G, Yan B (2015) Botnet domain name detection based on machine learning. IEEE ICWMMN 2015 Proceedings
9. Smola A, Vishwanathan SVN (2008) Introduction to machine learning. Cambridge University Press, Cambridge, UK
10. Srivastava V, Sharma A (2016) BOTNET detection approach by DNS behavior and clustering analysis. (IJCSIT) Int J Comput Sci Inf Technol 7(3):1389–1393
11. DGA Dataset. Available online: https://github.com/nickwallen/botnet-dga-classifier/tree/master/data

Query Time Optimization Using Hungarian Algorithm

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Abstract The huge amount of data that is committed to the databases, takes more time, than the time that is estimated which further creates trouble for database transactions. To untighten this process, data needs to be clustered based on common attributes, to commit data faster. Databases like Hadoop have structures like MapReduce, which are incompetent to handle the process alone. As a result, the accumulation of these transactions eventually slows down the process as well as adversely affects the performance of the application that creates havoc at the user end. The proposed system puts forth the idea of decomposing this data to hyper graphs based on correlating features between them. Furthermore, the use of Hungarian and Genetic Algorithm, achieves optimized transaction time.

Keywords Hadoop · MapReduce · Hyper graphs · Hungarian algorithm · Genetic algorithm

1 Introduction

Getting insights from available data is a challenging task. In today's era, data collected from various sources is dynamic in nature and present in overwhelming amounts. This data, which has no particular structure, is called as Big Data. Volume, variety and velocity are the three major characteristics of big data.

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Having a lot of data coming into an organization is one thing and to analyze it is a different thing. To analyze this big data, many data analytic services use Hadoop Distributed File System (HDFS) as a data warehouse and tools provided by the Hadoop Ecosystem. Increasing number of organizations want to have real time insights in order to fully understand what is going on in their organization. But as the amount of data is increasing day by day, we are facing intense need to scale the current analytic tools on big data, process it efficiently to make minimum use of our resources and provide desired results in less time. High performance and scalability have become the major concerns these days as data is growing rapidly. Companies operating in marketing sectors, online social networking sectors etc. are now capable of gathering all the data they need. However, while analyzing this data many problems occur such as higher response time to get the results or insufficient storage resources. As stated above, one of the main characteristics of Big Data is "volume", hence, optimizing the time required to obtain results of our queries is a foremost priority. A query optimizer provides solution to this problem. It is a crucial database management system (DBMS) component that determines efficient execution mechanisms by analyzing the queries. It generates one or more query plans for each query, each of which may use a mechanism used to run a query and the most efficient query plan is selected and used to execute the query. In this document, a system is put forth to optimize the query time by using Hungarian algorithm along with Genetic Algorithm and k-nearest neighbor algorithm (KNN). The Hungarian algorithm is an optimization algorithm that solves the problem by assigning the lowest-cost to the jobs so as to minimize the total time of executing all the queries. A genetic algorithm is a search based heuristic algorithm that is based on the process of natural selection where the fittest individuals of the current generation are selected for reproduction to produce offspring of the next generation. KNN algorithm can be used for classification as well as regression. It is a lazy learning, non-parameterized and supervised learning algorithm that uses a dataset in which the data objects (data points) are separated into various classes and the algorithm predicts the class of a new data object. This algorithm predicts the class out the new data object by a maximum vote of its neighbors.

2 Literature Survey

Hajeer and Dasgupta [1] transformed data into network graphs then performed clustering on them using Genetic algorithm furthermore distributed graphs on physical resources and finally was able to get optimized queries and applications.

Chopra et al. [2] proposed a distributed version of Hungarian Assessment Model. Which was used to optimize the total distance travelled by multiple robots. Here the robots were made to find suboptimal paths iteratively with the help of Hungarian Assessment model which helped robots to select best i.e. optimal path among all the possible paths.

Cao et al. [3] narrate that all currently available query methods are not efficient because there are too many ex-pensive computations involved. Their system used Hungarian Model based on similarity query method. Here they extracted the context of each place as a node and de-fined the similarity for pairs of nodes. Then, this mapping was transformed to assignment problem and was solved efficiently by using Hungarian Model.

Xie et al. [4] discussed about the problems faced for obtaining reliable as well as optimal map-ping between two networks when nodal and topological structures are considered. By using Hungarian algorithm and Greedy algorithm, every pair of node was aligned based on their sequence attributes and then they applied iterative procedure for align-ing connections Abreu and Prata [5] proposed a solution for Parallel Machine Scheduling problem with the help of Genetic algorithm with dependent setup times. Several studies have shown that it is very difficult to have the exact approach for the same because of high computational cost.

Di Nucci et al. [6] pro-posed a system, which can be used in regression testing; performed in maintenance phase of the software development. System can be used to check whether a part of software when changed, the software works as planned or not. Prioritization of test cases is done to reduce its cost. Prioritization of test cases, schedules the test case execution of available test cases. For scheduling test cases there are many fitness functions available, but it reduces the coverage scores. This paper proposes a solution over the problem using Genetic Algorithm along with Hypervolume Indicator. This system is cost effective, it increases productivity of Prioritization of test cases and it deals strongly under pressure.

Alipour-sarabi et al. [7] narrate the difficulty to obtain lower voltage and simple manufacturing processes, in designing and optimization. So here they have used meta-heuristic optimization algorithms along with optimization of the total coil numbers, cost and complexity, wherein modified functions are provided.

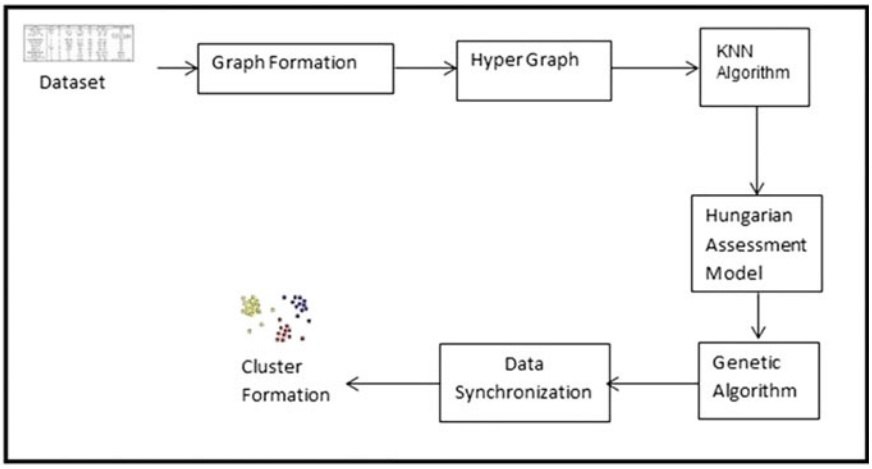
Jo et al. [8] presented PANENE, which is a progressive algorithm for nearest neighbour querying and indexing. Most of the KNN algorithms can only be used when dataset is indexed i.e. they are offline. They have also presented applications of PANENE such as Regression, Density Estimation and Responsive t-SNE.PANENE can also build and maintain the KNN lookup and cache.

Zhang et al. [9] have proved that K- nearest neighbour is very effective in fault detection for multinode characteristics, which can indeed detect it accurately; structures of different mode datasets are similar. In the designed system KNN is implemented in multinode cases and in the process of manufacturing semiconductors.

Zhang et al. [10] described that the possibilistic c-means algorithm is one of the important technologies in clustering, in recognition of pattern and data mining. This algorithm has been used in knowledge discovery and analysis of image. But for possibilistic c-means algorithm, it is difficult to work with heterogeneous big data. To solve this problem, they proposed a solution, to use high-order possibilistic c-means algorithm for big data clustering. Further, they have added distributed high-order possibilistic c-means algorithm which is based on MapReduce.

3 Proposed System

3.1 System Overview



We propose a system that transforms the data into graphs to give it a sense of structure and stores them in graph-based scalable store like neo4j. Storing data in the form of graphs allows us to stream changes dynamically. The structure of these graphs is in the form of node-predicate-node triples. The graph triples will be converted into quadruples by using chromosome_ID as an extra field to represent which node belongs to which population using genetic algorithm. Thus, the structure of the quad will become chromosome_ID-node-predicate-node. This chromosome_ID represents annexure of the cluster and not a member of the newly formed quad. The quadruples that belong to the same cluster and have a high degree of connectivity are placed into the same partition to ensure locality of intra-cluster quadruples. Closely connected inter-clusters are placed in nearby partitions physically by comparing the inter-cluster distance with the physical distance of partitions. The number of partitions depends upon the number of machines; each machine has its own partition. The quads related to any random cluster are placed in the same partition. This task is performed by Map Re-duce by scanning all the quadruples. In the second scan, the quadruples with the closest inter-clusters are placed in the same partition and released from the original dataset. Further, the second closest inter-clusters are placed into the next closest partition. This process is put in iterative mode till no more interrelated clusters are left. Queries are fired on these clusters. Hash partitioning is used to map the same subjects to the same blocks which results in faster throughput. To optimize our query time even further, we schedule the queries depending on the time taken to solve each query. Multiple query plans are generated using Hungarian algorithm and the one which results in minimum execution time is selected for execution. Thus, our

system smartly detects, distributes and manages data over a scalable and distributed file system.

4 Advantages and Limitations

- The process of converting the dataset to graphs at an earlier stage helps representing the data to increase the correlation of attributes in the dataset.
- Hyper graphs created provide an edge in disintegrating the graphs.
- The Hungarian algorithm through assignment of particular hyper graphs to specific queries provides an upper hand in optimising the time needed for its execution.
- The implementation of KNN algorithm leads to effective classification of the huge dataset.
- The usage of Genetic algorithm leads to efficient and optimised classification at every new level of generation created.

The system does not guarantee the security measures at every stage of execution. The graphs created are prone to be altered by the singular execution of the model. The attributes considered for classifiers are prone to change and need not be generic throughout. The assignments of queries created are curbed to the optimization required at that particular level.

5 Feasibility Study

The proposed system makes use of open source software, with no sum at stake, therefore technically feasible. Also the algorithms used in the system primarily promote optimised output, here query time, resulting in overall performance of the system.

6 Conclusion

Therefore the system implemented to optimise its functioning caters as a result of the efficiencies provided by the execution of algorithms used. The graphs that promote to structuring of data and further classifying it through KNN lead to optimised assignment of the query through Hungarian algorithm. The generation of classifiers prepared by the Genetic algorithm lead to optimized results at every iteration.

7 Future Scope

In future the system can be authenticated and authorized to specific users as well as system can be built as a readymade API for web service platforms.

References

1. Hajeer M, Dasgupta D. Handling big data using a data-aware hdfs and evolutionary clustering technique. IEEE Trans Big Data. Tbd-2016-07-0141
2. Chopra S, Notarstefano G, Rice M, Egerstedt M (2016) Distributed version of the hungarian method for a multirobot assignment. IEEE Trans Rob
3. Cao B, Wang J, Fan J, Yin J, Dong T (2015) Querying similar process models based on the hungarian algorithm. IEEE Trans Serv Comput 14(8)
4. Xie J, Xiang C, Ma J, Tan J, Wen T, Lei J, Nie Q (2007) An adaptive hybrid algorithm for global network alignment. J L A Tex Class Files 6(1)
5. Abreu LR, Prata BA (2018) A hybrid genetic algorithm for solving the unrelated parallel machine scheduling problem with sequence dependent setup times. IEEE Lat Am Trans 16(6)
6. Di Nucci D, Panichella A, Zaidman A, De Lucia A (2018) A test case prioritization genetic algorithm guided by the hypervolume indicator. IEEE Trans Softw Eng
7. Alipour-Sarabi R, Nasiri-Gheidari Z, Tootoonchian F, Oraee H (2018) Improved winding proposal for wound rotor resolver using genetic algorithm and winding function approach. IEEE Trans Ind Electron
8. Jo J, Seo J, Fekete J-D (2018) PANENE: a progressive algorithm for indexing and querying approximate k-nearest neighbors. IEEE Trans Visual Comput Graphics
9. Zhang C, Gao X, Li Y, Feng L (2018) Fault detection strategy based on weighted distance of k nearest neighbors for semiconductor manufacturing processes. IEEE Trans Semicond Manuf
10. Zhang Q, Yang LT, Chen Z, Li P (2017) PPHOPCM: privacy-preserving high-order possibilistic c-means algorithm for big data clustering with cloud computing. IEEE Trans Big Data

Enhanced Data Sharing with Blockchain in Healthcare

Sonal Lokhande, Shikha Mukadam, Mayuri Chikane and Mansi Bhonsle

Abstract With the age of modernization the technologies are built at rapid speed with highly advanced features in it. Similar to this there are issues related to personal healthcare. In this paper we proposed blockchain technology to secure data of every individual and to have properscalable, reliable data records. Our system provides patient comprehensive, unassailable log of leaseback admittance to their medical related statistics. Our proposal of innovative health data sharing solution by usage of permissioned blockchain to provide security and concealment using network formation organization and boost the distinctiveness management by using the participation service provided and braced by blockchain. It preserves the top score, a proof of veracity and authentication to retrieve facts from the blockchain. It gives highly ascendable, trusted, liable and genuine data. It paybacks the future scope in IT and Investigation by supplying apposite and expedient data with veracity and interoperability.

Keywords Blockchain · Hyperledger · Hospital insurance

1 Introduction

In topical centuries, the upsurge of various health issues has tremendously increased by putting forth various challenges for healthcare domain under Internet of Things. Enabled by blockchain individuals can contribute their share of health issues hence

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issued by hospitals and Insurance company. The Electronic Health Record(EHR) data can be used by hospitals and Insurance Company for various purpose such as disease diagnosis, treatment to be given, health monitoring. Health Insurance company can make appropriate use of blockchain system providing proper claims and easily avail facility to individuals without wasting their time. We physique the system on Hyperledger fabric which is a permissioned blockchain necessitating the network nodes to corroborate, accomplish and comprehends the privacy for chasing healthcare system along with broader analysis of our healthcare ecosystem from device to the user ownership for health data.

2 Literature Survey

This paper is regarding to the security measures use in blockchain. In this it doesnt consider about the entry of any data by the patients or any another person in blockchain network for the usage of the data by different faculties and industries who uses different data which is present in blockchain network. This is only focussing on the security and authentication of data. And it uses cloud networking to store the data for direct use and the to provide the security to blockchain network but in using the cloud it requires every time a access to it which may be very costly to regular use for a person [1].

It refers to only the sharing of data to the medical institutions rather than the other companies related to it. It assumes that the updated data by patients are already present in the blockchain network to work on it. It shows only working structure of blocks in sharing of data and the arrangement of data in a particular block using hash tables and hash values. It refuses to taking the value and only sharing of data to the medical institutions rather than any other equally require company at time of medical claims [2].

In this the authors only focuses on the data gathering from the users by different hardware machines but in some way, it is not beneficial for the poor people to a ord the hardware to get used to this technology. In other way it only transfers the data which is collected from users by mobile phones, laptops etc. It does not consider the safety of data that has being given by users and the data, if the patients have gone some medical care then the data has to updated again for the further use to medical institutions but it can always be done by the users only so the manual entry load is increased [3].

In this it mainly concentrates on the sharing, transferring and modification of data in medical healthcare only it does not related with other fields related to medical field and it only focuses on the one aim patients data collection it may be also get concentrates on the supply chain of medicine and drug prescription management which are also very helpful for the patient in other means. In this they only focuses on the data sharing of the user to the medical institutions to the patients family and vice versa [4].

3 Proposed System

The increasing demand in all aspects of the business as time changes and technology accordingly, the healthcare should be improved so as to make individual familiar with the growing revolution. The existing system is not effective and is tedious inorder to overcome this we proposed a blockchain in healthcare providing superior and quality health services.

Data is shared between the individual person and the respective hospital and insurance company based on the availability of data that needs to exchange between respective collaborations. The data is secured between the individual and respective exchangers.

The hospital retrieves the medical data from individual and vice versa, Whereas the financial details are retrieved from Insurance company. As the data is immutable it is highly secured and cannot be manipulated providing security (Fig. 1).

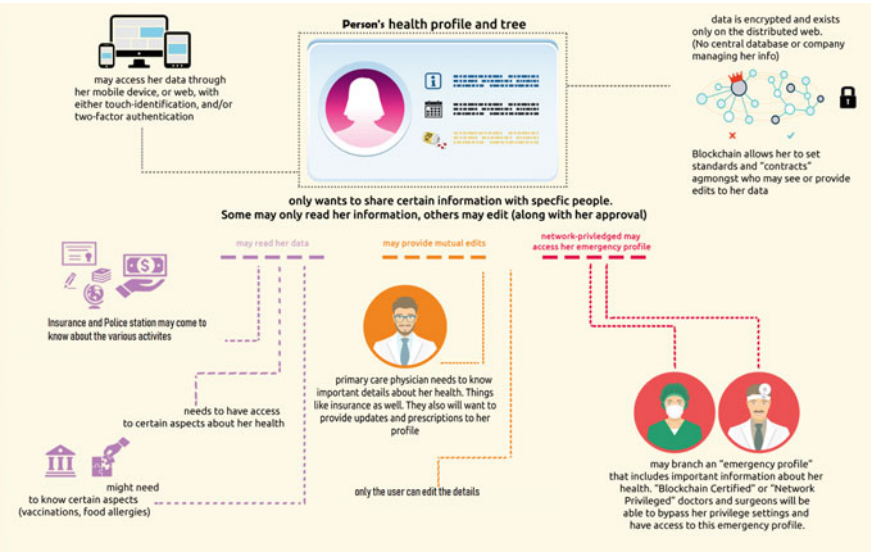

Fig. 1 Architectural flow of blockchain in healthcare

4 System Design

4.1 System Overview

Figure 2 shows the overall development for user-centric individual health data allocation. It follows units such as user, Insurance company, hospitals, medical and the blockchain network.

4.2 System Entities

User: Organization Users gathers data from device which displays users health related various data which is arrived into the system. Those data is uploaded accordingly on the blockchain accommodated on confidential platform via desktop or mobile solicitations. User is the person who plays the responsibility of permitting, contradicting and annulling data admittance from any other corresponding patients, which includes the healthcare providers, insurance company and the pharmaceutical companies. When the user is under medical conduct, they have the right to share data to preferred doctors. If the handling is done they have the access to annul and reject further access from the doctors. Same scenario gets applicable for insurance company which ensures steadiness.

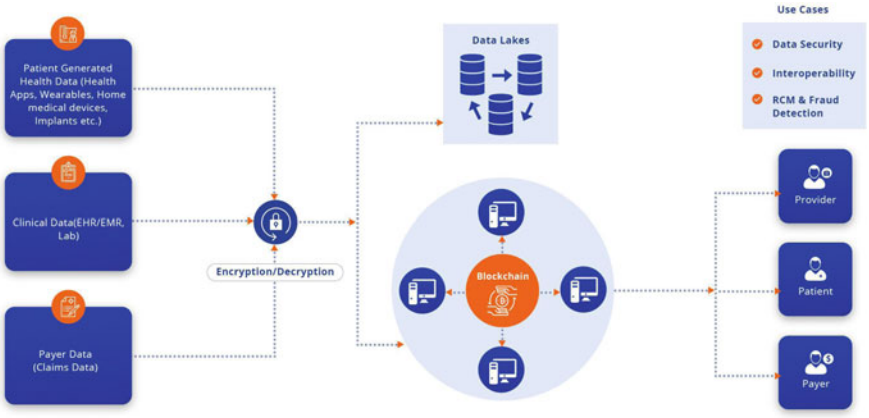

Fig. 2 Basic flow of blockchain in healthcare

5 System Implementation

5.1 Data Collection by the Users

The health-related data is collected by the user on either by using an android mobile application, web application or by any device which will be user friendly to collect the data or to access the previous one or to modify them.

The data collection is done by the registration portal/App for the new users for the previous or old users they can login by their given user name and password to access precursory data and change or modify it. By providing the required data they will be treated further by the medical facilities provided by this blockchain technology. The collected data is given manually by the users such as their height, weight heart rate, etc. at the time of registration to the portal/App.

5.2 Data Sharing by the Medical Faculty

In case of any emergency or any medical help by the users the data is shared to the nearest hospital for further action. In this case the given data is accessed by the doctors of the preferred hospital they check the details of medical data to treat the patient.

But the medical Faculty or hospital can access the data that is stored in the blockchain storage house by having some authentication to access the patients data or previous records and to update them further after by diagnosis. In this the user data is stored in the blockchain technology by which the data can be easily accessed by the required and authenticated people or institute.

5.3 Data Sharing to Insurance Company

By the use of Blockchain the patient or the user get the hospital nearest but, in case the Patient is from the middle-class family or not having sufficient money to pay the bill of the hospital. Then the hospital record and patients personal data is shared through blockchain network by to the insurance company to check that if the patient is having any Medical Insurance claim or not if the person is having the insurance claim then the insurance amount is checked that it is suffcient or not.

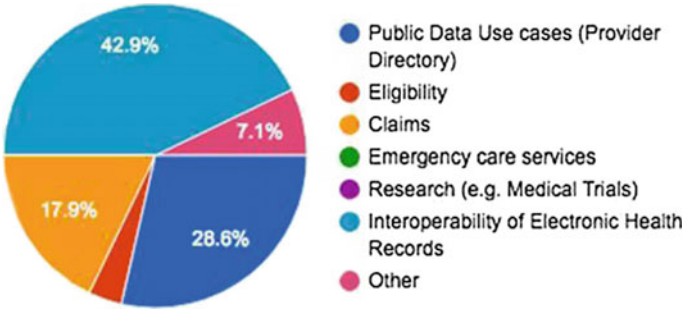

Fig. 3 Analysis of usage

6 Result

The resulting usage of data shown by g.3 at various level, the electronic data is measured and accordingly the interopertability is also undertaken into consideration of indiviudal person with respect to their understanding capacity (Fig. 3).

7 Conclusion

Due to the speedy expansion of blockchain, the healthcare commerce has already become blockchain-preoccupied with many companies in the sphere inclining to instrument it within their business. In this paper, we design and contrivance a mobile healthcare system for individual health data collection, distribution and alliance between entities and healthcare breadwinners, as well as insurance companies, the system can also be prolonged to quarter the usage of health data for research tenacities. By espousing blockchain technology, the system is implemented in a disseminated and trustless way. The algorithm to handle statistics records can sanctuary both veracity and solitude at the same time Due to the hasty enlargement of blockchain, the healthcare industry has already become blockchain-oriented with many companies in the province tending to implement it within their business.

References

1. Tosh DK, Shetty S, Liang X, Kamhoua CA, Kwiat KA, Njilla L (2017) Security implications of blockchain cloud with analysis of block withholding attack. In: Proceedings of the 17th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing, ser. CCGrid 17. IEEE Press, Piscataway, pp 458–467. [Online]. Available: https://doi.org/10.1109/CCGRID.2017.111

2. Peterson K, Deeduvanu R, Kanjamala P, Boles K (2016) A blockchain-based approach to health information exchange networks
3. Zhang P, Schmidt DC, White J, Lenz G. Blockchain technology use cases in healthcare. Vanderbilt University, Nashville; Varian Medical Systems, Palo Alto
4. Hölbl M, Kompara M, Kamišalic A, Nemec Zlatolas L. A systematic review of the use of blockchain in healthcare
5. Kish LJ, Topol EJ (2015) Unpatients—why patients should own their medical data. Nat Biotechnol 33(9):921–924
6. Clippinger JH. Why self-sovereignty matters. https://idcubed.org/chapter-2-selfsovereignty-matters/ . Online; Accessed 7 Mar 2017
7. Liang X, Shetty S, Tosh D, Kamhoua C, Kwiat K, Njilla L (2017) Provchain: a blockchainbased data provenance architecture in cloud environment with enhanced privacy and availability. In: International Symposium on Cluster, Cloud and Grid Computing. IEEE/ACM
8. T. O. of the National Coordinator for Health IT (ONC), the National Institute for Standards, and T. (NIST), Use of blockchain in healthcare and research workshop, 2016
9. Cachin C (2016) Architecture of the hyperledger blockchain fabric. In: Workshop on Distributed Cryptocurrencies and Consensus Ledgers, 2016
10. Kim H, Song H, Lee S, Kim H, Song I (2016) A simple approach to share users own healthcare data with a mobile phone. In: 2016 Eighth International Conference on Ubiquitous and Future Networks (ICUFN). IEEE, pp 453–455
11. Zhang J, Xue N, Huang X (2016) A secure system for pervasive social network-based healthcare. IEEE Access; McFarlane C, Beer M, Brown J, Prendergast N (2017) Patientory: a healthcare peer-to-peer EMR storage network v1.0
12. Liang X, Zhao J, Shetty S, Li D (2017) Towards data assurance and resilience in iot using distributed ledger. In: Military Communications Conference, MILCOM 2017. IEEE
13. Blockchain transparency. http://blog.appliedinformaticsinc.com/blockchaintransparency-integrity-and-clarity-to-thehealthcare-system/
14. Blockmedia solutions. https://www.healthit.gov/sites/default/les/14-38-blockchainmedicaid solution.8.8.15.pdf
15. Article. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4105729/

Survey on Sketch Based Image and Data Retrieval

Dipika Birari, Dilendra Hiran and Vaibhav Narawade

Abstract Sketch Based Image Retrieval (SBIR) is one of the efficient way of image mining. By considering growth in multimedia technologies, demand of image retrieval increased nowadays. CBIR work on shape, color, texture like properties of an image, where as SBIR works on query by sketch input. This paper presents survey about different image retrieval techniques and data retrieval methods. This paper includes various approaches for image and data retrieval from an image.

Keywords Image retrieval · Descriptor · Content Based Image Retrieval (CBIR) · Sketch Based Image Retrieval (SBIR) · Data retrieval · Edge extraction

1 Introduction

Nowadays evolutionary growth in multimedia technologies and widely use of internet is a major aspect. Audio, video, Images are called as multimedia data and that can be useful in military purpose, Medical diagnosis, digital forensic etc. Increase in demand of storage as well as retrieval of multimedia data makes multimedia retrieval too popular.

One method to retrieve images is Text Based Image Retrieval (TBIR). TBIR is based on image annotation. Image annotation can be manual or automatic. As per given query image, it searches database for similarity in surrounding text of an

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image. Therefore, input to this text-based system is an image and this image used for searching is called as query image. Google images are an example of text based image retrieval. This method of image retrieval is fast due to less time consuming string matching process. However, limitations with TBIR are that, it is not possible always to express content of images in words or text. This thing limits TBIR giving the irrelevant result. Annotation of images for image retrieval is also being not always correct. Therefore, to overcome this, one more method is introduced called as Content Based Image Retrieval (CBIR).

In CBIR system, query through images improves retrieval and eliminates the description of visual content of images in the form of text or words. CBIR described in the form of the low level features, like color, texture, shape & spatial locations to represent the images. Low-level feature of images are shown by feature vector and this vector is multidimensional. When we use this feature vector for images, which are available in database then, it forms feature database. Same feature extraction of feature database has been used for internal representation of feature vector of query image. Similarity measure is used for the calculation of distance between the feature vector of target image of vector database and query image vector. Finally by using indexing algorithm retrieval of images are performed.

To overcome with low-level features, query through sketch is introduced. Such systems are called as Sketch Based Image Retrieval (SBIR) system [1]. Figure 1 shows the Sketch Based Image Retrieval System where communication through sketch is the oldest form of writing. Sketch represents the mind thought of person with rough shape of an object. Query sketch is good way to express and represent the peoples thought, but mining of real images using query sketch is challenging task because of huge appearance gap between real images and sketch images. Real images contain color, texture, shape, etc., while sketch shows only rough shape of an object representing the main structure of an object. To bridge this challenge in SBIR, Descriptor plays the very important role to extract the meaningful or strong edges. Comparison between the two descriptors selects the true shaping edges. Canny edge extraction algorithm [2] plays the vital role in extraction of shaping edges. To reduce false matches constraints are applied on the edges. Therefore, Edge extraction is important part for SBIR system. Shape can also be extracted with contour extraction. Contour extraction of object is done with expansion or shrinking of contour with respect to object size.

2 Literature Review

Images containing complex background may contain variety of visual factors, whereas CBIR uses feature descriptor to represent visual contents of images. Descriptor should be invariant to scale, rotation, changes in illumination. Study of invariance is largely investigated in the field of computer vision but it is relatively new in image retrieval. There are two types of feature descriptors, Local and Global Descriptors. Descriptors, which are extracted from a part of an image, are called as local descrip-

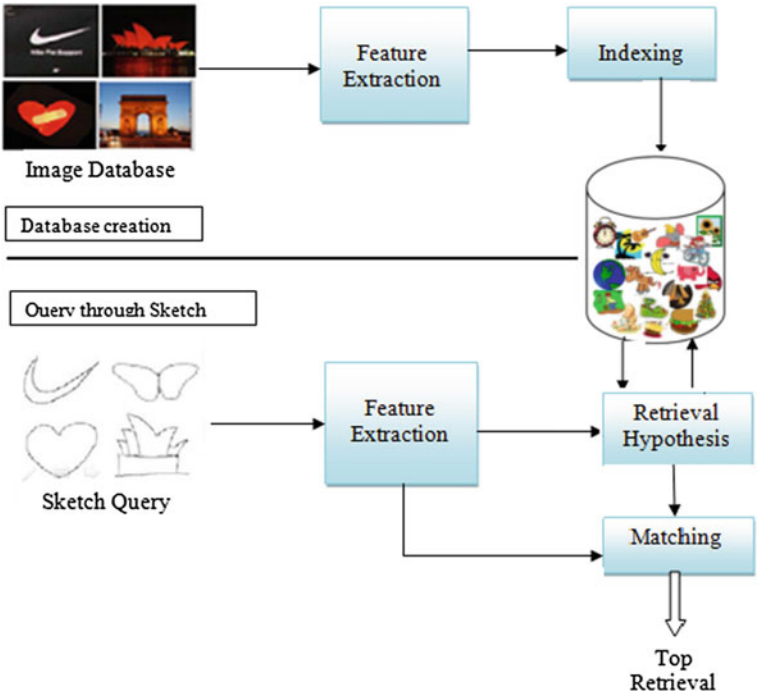

Fig. 1 Sketch based image retrieval system

tor and systems using local region features to represent image content are called as RBIR, while global descriptor is extracted from visual content of whole image and when system uses global features then it is called GCBIR. Both local and global descriptor features shows texture, color, shape, spatial information etc. of an image.

- Most of multimedia searches are TBIR and CBIR. In which it returns images on user's query image. But it is very user subjective and takes lot of time. SBIR is used in interactive way for image retrieval, as it is more expressive. Binary image sketch can be drawn using touch screen or by using mouse also. Input is query image in the form of sketch. Sketch is nothing but hand-drawn object of mind imagination. Finding similarity in between sketch and real images is challenging due to large appearance gap. Sketches can be only shown by shape and spatial information, whereas real images contain very much rich information like color, texture etc. Therefore, traditional retrieval system like CBIR cannot be inherited here [3]. This approach designs a system to retrieve near duplicate images to the hand-drawn sketches with small changes of location. For example, if users want to draw a sunset scene and his requirement of sunset scene is sun has been placed at the top right of canvas. Which indicates that image displaying the sun related to given query approximately the same spot will be preferred. This approach uses the concept that users are searching for more spatially consistent images with their

given image query sketch. In Patch hashing, it divide an image into overlapping areas called as patches and computed a HOG feature for each patch.

- Image can be extracted using contour extraction. Eitz et al. [4] tackle to one challenge of matching the query image in contour with region or part of an image and for this author used one perception method by human called as human perception mechanism. In image processing, image is processed with two types of regions. One is main region and other is Region of Interest (ROI). Region of interest works on salient part of an image. This ROI method is efficient where image contains complicated backgrounds. Eitz et al. represents an algorithms in which image get divided into different parts called as cells and each cell represent a tensor descriptor. Proposed Hierarchical Orientation Combination in which hierarchical structure is followed by human visual system for image processing, where difference image is calculated by taking value of image resolution, orientation and RGB color component. Orientation information is computed by calculating maximum of RGB color component. Because of no use of index structure for database, algorithm must scan the whole database for each query.
- EOH builds a histogram with directions of the gradients of the edges. It uses sobel operator for detection of angles rather than detection of edges. It uses 5 orientations i.e. vertical, horizontal, diagonals and non-directional [5].
- SIFT image feature provide a set of features of an object that are not affected by object scaling and rotation. For object recognition, they allow for objects in multiple images with same location, taken from different positions [5].
- CV model, also known as PC (piecewise constant) model, proposed in [6], is a simplified Mumford-Shah function. This model formed with global mean intensities, which utilizes interior and exterior part of an image. It shows good result for weak boundaries of an object, but the segmentation fails with intensity in-homogeneity which occurs in many medical images.
- F. Canny in 1986 [2], introduced a detector, which is used to minimize the amount of data in a query image without disturbing its structural properties. With the operations like blurring of image, marking of large magnitude of gradient, two thresholding to find the potential edges, tracking of strong and weak edges, some amount of data in an image get reduced without change in structural properties for further use of image in processing.
- In Wang et al. [7] discuss the different types of sketch representation. Sketch is represented by its features with three ways; Stroke Description Based Sketch features, Combinatorial Primitives Based sketch features, Shape Feature Based Sketch feature.
- To represent the sketch it uses local and global features. To compute histogram of gradients at any random point of the sketch, Boubekar and Alexa [8] used standard HoG with bag of visual words. It divides image into small parts called as regions and that connected regions called as cell. Each cell of that image computes a histogram. Histogram consists of gradient orientation and direction of pixel in particular cell. According to gradient orientation of each cell is quantized into bins. Spatial regions are called blocks which makes groping of histogram. Normalization of this histogram creates a block histogram. Finally group of these block histogram

shows the descriptor. This window based descriptor is used for object detection. But due to absence of spatial information in bag of visual words, it is difficult to achieve a good result. To improve this performance of HoG in SBIR, Hu et al. [9] propose a method called as GF-HoG descriptor. To extract window based descriptor Hu and collomosse [10] introduce GF-HOG descriptor which is dense gradient field in which local spatial feature are encoded by choosing an appropriate window size.

- Stroke is the basic unit of processing, and extraction of features of the stroke represents the sketch. MindFinder [11], uses combination of orientations and coordinates of edge pixel as features which results in dictionary. In such way it shows the spatial information of sketch as well as enhances the shape feature descriptor. But there is restriction on the scale and position which limits the SBIR.
- It is used to represent the complex sketch and uses one or more than one primitives to draw the sketches. One proposed method by Yang et al. [12] is to divide contour in different segments, and for representation of that segments they used 12-dimensional feature vector which gives the invariance of scale and orientation. Then by using Hungarian algorithm, similarity of two vectors is obtained. But It requires large memory consumption. To overcome this limitation of large memory consumption Xiao et al. [13] divides the contour into shape words. And this shape words contains straight line as well as curve also. Unlike Yang, it uses Chamfer matching to calculate similarity in between shape words.
- Reversible Data Hiding (RDH) is a watermarking technique used for authentication. But some of RDH algorithm works on gray images and some works on color images. Some these algorithms works on gray images, But color images pretend to be more powerful than gray images. Therefore, many algorithms are introduced for color image watermarking, but they destroy the color image irreversibly. Hou et al. [14] proposed RDH algorithm to improve recognition accuracy. After applying RDH on an image, if that image is used for some image processing purpose then that processing will be interfered. For example, in object detection system, the marked mage will affect the feature extraction and result of recognition decreases. So for not interference a novel RDH algorithm [14] will be used with embedding and extracting process.

3 Conclusion

Thus from above study it has been concluded that Sketch Based Image and Data Retrieval (SBIDR) can be performed using different approaches like HoG, Gf-HoG, SIFT Descriptor, Histogram Line Relationship Descriptor, Contour extraction by Chan–Vese model, Patch hashing technique. Different Reversible Data Hiding algorithm used for data retrieval from an image. By using some of the techniques above a new approach is proposed that includes image as well as data retrieval based on sketches.

References

1. Wang S, Zhang J, Han TX, Miao Z (2015) Sketch based image retrieval through hypothesis-driven object boundary selection with HLR descriptor. IEEE Trans Multimedia 17(7)
2. Canny J (1986) A computational approach to edge detection. IEEE Trans Pattern Anal Mach Intell PAMI 8(6):679–698
3. Bozas K, Izquierdo E (2012) Large scale sketch based image retrieval using patch hashing. Adv Visual Comput 7431:210219
4. Eitz M, Hildebrand K, Boubekeur T, Alexa M (2009) A descriptor for large scale image retrieval based on sketched feature lines. In: Proceedings of the 6th Eurographics Symposium on Sketch-based Interfaces Modeling, p 2936
5. Sharath Kumara YS, Gurub DS (2015) Retrieval of flower based on sketches. In: International conference on information and communication technologies. Proc Comput Sci 46:1577–1584
6. Liu T, Xu H. Medical image segmentation based on a hybrid region-based active contour model
7. Wang J, Zhao Y, Qi Q, Huo Q, Zou J, Ge C, Liao J (2018) MindCamera: interactive sketch-based image retrieval and synthesis. In: Special section on recent advantages of computer vision based on Chinese Conference on Computer Vision (CCCV) 2017, vol 6
8. Eitz M, Hildebrand K, Boubekeur T, Alexa M (2011) Sketch-based image retrieval: benchmark and bag-of-features descriptors. IEEE Trans Vis Comput Graphics 17(11):1624–1636
9. Hu R, Barnard M, Collomosse J (2010) Gradient field descriptor for sketch based retrieval and localization. In: Proceedings of the IEEE International Conference on Image Process (ICIP), September 2010, pp 1025–1028
10. Hu R, Collomosse J (2013) A performance evaluation of gradient field hog descriptor for sketch based image retrieval. Comput Vis Image Understand 117(7):790806
11. Cao Y, Wang C, Zhang L, Zhang L (2011) Edgel index for large-scalesketch-based image search. In: Proceedings of the IEEE Conference Computer Vision Pattern Recognition (CVPR), June 2011, pp 761–768
12. Yang C, Tiebe O, Pietsch P, Feinen C, Kelter U, Grzegorzek M (2014) Shape-based object retrieval by contour segment matching. In: Proceedings of the IEEE International Conference on Image Process (ICIP), October 2014, pp 2202–2206
13. Xiao C, Wang C, Zhang L, Zhang L (2015) Sketch-based image retrieval via shape words. In: Proceedings of the ACM International Conference on Multimedia Retrieval (ICMR), pp 571–574
14. Hou D, Zhang W, Chen K, Lin S-J, Yu N. Reversible data hiding in color image with grayscale invariance. In: Transaction on circuits and systems for video technology

IoT: The Future for Quality of Services

Shubham Oza, Akshay Ambre, Saurabh Kanole, Pravin Kshirsagar, Nikhil Dhabekar, Krishan Paliwal and Vaibhav Hendre

Abstract Within the technology era, everyone needs to stay connected with each other, with their encompassing setting and objects around them. It's become achievable with the foremost recent technology of this century, developed **and launched in 2008/2009 "Internet of Things". It's originated from the thought of embedding and computing** [1] (Sharma and Tiwari, in A review paper on "IOT" & it's smart applications). Sensor connected gadgets, Smartphones, Smart vehicles, Smart Surroundings, an insightful world. These ideas are embraced for quite a while. Accomplishing these objectives has been explored, to date, by a few various and some of the time disjoint analysis communitie. In the IoT, everything is created smart by embedding detector with any quite objects and then sensors data is created offered on the net through mesh networking to manage the devices or systems. IoT provides each object a private identity through assignment field of study, RFID, WSN or WPAN and connects it with surroundings.

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Keywords Internet of Things (IoT) · Wireless sensors · Smart objects · IP network · IoT · Connected devices · Networked devices · Smart devices · Machine to machine communication · WPAN

1 Introduction

The term Internet of Things (IoT) was coined by 'Kevin Ashton' in 1999 at 'Procter and Gamble' (P&G) whereas connecting the newest theme of RFID within the offer chain of that company [2, 3]. Simultaneously 'Bill Joy' at 'World Economic Forum' in 'Davos' as a part of his "Six Webs" structure introduced the Device to Device (D2D) communication, later on, ends up in IoT [4]. By internet of Things all the objects/devices recognise themselves and communicate with one another and share the specified info with one another. Since the start of laptop era each device has created its own language and protocol. Within the IoT communication language are supported practical protocols. The IoT has created potential to act between Things to human (T2H), Things to Things (T2T), human to human (H2H), human to things (H2T), at a virtual level in daily routine life [5].

The aim of this paper is to describe the IoT and its application more deeply. And the use of it in the future because we all know that IoT is the future.

Figure 1 reviews that with the internet of things, will be able to communicate to the internet at any time from anyplace to produce any services by any network to anyone. It is implemented by assigning the address to the objects or human by using any addressing scheme [5]. Different available technologies can be used to implement IoT.

Basic structure of the IoT is based on smart devices i.e. objects built with communication capabilities of Machine to Machine [7]. The object can be of any type it is feasible to assign an IP address to every device/object to provide the ability to transmit or receive data over the network [8]. In IoT, smart things/objects are main members in the model. These smart things are able to make communication among them as well as to interact with the surrounding environment by interchanging, information, data sensed about the environment [9].

Figure 2 shows that all workstations will be connected to each other via cloud/internet. Figure 2 surveys that with the web of things, anything's will ready to impart to the web. Whenever from whenever from wherever to deliver any administrations by any system to anyone this idea will make another kinds of uses can include, for example, brilliant vehicle and the savvy home, to give numerous administrations, for example, refreshes, security, Energy sparing, Automation, Communication, PCs, diversion.

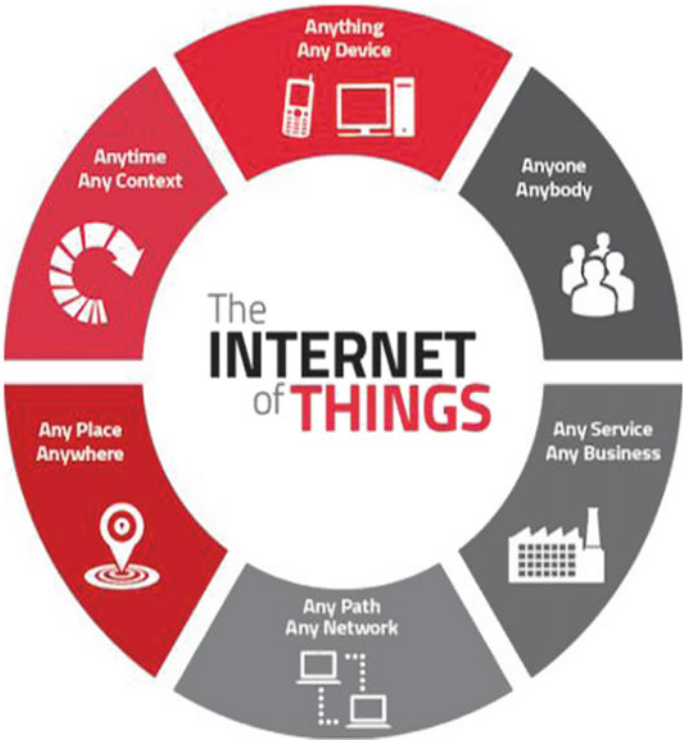

Fig. 1 Uniformity of IoT. http://www.iotleague.com/what-is-internet-of-things-the-basics-explained/ [6]

Fig. 2 System model of IoT. www.newint.org [10]

2 Architecture of IoT

There are four-stage architecture of an IoT system (Fig. 3).

Four things type basic building blocks of IoT system—ensors, processors, gateways, applications.

Each of those nodes should have their own characteristics so as to create Associate in Nursing helpful IoT system.

1. **Applications** sort relate other complete of an IoT framework. Applications zone unit basic for right use of all the data gathered. These cloud based for the most part applications that region unit subject for rendering viable accepting to the information gathered. Applications territory unit controlled by clients and zone unit conveyance reason for explicit administrations.
2. **Gateways** zone unit obligated for steering the handled learning and send it to address areas for its (information) right use.
   In elective words, we will say that entranceway causes in back and forth correspondence of the information. It gives arrange property to the information. System property is essential for any IoT framework to talk. LAN, WAN, PAN and so forth region unit tests of system entryways.
3. **Processors** zone unit the mind of the IoT framework. Their fundamental work is to strategy caught by the sensors and technique them accordingly on concentrate the valuable information from the expansive amount of information gathered. In a word, we will say that it gives insight to the data.

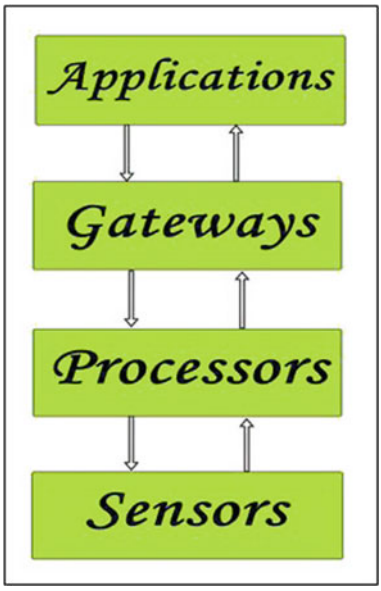

Fig. 3 Architecture of IoT. https://www.csharpcorner.com/UploadFile/f88748/ [11]

Processors essentially take a shot at period premise and might be just controlled by applications. These likewise are at risk for anchoring the data—that is play-acting mystery composing and cryptography of data. Inserted equipment gadgets, microcontroller and so forth region unit those that strategy the information because of they require processors associated with that.

4. **Sensors** These sort the essence of the IoT gadgets. These regions in this manner known as "Things" of the framework. Their fundamental design is to assemble learning from its incorporating (sensors) or give out information to its including (actuators). These should be unambiguously conspicuous gadgets with a novel logical order address so they will be just unmistakable over an outsized system. These need to move in nature which recommends that they should be prepared to gather constant learning. These will either deal with their own (self-governing in nature) or are regularly made to figure by the client wagering on their needs (client controlled). Instances of finders are: gas sensor, water quality identifier, wetness indicator and so forth.

3 Technologies Used in IoT

IoT may have enforced with mixing of many technologies because the name reflects Internet of Things is the technology to form data or information obtainable on the internet remotely management the period or physical/practical application [12]. It depends upon developer or user to pick out one of 2 between "Internet-oriented" or a "Things oriented" in line with the appliance or task has got to be performed, their self-interests, experience and backgrounds. The actual definition of IoT acquire from a "Objects oriented" aspect; the thought of objects were truly distinct items: "Radio Frequency Identification" (RFID) systems [7].

1. **Cloud Computing**

Cloud computing and also the IoT each serve to extend potency in everyday tasks and each have a complementary relationship. The IoT generates huge amounts of information, and cloud computing provides a pathway for this information to travel. Several Cloud suppliers charge on a pay per use model, which implies that you just solely pay money for the pc resources that you just use and no more. Economies of scale is differently within which cloud suppliers will profit smaller IoT start-ups and cut back overall prices to IoT firms. Another advantage of Cloud Computing for the IoT is that Cloud Computing allows higher collaboration that is important for developers these days. By permitting developers to store and access information remotely, developers will access information in real time and work on comes at once. Finally by storing information within the Cloud, this permits IoT firms to vary directly quickly and portion resources in numerous areas. Massive information has emerged within the past number of years and with such emergence the cloud has become the design of selection. Most firms notice it possible to access the huge quantities of huge information via the cloud.

2. **WPAN (Wireless Private Area Network)**

The wireless device network is accustomed produce Wireless non-public space Network. These is RF Modules, ZigBee Modules. The Wireless Device Network is that the network of nodes that is reciprocally perceived also as will management the surroundings and build ready to move with computers or people at large/completely different nodes and also the close surroundings. To describe the frequency needs, the characteristics and needs of the school of thought (Industrial, Scientific and Medical) band square measure introduced. Next, the practicality and characteristics of IoT wireless communication technologies supported wireless local area network (Wireless native space Network), WPAN (Wireless Personal space Network), and LPWAN (Low-Power Wide space Network) square measure delineated. Then any details on WPAN (which embrace Bluetooth, ZigBee, 6LoWPAN, and IEEE 802.15.4 technology) and LPWAN (which embrace LoRa, UNB, Sigfox, and NB-IoT) square measure provided. Additionally, the benefits of IoT and 5G mobile communication networks and also the characteristics of mMTC (massive MTC) is roofed.

3. **Machine to Machine (M2M)**

Machine to machine (usually contracted as M2M) alludes to coordinate correspondence between gadgets of any interchanges channel, and in addition wired and remote. Machine to machine correspondence will grasp mechanical instrumentation, a locator or meter to talk the data it records, (for example, temperature, stock dimension, and so forth.) to application bundle that may utilize it (for instance, modifying partner process upheld temperature or putting requests to fill stock). Such correspondence was at first polished by having an abroad arrangement of machines exchange data back to a central community for examination, which may then be rerouted into a system sort of a pc. Later machine to machine correspondence has turned into an arrangement of systems that transmits data to non-open apparatuses. The growth of informatics networks round the world has created machine to machine communication faster and easier whereas the other has less power. These networks additionally enable new business opportunities for customers and suppliers (Fig. 4).

4 Performance and Analysis

The global IoT market can grow $457B by 2020, attaining a Compound Annual Growth rate (AGR) of 28.5%. Ready or not, the web of Things is growing over e world. Every day, new objects emerge to have some kind of connection. From occasional manufacturers to security cameras, air quality sensors to connected cars, there isn't one a of our life that won't be touched by IoT devices (Fig. 5).

In fact, the technology big Ericsson predicts that in 2018, there are a lot of IoT gadgets than mobile devices. For several corporations, now is the time to begin considering the long-run application of this new landscape International knowledge Corporation (IDC) free AN date to its Worldwide Semi-annual net of Things ending

Fig. 4 M2M network. http://iotworm.com/machine-to-machine-communication-technology/ [13]

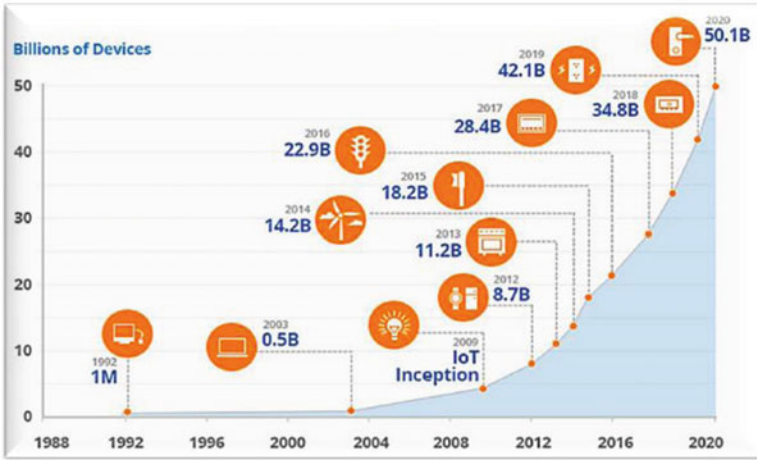

Fig. 5 Growth of IoT year by year [14]

Guide report, that foretold IoT disbursement can reach US$1.29 trillion in 2020 [2]. Table 1 shows Internet of Things (IoT) associated gadgets base worldwide from 2015 to 2025 (Fig. 6).

Table 1 Devices associated with IoT year wise [15]

Year	IoT connected devices (devices in billions)
2015	15.41
2016	17.68
2017	20.35
2018	23.4
2019	26.66
2020	30.73
2021	35.82
2022	42.62
2023	51.11
2024	62.12
2025	75.44

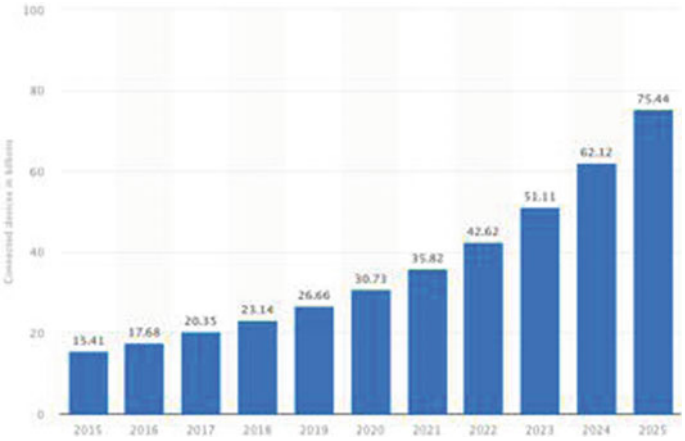

Fig. 6 Devices associated with IoT year wise. https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/ [15]

5 Applications

Potentiality of applying the "Internet of Things" indifferent domains like trade, domestic, retailing, defence, health, education and different varied fields is very high; rather in some domains it's already in Use and analysis goes on. Varied industrial and domestic applications come back beneath the umbrella of IoT.

1. **Smart Home and Buildings**
   Wi-Fi and Mobile internet have begun winding up some portion of the home IP organize and due the expanding rate of selection of versatile registering gadgets like advanced mobile phones, tablets, and so forth. For instance, a systems administration to give internet spilling administrations or system at homes, may

Fig. 7 Smart Home. https://www.livegulfshoresloc [16]

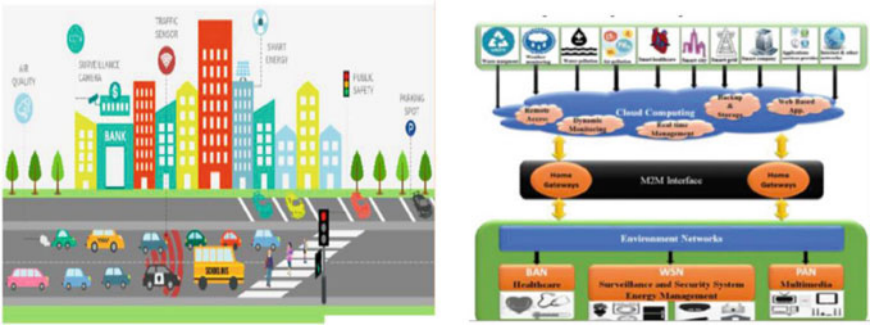

Fig. 8 Smart Cities. eslocal.com, https://www.livegulfshoreslocal.com [16]

give an intend to control of the gadget usefulness over the system. We can control each article in our home like lights, windows, TV, AC and so forth (Fig. 7).

2. **Smart Cities**
   Smart urban areas require cautious concocting in each stage, with help of understanding from governments, voters to execute the IoT innovation in each side. Urban areas is enhanced from numerous points of view by rising framework, open transportation like metro's and town transports as a result of that traffic likewise will be in control. By relationship of all frameworks amid a town like climate perception (Fig. 8).
4. **Medical and Health (Physically disabled)**
   Wearable sensors is accustomed find within the hospital for each doctor and nurses in conjunction with the patients at any purpose in time [17]. To detect the adverse reaction of medication in patient knowledge systems that area unit supported IoT will be used. In case of a heart attack stimulate the centre muscle through the combination of the sensor's implantation. Data can be recorded Wirelessly by victimization IoT technology [18]. IoT is extremely helpful for

associate aged and physically disabled person by victimization wearable good identity sensors. These wireless sensors transmit the health standing of someone and may additionally alarm [19].

5. **Safety, Security**: The home safety and security area unit should in today's life. There area unit variant wirelesses sensors area unit integrated with IoT to supply safety by providing info on the web through a mesh network.
   One will remotely management the power system, lockup system and might even be aware of water standing of own residence [20].

6 Conclusion

The IoT can change how we utilize our electronic frameworks. IoT can convey a change in individuals‟ personal satisfaction. Through a broadly conveyed, clever system of savvy gadgets, the IoT can possibly empower augmentations and upgrades to basic administrations in transportation, coordination's, security, utilities, training, social insurance and different areas, whereas providing a mark new system for application improvement. We people will be increasingly intelligent with the machines we are utilizing today. With the help of IoT we can reduce human efforts save the workload and energy. We will also be using more of the future technologies like AI and cloud computing these will also help in other fields like robotics and thus robotics will also be the part of the ecosystem.AI will power the IoT ecosystem. This paper concludes that "IoT" is associate degree rising technology. The combination of embedded systems and internet made-up the researchers in new directions and therefore the technology was developed.

Use of wireless sensors to form the mesh of network and send knowledge or info over net enhance the utility of IoT in each field. There's no specific design for all kinds of applications. It's deployed in step with the appliance, personal interest and therefore the experience of personnel. To form human life more leisurely, safe and secure still legion work is required to be done on its quality of services and communication protocols and standardized design of "Internet of Things".

References

1. Sharma V, Tiwari R. A review paper on "IOT" & it's smart applications. a. M. Tech Scholar, Dept. of Electronics & Communication Engg. Dr. C.V. Raman University Bilaspur Chhattisgarh-India. b. Asst. Prof, Dept. of Electronics & Communication Engg. Dr. C.V. Raman University Bilaspur Chhattisgarh-India
2. Maney K (2015) Meet Kevin Ashton, Father of the internet of things. Online. Accessed: 21 Dec 2017
3. Ashton K (2009) That 'internet of things' thing - 2009-06-22 - Page 1. RFID J. [Online]. Accessed: 14 Dec 2017

4. Ibarra-Esquer JE, González-Navarro FF, Flores-Rios BL, Burtseva L, Astorga-Vargas MA (2017) Tracking the evolution of the internet of things concept across different application domains. Sensors (Basel) 17(6)
5. Said O, Masud M (2013) Towards internet of things: survey and future vision. Int J Comput Netw 5(1):1–17
6. http://www.iotleague.com/what-is-internet-of-things-the-basics-explained/
7. Kortuem G, Kawsar F, Sundramoorthy V, Fitton D (2010) Smart objects as building blocks for the internet of things. IEEE Internet Comput 14(1):44–51
8. Buratti C, Conti A, Dardari D, Verdone R (2009) An overview on wireless sensor networks technology and evolution. Sensors 9(9):6869–6896
9. Giusto D (2010) The internet of things: 20th Tyrrhenian workshop on digital communications. Springer, Berlin
10. http://www.newint.org
11. https://www.csharpcorner.com/UploadFile/f88748/
12. Atallah L, Lo B, Yang G-Z, Siegemund F (2008) Wirelessly accessible sensor populations (WASP) for elderly care monitoring. In: 2008 Second international conference on pervasive computing technologies for healthcare, 2008, pp 2–7
13. http://iotworm.com/machine-to-machine-communication-technology/
14. Elmustafa SAA, Red Sea University. Internet of things applications, challenges and related future technologies
15. https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/
16. https://www.livegulfshoreslocal.com
17. Sundmaeker H, Guillemin P, Friess P, Woelfflé S (2010) Vision and challenges for realising the internet of things the meaning of things lies not in the things themselves, but in our attitude towards them. Antoine de Saint-Exupéry
18. a. Industrial internet of things: cobots and connectivity. [Online]. Available: http://www.roboglobal.com/industrial-internet-of-things-cobots-and-connectivity. Accessed: 19 Dec 2017. b. Madakam S, Ramaswamy R, Tripathi S (2015) Internet of things (IoT): a literature review. J Comput Commun 3(3):164–173
19. Darwish A, Hassanien AE (2011) Wearable and implantable wireless sensor network solutions for healthcare monitoring. Sensors 11(6):5561–5595
20. Gravina R et al (2010) Enabling multiple BSN applications using the SPINE framework. In: Body sensor networks (BSN), 2010 international conference on IEEE, 2010, pp 228–233
21. Stankovic JA, Life Fellow, IEEE. Research directions for the internet of things
22. Jacobsson A, Boldt M, Carlsson B (2016) A risk analysis of a smart home automation system. Future Gener Comput Syst 56:719–733
23. Chowdhury MN, Bhuiyan MDMH, Islam S (2013) IOT: detection of keys, controlling machines and wireless sensing via mesh networking through internet. Glob J Res Eng

Performance Analysis and Energy Handling of Adhoc Routing in Viral Mobile Communication Network

D. G. Lokhande and D. N. Kyatanavar

Abstract In modern era the GSM technology is obsolete. In spite of GSM, CDMA is used for the point to point information transmission using an innovative concept of viral mobile communication. A MANET (Mobile Adhoc NETwork) is a special kind of wireless network with well proficient of independent actions. MANET is dimensionless and operates without centralized administration, so it is called as infrastructure-less network used for communication between the nodes in the network. The nodes are self-configured, autonomous and quickly deployable. Nodes are portable and use dynamic topology but have limited energy and computing resources. Routing protocols should incorporate quality of service metrics to support throughput, jitter, packet delivery ratio and end to end delay etc. The consumption of the energy of each node is most important at the time of transmitting and receiving the packets from one node to another. The performance metrics used to analyze the routing protocols and select the proper routing protocol. The main objective was to implement efficient and effective energy handling scheme between different routing protocols.

Keywords MANET · AODV · DSDV · Dumb agent · Energy

1 Introduction

The viral architecture means a system that can be adopted incrementally and gain impetus as its scale. The growth behavior of the nodes in the system is called as the viral growth. Adhoc network is a distributed type of wireless network and so the viral network should be adhoc, scalable and futuristic. The network is said to be adhoc

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because it does not require a centralized structure, and scalability of network means competence of a process, to handle growth of nodes in beautiful manner [1].

The mobile nodes in adhoc wireless networks are restricted by battery power for their operation hence management of energy is a key issue in such networks. Energy of each node is a precious resource that must be used efficiently in order to avoid early termination of any node [2–4, 10].

Energy of node has been considered while routing and the node can perform well only if it has sufficient amount of energy. The energy of the node drains out then further packet will not be sent and the performance will be degraded also Quality of Services (QoS) will be suffered and we get lower efficiency, so to get better efficiency we need to observe the energy level of the individual node which ensure good QoS and to get the reliable communication between the nodes [5].

2 Methodology

2.1 Routing Protocols in Mobile Adhoc Networks

Routing is the process to select the disparate routes in a network for moving packets of data from source to destination. A routing protocol incorporate of routing algorithm with a set of rules that observing operation of the network. The main concern of adhoc routing is that the routing protocols must be able to adapt the topological changes rapidly and change the network topology quickly [6]. The different adhoc routing protocols can be given below:

DSDV (Destination-Sequenced Distance Vector) It is the preemptive type of routing protocol based on the Bellman Ford routing algorithm with some modifications. In MANET, each mobile node keeps a routing table which contains the information of all available destinations and the number of hops for each node on the network. Each entry in the routing table is labeled with a sequence number which is originated by the destination node. Sporadic transmissions of updates help to maintain the topology changes in the network. If any new significant change for routing information, the updates are transmitted immediately. DSDV requires advertisement either by broadcasting or multicasting the routing updates that can be done by full dump in which the entire routing table is sent to the neighbor or incremental update in which the required changes are send. The DSDV is energy expensive due to high mobility of the nodes and delay can be minimized, as path to destination is known to all nodes.

AODV (Ad Hoc On-Demand Distance Vector) AODV Routing is an improvement over DSDV algorithm. In AODV, the routes are created on demand by minimize the number of broadcast. In on demand approach source node sends a packet to a destination by broadcasting route request packet on network. The intermediate node also broadcast the packet to neighbor node till the packet reaches the destination. Once the packet received to destination it replies the RREP. During forward process

the intermediate node record the address of neighbor from which the first packet is received. The path is updates in routing table which helps to find the reverse path to identify the source. If the node is moving or changing topology, the route maintenance takes to indicate the route discovery.

Dumb Agent Dumb agent is a single hop routing created for the MAC layer and work for the shortest adhoc network. The dumb agent simply forwards both unicast and broadcast packets to the ping agent; hence it does not support multi-hop scenarios. In dumb agent routing simulation, it is simply host agent and provides a place to store database of routing information.

2.2 Performance Metrics

In the appraisal of routing protocols various performance metrics are used. They show the diverse characteristics of the whole network performance. In this performance comparison we calculate the throughput, jitter, packet delivery ratio, end to end delay and packet loss of selected protocols in order to study the effects on the whole network. The three protocols AODV DSDV and Dumb Agent are observed on different traffic conditions. The simulation is done on the following metrics [7–9]:

(1) Throughput: The amount of information transferred over a given period of time.
(2) Jitter: Jitter is defined as a variation in the delay of received packets.
(3) Packet Delivery ratio (PDR): It is the ratio of data packets received by destination with respect to data packet generated by the source.
(4) End to End Delay: The time taken for a data packet to be transmitted across a network from source to destination.
(5) Path loss: The amount of packets failed to reach respective destination node.

3 System Implementation

The simulation is carried out for the wireless channel on NS2 Platform in LINUX environment. The smooth movement of the mobile node for which the initial energy and individual energy of the each node is set as shown in Table 1 and the simulation carried out for AODV, DSDV and dumb agent. The other parameters such as simulation time and agents are same. The status of node as per the energy level of the node is as given below:

Green Color ● Battery status (50–100%) It is active.
Yellow Color ● Battery status (50–25%) It is critical.
Red Color ● Battery status (below 25%) It is the state of dangerous level.
Black Color ● Battery status (0%) It is inactive state.

Table 1 Energy calculation parameters

Parameter	Values
Initial energy	100 J
Transmitted power	1.5 W
Received power	0.5 W
Ideal power	0 W
Sense power	0.003 W

4 Results

The performances of different routing protocol are analyzed using NS2 simulator. The network with 25 nodes maximum and other parameters based on which the network is shaped. The network simulator is applied with traditional AODV, DSDV and Dumb Agent routing protocols and results are obtained for analysis. The different metrics are compared for AODV, DSDV and Dumb Agent is given in Table 2 which shows the QoS.

Table 2 shows that, the demonstration of AODV is superior than DSDV since, AODV have more packet delivery ratio, throughput and minimum packet dropped. These two protocols allow the multi hop packet transmission. But if both are compared with Dumb Agent then the performance is more superior that both the routing protocols.

The static arrangement of all the nodes available in the $1000 \times 1000\,m^2$ geographic area. The nodes having sufficient amount of energy (100 J) and all are in active state (green status).

In Fig. 1 the dynamic nature of all nodes with 5 m/s movement takes place which also change the network topology over the entire period of simulation time. The dynamic nature of AODV, DSDV and DumbAgent is same but their performance metrics are different which is shown in Table 2. From the simulation of Fig. 1 it is observed that node 3 consumed the more energy and it is in the dangerous state. But

Table 2 Performance analysis of AODV, DSDV and DumbAgent

Performance parameter	AODV	DSDV	DumbAgent
Number of packets sent	5000	5000	5000
Number of packets received	3704	3364	3921
Packet delivery ratio	74.08	67.28	78.42
Control overhead	2438	559	4
Delay	0.771159	0.665957	0.652543
Jitter	0.0163717	0.0149745	0.0138056
No. of packet dropped	1296	1636	1079
Throughput	750,827	681,907	784,357

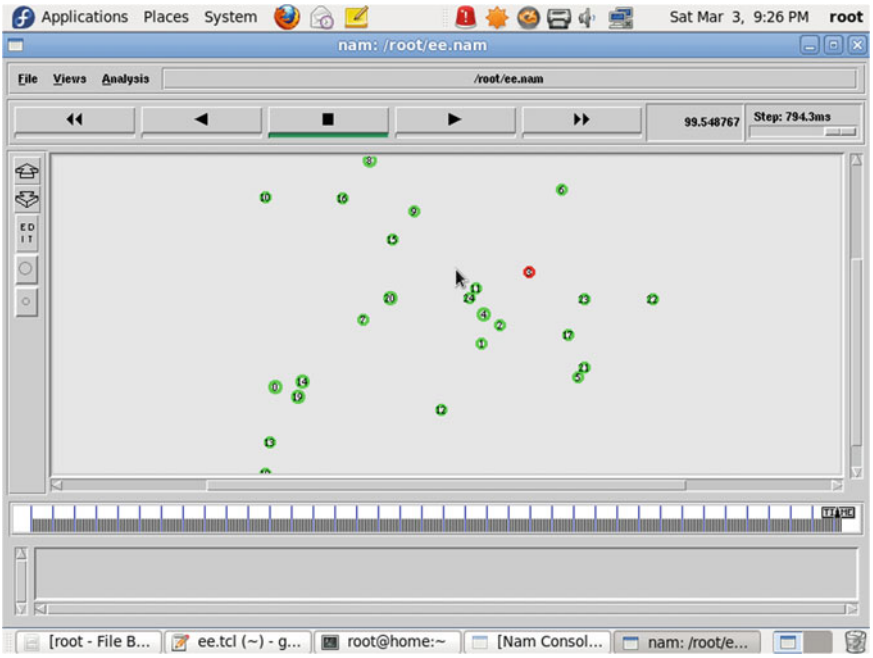

Fig. 1 The dynamic arrangement of all the nodes for AODV, DSDV and dumb agent routing protocol

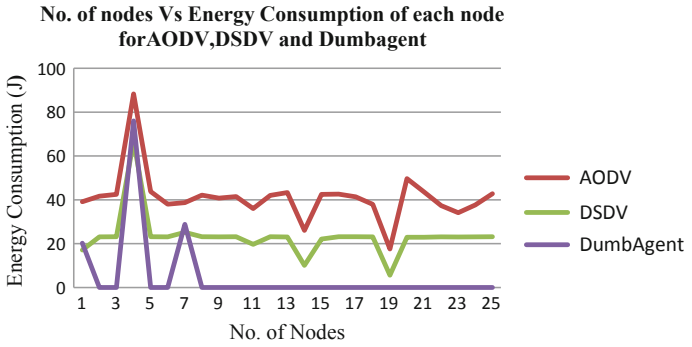

Fig. 2 The energy consumption of individual node for AODV, DSDV and dumb agent routing protocol

for the three different routing protocols exact energy consumption is not justified and hence there is a need to calculate the individual consumption of energy of each node for different routing protocols is shown graphically in Fig. 2.

5 Conclusion

In this paper, energy based routing protocols are used and compared on the basis of the performance metrics for the change of the vibrant nature of the network topology. The result shows that, in the multi hop environment the packet delivery ratios and throughputs of AODV are more than DSDV. But for multi hopped network it shows that energy is efficiently used in the DSDV protocol as compared to AODV protocol. The performance of battery management shows that DSDV handle the amount of energy efficient manner than AODV. The another observation is that the performance metrics of dumb Agent is outperform in all sense and energy consumption is also minimum, but it has one drawback that it is used for single hoped network which limit the expansion of the viral network. The energy management plays vital role each mobile node in adhoc wireless network which ensure the more number of packets transmitted by the node with a given amount of energy reserve and also, energy efficiency increases the life of the node. These routing protocols set a reference to develop the viral communication network for the point to point information transmission.

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References

1. Yadav DS, Pandey RK (2015) A review paper on viral mobile communications system. IJSRST I(5):12–16. ISSN-2395-6011
2. Doddamani LM, Yaragop SM, Chikarraddi A, Kanakaraddi S (2016) Energy consumption comparison of AODV and DSDV routing protocols. In: ICEEOT 2016 IEEE, pp 2128–2132
3. Das SR, Perkins CE, Royer EM (2000) Performance comparison of two on-demand routing protocols for ad hoc networks. In: Proceedings of the IEEE conference on computer communications (INFOCOM), Tel Aviv, Israel, pp 3–12, March 2000
4. Kaur J, Kumar S (2014) Analysis of variations in speed for different mobility models in ad hoc networking. Int J Recent Innov Trends Comput Commun 2(6):1506–1510. ISSN: 2321-8169
5. Bala M, Kaur H (2017) Review on routing protocols in mobile adhoc networks. IJARCS 8(4):1–5, (special issue). ISSN No. 0976-5697
6. Palanisamy N, Muralibhaskaran V (2017) Mobility pattern free dynamic and effective location update in MANET. ICTACT J Commun Technol 08(01):1478–1484. https://doi.org/10.21917//ijct2017.0219
7. Lokhande DG, Siddiqui AM (2017) Internet of thing for ubiquitous smart home system. In: ICISIM, pp 314–320. https://doi.org/10.1109/icisim.2017.812291
8. Gayathri VM, Raichal S, Nedunchelian R (2013) Comparison of AODV and DSDV protocols based on energy consumption and QoS performance. Int J Eng Technol (IJET) 5(3):2837–2841. ISSN 0975-4024
9. Siva Ram Murthy C, Manoj BS (2014) Adhoc wireless networks architectures and protocols. Pearson Publication, pp 585–602
10. Sridhar S, Baskaran R, Chandrasekar P (2013) Energy supported AODV for QoS routing in MANET. In: The 2nd international conference on integrated information, social and behavioral sciences, vol 73, pp 294–301. https://doi.org/10.1016/j.sbspro.2013.02.055

Performance Analysis of Deskewing Techniques for Offline OCR

Pritish M. Vibhute and Mangesh S. Deshpande

Abstract Optical Character Recognition (OCR) is a significantly important research domain of pattern recognition. Achieving a better accuracy of recognition along with acceptable execution efficiency is a key challenge in performing the recognition task. The stage of preprocessing which assist the step of feature extraction is responsible for performing a series of operation including Deskewing to retain and maintain only that part of the information which is essential for the operation of recognition. The paper presents detailed performance analysis different skew detection methods. The analysis presented in this paper will help in deciding which method performs well for any particular script. The analysis is helpful in deciding deskewing technique for handwritten & printed script.

Keywords Optical character recognition · OCR · Tilt removal · Offline OCR · Deskewing · Skew removal

1 Introduction

Optical Character Recognition (OCR) of any script is the step by step process of automatic recognition of the alphabets or characters, numbers, symbols and punctuation marks from the scanned image.

The skew correction of the text documents is one of the very important and essential steps. The skew is introduced in the input image because of following.

1. Incorrect placement of paper on the screen of the scanner.
2. Improper camera angle at the time of capturing the image of document page.

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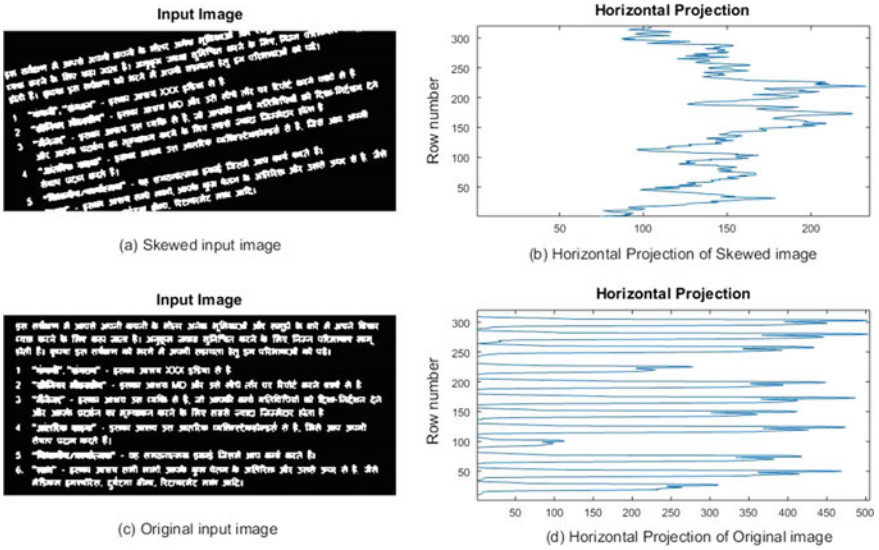


Fig. 1 Line segmentation using horizontal projection

Analysis of the document cannot be performed when a it is skewed, even at a very small angle. Failure in achieving deskewing can result in a serious degradation in the performance of the recognition algorithm specifically the step of segmentation [1].

Segmentation techniques are majority based on projection. If input image consists of skew then it results in overlapping of lines and hence corresponding row count will be non zero which misleads the segmentation algorithm. Figure 1 explains the concept of line segmentation using horizontal projection and how it fails in presence of skew.

Skew present in the input image can also cause the individual character to rotate around its center axis Like in case of italic characters. If the feature extraction method used is not independent of the rotation of the character then classifier fails in taking the decision. This intern reduces the recognition accuracy of the algorithm.

The paper is organized as; Sect. 2 shares the findings of the literature review of different skew estimation methods. Section 3 presents the analysis of different deskewing algorithm, whereas Sect. 4 comments on the conclusion.

2 Skew Detection Techniques

Numerous methods of skew angle detection have been designed and proposed in the literature [2, 3, 4]. Most popular and promising deskewing techniques include FFT magnitude plot-based method [3], Hough-Transform-based methods [5, 6], Blog formation and Histogram of orientation [7], Horizontal projection based method and

entropy-based method [1]. The comparative performance evaluation of these methods has not been studied so far. Therefore the main focus of the paper is to analyze the performance of different methods for the accuracy as well as the execution time and to analyze the performance for different scripts like Devanagari, Roman, Urdu etc.

2.1 FFT Based Method

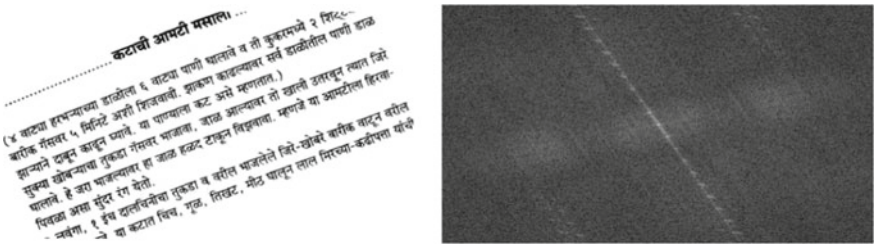
In this method, the magnitude spectrum of the image is obtained by taking 2-D FFT of the image. Lines in the document carry most of the energy in the frequency domain and hence should be along the rows of letters and also perpendicular to the lines. As shown in Fig. 2, initially, Fourier transform of a skewed grayscale input image, Fig. 2a, is taken. The discrete Fourier transform of 2*D* image $f(x, y)$ of size $M \times N$ is given by Eq. (1) [3].

$$F(u, v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) e^{-2j\pi\left[\frac{ux}{M} + \frac{vy}{N}\right]} \tag{1}$$

2*D* magnitude plot is firstly converted into gray scale and then into binary image of the same size as that of the input image. The slope of line, passing through center point of image, represents the skew angle as shown in Fig. 2b. Finally deskewing is performed, followed by board padding, to the generated skew free image.

2.2 Hough Transform Based Method

When it comes to understanding the slope of the lines in an image, the first job is to collect edge pixel of the line structure together to understand its pattern. Hough



(a) Skewed input image (b) Magnitude plot of the image

Fig. 2 The result of different steps of document skew detection using FFT

transform assigns more weight to the pixels which are already in a line. It maps lines from Cartesian space xy space to radii and angles space i.e. (ρ, θ) using Eq. (2) [8].

$$x \cos\theta + y \sin\theta = \rho \tag{2}$$

For detection of skew angle, edge detection of an input image need to be performed. After detection of the edges; image will be transferred to (ρ, θ) domain using Hough transform. Most dominant angle represents skew angle of document [5, 6].

2.3 Blog Creation and Histogram of Orientation Based Method

Here, input image is preprocessed to convert the words into blogs. If blogs formed are considered as an object, slop of major axis of the blog represents the overall orientation of the text.

2.4 Horizontal Projection at Different Angles

In this method, an input image is rotated at different angles in the prescribed range. The minimum angle of rotation decided the precision in detecting the skew angle. As precision angle increases, the accuracy of skew angle detection decreases. After rotating the image, the horizontal profile is generated. From the horizontal profile, pixel density pattern is generated. The first-order differentiation of pixel densities helps in finding maxima which represent the actual skew angle.

2.5 Entropy-Based Deskew

In the entropy-based method, an input image is converted into a two-tone image. A converted image is rotated at different angles. After each rotation entropy of $2D$ input image is calculated. The angle with minimum value of entropy is considered as skew angle of the document.

3 Performance Evaluation

3.1 Database Creation for Tilt Analysis

Detailed literature review shows that no such standard database is available for the performance analysis of algorithms designed for tilt angle detection of different scripts like Hindi, English, and Urdu etc. Hence the database of skewed document images is created for this work by introducing a synthetic skew in the plane image of the document with following specification.

Each image is artificially skewed for angles in the range of −20° to 20° degrees. 20% images in the databases consist of tilt angle equals to 0 which help in analyzing the performance of the algorithms in no skew situation. Script of images is Devanagari-Hindi and Marathi, English and Urdu. 13% images are chosen with some graphics on board, such as the logo while remaining with no graphics i.e. images with plain text only. 20% samples consist of few isolated characters or only one line of text. 80% images in the database are actually grayscale images whereas 20% are binary images with no color image. Figure 3 shows some sample images from database.

3.2 Skew Angle Detection Techniques

All skew detection techniques mentioned are applied for the deskewing of the documents from different scripts like English, Hindi, Marathi, and Urdu. Each script had its own set of characters, symbols, punctuation marks, structures, writing styles etc. Due to the distinct nature of each script, one method cannot be used for all scripts.

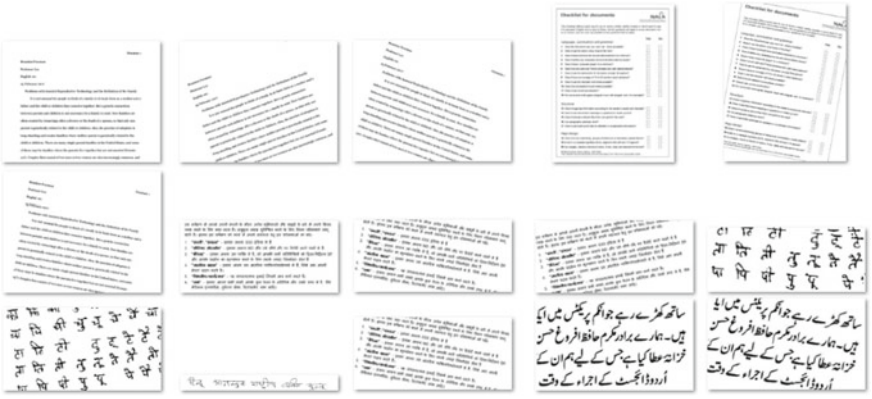


Fig. 3 Sample images from the database

Table 1 demonstrates that, almost all techniques worked well for sample 1, 2, 3, 5 and 6. Sample 4 consists of an input image in English with a logo in it. All methods except entropy methods failed. It leads to the conclusion that either said logo need to be removed before supplying an image to the deskewing algorithm or entropy based technique need to be used in a said situation. Almost all techniques demonstrate poor performance for sample 8 as it consists of Urdu script. Only Hough transform and projection based technique worked well for sample 9 as it consists of 3D skew in contrast with remaining 2D samples. Sample 12, 13 and 15 actually consist of no skew, it helps in analyzing systems behaviors in clean, unskewed images. The result shows that except horizontal projection other methods worked well. Sample 14 cannot be tested by blog formation method, as said sample only hold few characters and no words. Hence algorithm is unable to extract essential information from the same.

Table 1 Performance analysis of different skew detection techniques

Input sample	Actual synthetic skew In degrees	Estimated skew angle in degrees				
		FFT based method	Hough transform based method	Blog creation and histogram of orientation based method	Horizontal projection based method	Entropy-based method
Sample 1	10	10	10	10	10	10
Sample 2	20	20	20	20–21	19	15
Sample 3	−20	−20	−20	−20	−22	−15
Sample 4	10	NE	NE	NE	NE	10
Sample 5	10	10	10	10	12	10
Sample 6	−10	−10	−10	−8	−9	−10
Sample 7	−10	10	−10	0	−12	10
Sample 8	10	0	9	12	−75	9
Sample 9	3D 25	0	27	−45	−26	0
Sample 10	−5	−5	−6	−6	−88	−5.5
Sample 11	8	6	7	0	8	7.5
Sample 12	0	0	0	0	2.653	0
Sample 13	0	NE	NE	NE	NE	0
Sample 14	−2	−1	−2	NE	−29	−2
Sample 15	0	0	0	0	−26	1

NE Not estimated

3.3 Skew Angle Detection Analysis

The result of skew angle detection analysis for an image is demonstrated in Fig. 4 for the purpose of comparison.

3.4 Timing Analysis

Figure 5 represents the average execution time of each individual deskewing algorithm. Blog formation based method takes the least amount of time for execution whereas projection based method consumes maximum amount of time for execution.

3.5 Script Analysis

Table 2 elaborates the fact that which algorithm is more suitable for which script.

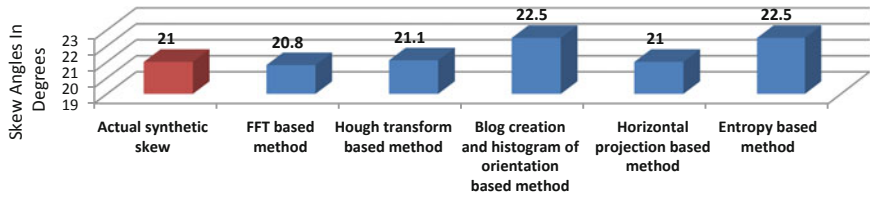


Fig. 4 Skew angle detection by different algorithms

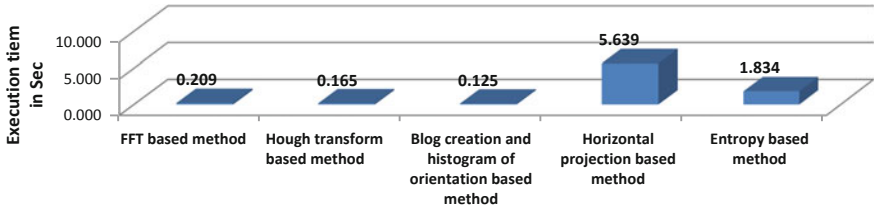


Fig. 5 Performance analysis of different skew detection methods for elapsed time

Table 2 Analysis of different deskewing techniques for a different script

Script	Best performing technique
English, Hindi, Marathi	All five
Document with graphics	Entropy-based method
Urdu	Hough transform and histogram based method

4 Conclusion

Different skew detection and correction algorithms are implemented and tested against different scripts by comparing resultant predicted angle with the actual angle of skew. Algorithms are also tested for its execution time and analysis clearly shows that trade-off exists between accuracy and execution time. Best performing method may consume more time and hence computationally less efficient. Each method had some limitation and hence the combination of different skew detection methods will definitely help in predicting exact angle but on the cost of execution time.

References

1. Verma RN, Malik LG (2015) Review of illumination and skew correction techniques for scanned documents. Procedia Comput Sci 45:322–327
2. Kaur L, Jindal S (2011) Skew detection technique for various scripts. Int J Sci Eng Res 2(9):2–4
3. Chang W (2004) Skew correction for text document using fourier domain analysis. Case West Reserve Univ 1–4
4. Victor A, Brar GK, Seth S (2015) An algorithm for deskewing a document image 10:39071–39073
5. Kapoor R (2004) A new algorithm for skew detection and correction 2:1215–1229
6. Kapoor R, Bagal D, Kamal TS (2002) Skew angle detection of a cursive handwritten Devanagari script character image. J Indian Inst Sci 82:161–175
7. Abuhaiba ISI (2003) Skew correction of textural documents. J King Saud Univ—Comput Inf Sci 15:73–93
8. Le DS, Thomat GR, Wechsler H (1994) Automated page orientation and skew angle detection for binary document images 27(10)

Implementation of TAS in MIMO Using Software Defined Radio

Vaibhav Hendre and Prathamesh Chinchamalatpure

Abstract Multiple Input Multiple Output (MIMO) systems are used in recent wireless communication systems due to diversity benefits. At the cost of performance degradation, complexity of hardware associated with radio frequency front end is reduced with antenna selection. TAS techniques are more popular in MIMO system as they provide the benefit of reduced hardware. The recent literature verifies the performance of the TAS systems analytically and on simulation platform. In this paper, the practical implementation of TAS-MIMO system is proposed using Software Defined Radio (SDR). The TAS-MIMO system is implemented to create an on-field environment for transmitting the signals over the channel. This paper validates the analytical results with the practical hardware implemented using SDR for different MIMO configurations.

Keywords MIMO · MIMO-TAS · Orthogonal space time block code (OSTBC) · Maximum ratio combining (MRC)

1 Introduction

In wireless communication, MIMO system is used for increasing the capacity of the radio channels at both the transmitter and receiver. The antennas at both ends of the MIMO system are combined to achieve optimized performance parameters and to minimize errors. It provides a high-speed mobile data and telecommunications services for 4G and Long Term Evolution (LTE). MIMO systems were presented in early 1980s initially through simulation. The analytical representation of such systems created a great interest in MIMO systems. MIMO systems play the key role in third-generation cellular systems. The recent research shows the different aspects of MIMO implementation analytically and through simulations. The current wireless standards including IEEE 802.11 and advance recommend the use of MIMO systems.

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MIMO system became the most important technology for next generation cellular communication, mobile Wi-Max, Local Area Network (LANs), wireless PAN and broadcasting. In wireless communication, the behavior of radio waves implies to the radio propagation, when they are propagating from transmitter to receiver [1]. The multiplexing gain and diversity gain provided by MIMO systems are mainly based on how many number of antennas used at the transmitter and receiver. The multiple antennas are easy to deploy but it requires putting multiple RF-chains with every antenna. It will increase the hardware complexity and cost of the system. The power efficiency of the system decreases significantly as the power amplifiers used for every RF-chain consumes almost 50–80% of the total power. The Antenna Selection (AS) technique proposed in literature provides the same benefit of MIMO system with less number of RF-chains [2].

The performance of the MIMO system can be enhanced through AS technique by selecting the proper subset of transmitting and receiving antenna based on the channel conditions [3]. Therefore the estimation of channel state information (CSI) is the most important role in AS [4]. With the used of AS techniques it is possible to deploy the large number of antennas which will eliminate the effect of small-scaling fading and uncorrelated noise [5]. The AS techniques can be implemented at the transmitter and receiver end effectively. But Transmit Antenna Selection (TAS) technique has attracted great research efforts with lower complexity and generally acceptable performance loss. Therefore, they are becoming more popular and are considered in the uplink and downlink of recent LTE systems [6, 7].

The various analytical aspects of TAS are discussed in literature and the performance analysis is carried out for BER and ergodic capacity of the system in [8, 9]. The TAS system proposed in [10] is considered here for hardware implementation by using GNU Radio concepts available in [11]. However, the practical implementation of TAS-MIMO system needs to be carried out in more detail. This paper implements the TAS-MIMO system using Software Defined Radio (SDR) and related hardware. The performance of MIMO system is verified for different MIMO configurations using hardware implementation. The BER analysis presented in the literature is verified through the hardware implementation. The performance analysis of TAS-MIMO system is verified using SDR platform for BER. It is observed that the performance of the practical system is in line with the analytical results.

2 System Model and Hardware Aspects

The system model for the proposed system is as shown in Fig. 1. The data source, modulator and OSTBC encoder is implemented using GNU radio platform. The modulated and encoded signal is then interfaced with SDR hardware platform. The hardware switch is designed and implemented at the output of SDR to which multiple antennas are connected. A SDR translates hardware related design issues into software issues. This software defines the transmitted waveform and demodulates the received waveform, both in real-time. The data signal should be in digital form so

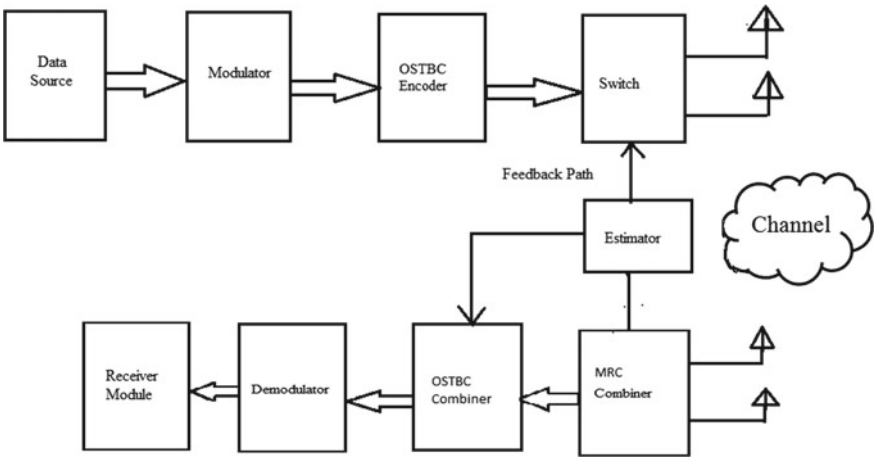

Fig. 1 System block diagram

that different processing functions like modulation, FFT, channel coding, filtering, etc. can be performed by the Personal Computer (PC). This digital signal is then converted into an analog form because our end to end systems are in analog form supported by some hardware device. The hardware device consists of a complex architecture that performs the Digital to Analog (D/A) conversion and then modulates the baseband signal to be sent on the desired carrier frequency. After this the modulated signal is handed over to the RF end, which consists of an antenna that propagates it to the desired destination.

An SDR differs from the traditional radio by many aspects. In a traditional radio, we rely on dedicated hardware which is concrete and can perform specific functions only and does not allow flexible implementation. On the other hand, an SDR can incorporate flexible changes as per the user's requirements, without bothering about hardware issues, and more importantly, at a very low cost. SDR produces a radio platform where different radio protocols are implemented using software. It also enables us to design a prototype which can be used for different research purposes. The basic purpose of SDR is to minimize the hardware constraints and perform necessary processing in the software only supported by GPP (General Purpose Processor).

The pilot training system is used to estimate the CSI at the receiver end. The pilots are sending initially at the start of every frame. The CSI is estimated at the receiver for every antenna subset and using MRC technique the best antenna subset is indentified. The index of the best subset is feedback to the transmitter switch which selects the corresponding antenna for the transmission. The received signal at ith receive antenna is given as

$$y_i = h_{ij}x + n_i \tag{1}$$

where y_i is the received symbol on the ith receive antenna, h_{ij} is the channel on the ith receive antenna, x is the transmitted symbol and n_i is the noise on the ith antenna.

Expressing it in matrix form, the received signal is,

$$Y = HX + N \tag{2}$$

where $Y = [y_1 y_2 \dots y_N]^{\mathrm{T}}$ is the received symbol from all the receiving antennas and $H = \begin{bmatrix} h_{11} & \dots & h_{1N} \\ \vdots & \ddots & \vdots \\ h_{N1} & \dots & h_{NN} \end{bmatrix}$ is the channel matrix. The transmitted symbol is represents as $X = [y_1 y_2 \dots y_N]^{\mathrm{T}}$ and $N = [n_1 n_2 \dots n_N]^{\mathrm{T}}$ is the noise received by all the receive antennas.

Hence, the index I in MRC can be generally given as

$$I = \sum_{j=1}^{N} \left| h_{i,j} \right|^2 \tag{3}$$

i.e. sum of the channel powers across all the receive antennas.

$$I = \max_{1 \le i \le L} \left\{ C_i = \sum_{j=1}^{L_t} \left| h_{i,j} \right|^2 \right\} \tag{4}$$

where I = Index of selected transmit antenna, L = Total no of antennas, $h_{i,j}$ = channel path from jth antenna to ith antenna, C_i = total power of ith antenna.

3 Results and Discussion

The performance analysis is carried out for the proposed experimental set-up initially for different MIMO configurations to validate the performance of MIMO. The fading environment effect was not possible to provide practically, therefore it is embedded in GNU radio platform. Figure 2 shows the BER analysis for different MIMO configurations. It is observed here that the performance of the system increases with higher number of transmitting and receiving antennas.

The similar performance analysis is presented for Rician fading environment in Fig. 2b. It is observed that due to line of sight considerations in Rician fading the performance of the system is better as compared to Rayleigh fading above 8 dB.

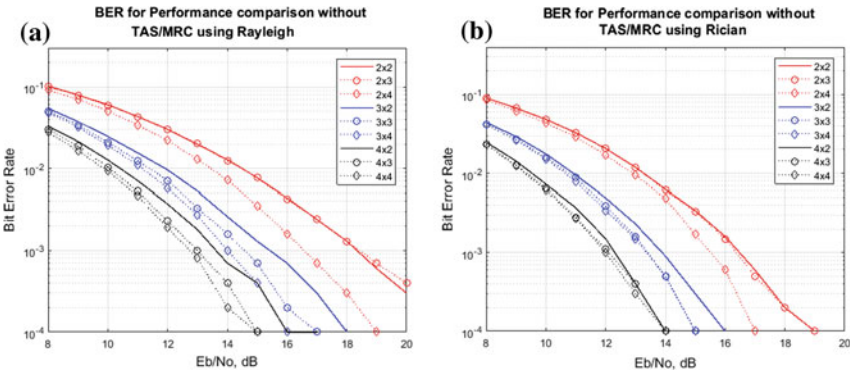

Fig. 2 BER graph for MIMO without TAS with **a** Rayleigh and **b** Rician fading

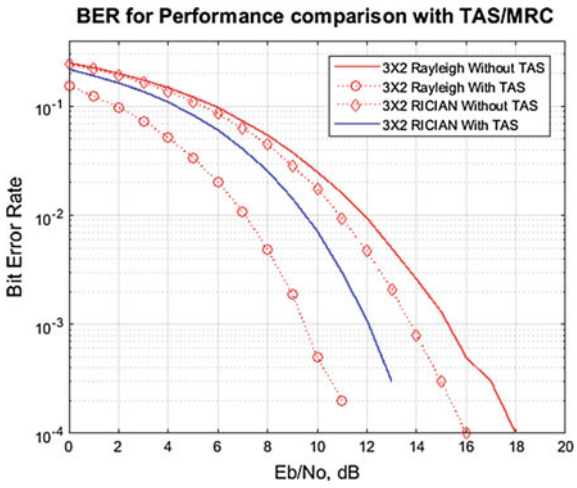

Fig. 3 BER graph MIMO system with and without TAS

Figure 3 presents the TAS-MIMO system validation for (3×2) MIMO system for with and without AS for both Rayleigh and Rician fading environment. It confirms the analytical results where performance of (3×2) MIMO system with single TAS is better as compared to without case. Figure 4 shows the comparison of theoretical and practical BER results for proposed system which confirms the validation of the results through hardware.

Figure 5 presents the scope plot of data transmission and corresponding scatter plot. The FET plot of data transmission and data reception is as shown in Fig. 6.

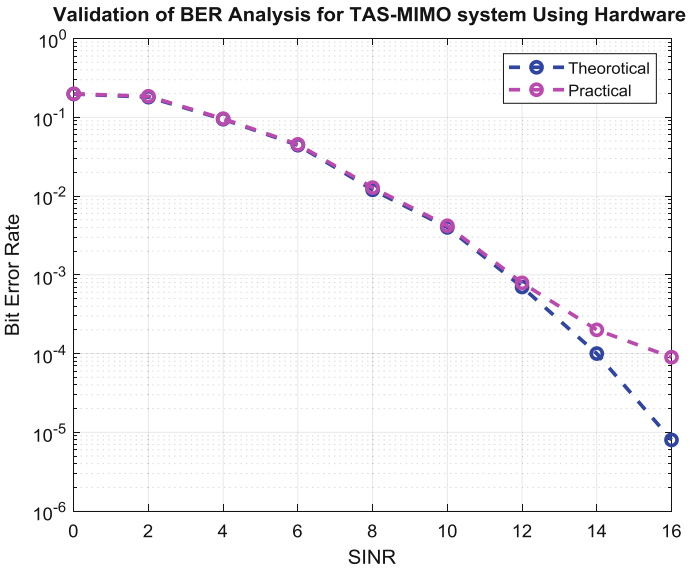

Fig. 4 Validation of BER analysis for TAS-MIMO system using hardware

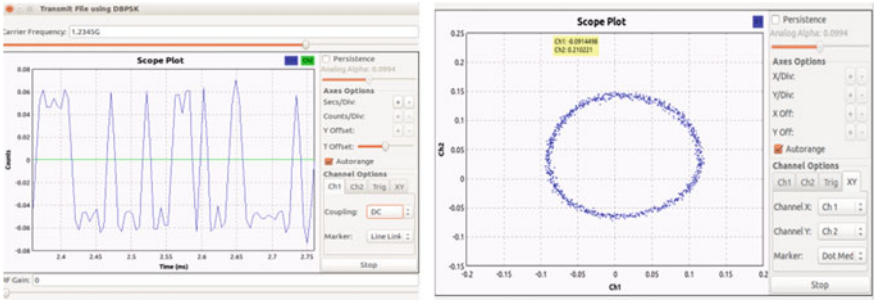

Fig. 5 Scope plot for data transmission and scatter plot

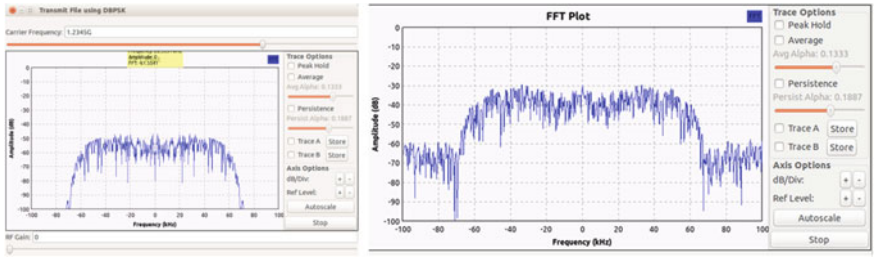

Fig. 6 FFT plot for data transmission and reception

4 Conclusion

This paper represents hardware implementation of MIMO systems with TAS using SDR platform. The hardware implementation validated the results achieved analytically. This paper deals with transmission of image using SDR, also it is found that there is improvement in BER performance with TAS.

References

1. Cho YS, Kim J, Yang WY, Kang C-G (2010) MIMO-OFDM wireless communication with MATLAB. Wiley. ISBN 978-0-470-82561-7
2. Nallagatla BK, Babu KV, Reddy GR, John BB (2014) Hybrid antenna selection at transmitter (HAST) scheme for future broadband wireless system. In: International conference on communication and signal processing, 2014, India
3. Benmimoune M, Driouch E, Ajib W, Massicotte D (2015) Joint transmit antenna selection and user scheduling for massive MIMO systems. In: IEEE wireless communications and networking conference
4. Benmimoune M, Driouch E, Ajib W, Massicotte D (2015) Feedback energy reduction in massive MIMO systems. In: 2015 IEEE global communications conference (GLOBECOM)
5. Engler H-G, Jorswieck EA (2016) Long-term antenna selection for large-scale MIMO links. In: 2016 IEEE sensor array and multichannel signal processing workshop (SAM)
6. Gao Y, Kaiser T (2016) Antenna selection in massive MIMO systems: full-array selection or subarray selection?. In: 2016 IEEE sensor array and multichannel signal processing workshop (SAM)
7. Hendre VS, Murugan M, Chandgude A (2015) Multiple transmit antenna selection in MIMO-OSTBC system in Nakagami-m fading channel. In: Procedia computer science, vol 54. Elsevier, pp 558–565. ISSN No.: 18770509
8. Al-Shuraifi M, Al-Raweshidy H (2014) Optimizing antenna selection using limited CSI for massive MIMO systems. In: Fourth edition of the international conference on the innovative computing technology (INTECH 2014)
9. Hu J, Cai Y, Yang W, Xu S (2014) Secrecy performance of MRT/RAS system with outdated CSI in MIMO wiretap channels. In: International conference on cyberspace technology (CCT 2013)
10. Molisch A, Win M (2003) MIMO systems with antenna selection-an overview. In: Radio and wireless conference, RAWCON'03, proceedings 2003
11. www.gnuradio.org/

Review of Smart Healthcare Systems and Applications for Smart Cities

Jignyasa Sanghavi

Abstract From the last decade concept of Smart city has gain importance worldwide. It is considered to be most innovative system which will communicate with people and also smart infrastructure embedded in smart city. Smart infrastructure will be capable of monitoring and managing the traffic, transport, water supply, law enforcement, healthcare and all basic facilities. Advancement in mobile cloud computing technologies, ubiquitous computing, intelligent sensor networks and cognitive services for interaction among the sensors forms the foundation for smart city. Smart healthcare is the crucial part of smart cities and will play very important role in converting traditional cities to smart cities. Researches in the field of Information and Communication Technology (ICT) have made medical services smarter with high quality which is improving living standards of individual. Smart health applications will act as catalyst in the improvement of the quality of healthcare services provided by government or private hospitals and in reducing the burden of health professionals. This paper gives the review of smart health applications which will be benefiting the society by providing easy telecommunication between patients and health practitioners, pharmacist etc., maintaining fitness, tracking patients' health online using implantable devices, wearable devices or smartphone applications.

Keywords Smart healthcare · Information and communication technology (ICT) · Ubiquitous computing · Cognitive computing · Assistive technology · Smart implantable

1 Introduction

The advanced researches in the domain of ICT, Internet of Things (IoT), mobile computing and ubiquitous computing smart city promises to provide urban citizens with high quality of life. Smart and Innovative solutions are required for executing smart city project. Smart city is still in innovation phase and hence perfect definition

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is not there but Singh [1] has described smart city with eight key aspects: smart governance and smart education, smart building, smart infrastructure, smart energy, smart technology, smart citizen, smart mobility and smart healthcare.

From couple of years ago the notion of big data has come into boom and has gain importance in the research domain. However big data is not new concept, data has resided in all the eras of computers. Due to advances in the technologies in every domain and usage of these technologies in their domains has created heaps of data. Big data is about using that huge data efficiently for prediction and taking decisions.

Smart city includes the deployment of numerous sensors in the environment and communication infrastructure for real time gathering of data which would be provided by environment or body area network. The role of big data comes into picture when dealing with smart devices for taking suitable decisions based on real time situations. Smart cities are today's need for improving the living standards of citizens. Many private companies like Oracle, Cisco, etc. are coming forward for research and investment in projects of smart cities. The current report of WHO, Global Health Observatory data shows that 54% of world population lives in cities and this percentage is expected to grow up to 70% by 2050 [2]. Looking at these statistics the development of infrastructure to address the need of such a large population and provision for efficient management of the data generated from them is urgent need of this time.

The ageing of the society, young population prone to chronic diseases, allergies, diabetes, pulmonary diseases, memory loss, physical impairments, etc. are some of the basic problems of society. Fostering the healthy habits amongst the population of the country, proper treatment, prevention measures, etc. are the biggest challenges for public healthcare in smart cities. This paper will elaborate the smart healthcare and the health applications and wearable devices that can be used to provide smart health services in urban areas.

2 e-Health Versus m-Health Versus s-Health

From the last two decades the information technology is widely used in medical domain for availability, traceability and liquidity of medical cases or data. This gave rise to concept of electronic health (e-health). The electronic health records, biomedical databases and public health has proved efficient for the society and the health practitioners. Advancement in technology developed the mobile phones which introduced mobile health (m-health) system. The mobile phones and other wireless communication devices are used to educate people about preventive healthcare, practice of medicines, give alerts and reminders of epidemics and preventive measures, etc. The arrival of smartphones gave rise to mobile application development in medical domain for patients, health practitioners, medical students and pharmacist. Statistics shows that mobile devices are portable, affordable and user friendly therefore used by all generations. The mobile health (m-health) was introduced which is the component of e-health. M-health has the potential to reach many people even in the

rural interior parts of the country. M-health is basically huge domain in healthcare which can be categorized in drug apps, doctors app, patients status tracking app, user oriented apps for physical fitness, etc. Smart Health (s-health) is the combination of m-health with intelligent sensors. m-health deals with mobile wireless communication and s-health along with mobile communication is the combination of ubiquitous computing, ICT and smart infrastructure of intelligent sensors.

3 Literature Survey of Healthcare Devices and Applications

The busy and stress life style, unhealthy eating habits and other factors have made majority people prone of diseases. This has increased the demand of health practitioners. The healthcare applications can be taken as alternative for maintaining the fitness, educating or alerting citizens about some prevention methods, epidemics, etc. The healthcare devices can be used for monitoring, predicting and taking action accordingly. Recently many healthcare devices and applications are developed and successfully implemented in many smart cities. The rest of the paper is describing various categories of smart healthcare devices and applications.

3.1 Smart Homecare Services

Most part of the world is facing the problem of aging i.e. growth of aged population, which is increasing the requirement of medical health services. To cop up with this problem many researchers has given innovative solutions like:

- Homecare or home visits services for routine checkups of old aged people by medical practitioners or staff. Patients complete medical record is maintained including patients' physical and mental condition, digital images of medical reports, etc. which can be retrieved by medical staff using smart phones [3].
- E-Homecare services are extended version of Homecare services which also includes scheduled injections, management of dietary needs, daily exercise, and health monitoring [4].
- Assistive home monitoring systems are used for heart disease patients. It is made using different biosensors which are embedded into the surrounding of patient [5].
- Smart Floor, large sensors consisting of an array of pressure sensitive floor tiles at home are used for monitoring patients [6].
- Security systems and Comfort systems are becoming part of smart home. For elderly people situations like fall, intrusion and other dangers can be monitored via security systems. Comfort systems are used for managing home appliances like automatic doors, light, Scheduling appliances, notifications via smartphones and remote video surveillance on mobile phones [7, 8].

The concept of Smart homes gains the importance in the early 2000s. Smart homes became affordable option which included domestic technologies, home networking and other luxury gadgets. Today's smart homes are more advanced with sensors, IoT, ubiquitous computing and cognitive technologies.

3.2 Portable Healthcare Devices Linked with Smart Phone

Since medical equipment is expensive, portable devices in connection with smart phones are used in many parts of the world.

- "Mobisante" is portable device for ultrasound imaging. Health practitioners in remote locations use this device to examine patients such as pregnant women, heart patients, etc. The images are transmitted to hospital via smartphone [9].
- "ROCHAS" (Robotics and Cloud Assisted Healthcare System) is mental healthcare device for elderly people or mentally disabled [10].

3.3 Smart Wearable Devices

Smart wearable devices are helpful for patients with high blood pressure, heart diseases, diabetes, cancer, joint problems, etc.

- "Life line" bracelet monitors heart rate, blood sugar levels, human's body temperature, date rape drug monitoring to warn the wearer whether drug is consumed previously and allergies monitoring to warn for food allergies [10].
- "Gluco (M)" wristband monitors the blood glucose levels and helpful for diabetic patient [11].
- "LUMO BodyTech" monitors human biomechanics. It consists of biomechanics sensors used for monitoring posture and back pain and mobile app with intelligent algorithms [11].
- "Cardiomobile" is a real-time remote monitoring system for exercise-based cardiac rehabilitation. It monitors ECG rate, walking speed and heart rate [12].

3.4 Smart Textiles and Footwear

Smart garments are used for monitoring the person's health state parameters like heart rate, breathing rate, body temperature, blood oxygen saturation, posture and position and external factors like pollution, temperature, etc.

- "ProeTex" smart garment for emergency-disaster is developed by team of 23 European partners including industries, research institutes, organization, etc. which is funded by European Commission [13].

- "BBA bootee" the smart device monitors vital signs in infants which are suffering from prematurity, chronic lung diseases, and malformation syndromes [14].
- "Gaitshoe" smart shoes monitor heel strike, foot orientation and position [15].
- "eShoe" with the same concept for interpreting the human ambulation [16].
- "Arduino Lilypad" shoes for assisting blind people to reach their destination and also help them to avoid obstacles on their way [17].

3.5 Smart Healthcare Mobile Applications

The built-in sensor in smartphones and ever increasing computational capabilities has increased the trend of mobile based diagnosing and managing system.

- "MobSpiro" the Mobile Based Spirometry for Detecting Chronic obstructive pulmonary disease COPD uses human exhalation recorded by mobile microphone [18].
- Pulmonary Rehabilitation is mobile application for chronic obstructive pulmonary disease (COPD). Bluetooth pulse oximeter is used to measure the heart rate during exercise.
- A facial-expression recognition system is used for determining patient's health status [19].
- eCAALYX (Enhanced Complete Ambient Assisted Living Experiment, 2009–2012), a smartphone app for older people with multiple chronic conditions [20].

3.6 Smart Implantable Devices

Smart implantable devices are planted inside the body for monitoring body organs.

- "SmartPill" Wireless capsule is used to transmit intraluminal pH, pressure and temperature data at regular intervals to SmartPill GI Monitoring system [21].
- Titan implantable hemodynamic sensor (IHM) is a device having size of a pencil eraser that can be implanted in the heart of a patient to measure critical variables like temperature, and then wirelessly transmit this data to a secure database [8].

4 Summary

The purpose of this study was to focus on the current trends of smart healthcare systems and applications. For this it was necessary to elaborate smart cities, smart healthcare and different eras of healthcare from traditional methods to e-health, then

m- health and finally s-health. The systems included smart homecare for elderly people or disabled people and reasonable portable healthcare systems linked with smart phones for usability in remote areas by health practitioners. Smart wearable devices like bracelets or bands are used to track body temperature, pressure, glucose level, ECG, etc. Smart textiles are used for preventing infant deaths and also monitoring human health factors. Footwear's are useful for blind people and making them independent. Smart implantable devices are used for monitoring internal factors of body. In this paper we tried to showcase maximum smart devices and applications.

References

1. Singh S (2017) Smart cities—a $ 1.5 trillion market opportunity. Available at https://www.forbes.com/sites/sarwantsingh/2014/06/19/smart-cities-a-1-5-trillion-market-opportunity/#49063a406053. Last accessed 29 July 2017
2. WHO (2011) Health—new horizons for health through mobile technologies. Geneva, Switzerland. ISBN 9789241564250
3. Lee C-N (2012) A home care service platform for mobile healthcare. In: Proceedings of the international conference on machine learning and cybernetics, Xian
4. Demiris G, Tan J (2005) Rejuvenating home health care and tele-home care. In: E-health care information systems: an introduction for students and professionals. Jossey-Bass, San Francisco, pp 267–290
5. Klack L, Möllering C, Ziefle M, Schmitz-Rode T (2011) Future care floor: a sensitive floor for movement monitoring and fall detection in home environments. In: Lin J (ed) Mobi-health 2010. LNICST, vol 55. Springer, Heidelberg, pp 211–218
6. Leusmann P, Mollering C, Klack L, Kasugai K, Ziefle M, Rumpe B (2011) Your floor knows where you are: sensing and acquisition of movement data. In: Proceeding of 12th IEEE international conference on mobile data management (MDM), pp 61–66
7. Andrich R, Mathiassen N, Hoogerwerf E, Gelderblom GJ (2013) Service delivery systems for assistive technology in Europe: an AAATE/EASTIN position paper. J Technol Disabil 25(3):127–146
8. Najafi N (2015) Left heart wireless implantable hemodynamics monitor. http://mems-iss.com/left-heart-wireless-implantable-hemodynamic-monitor/. Last accessed 29 July 2017
9. Chutani S (2017) Available http://www.mobisante.com/. Last accessed 2017/07/05
10. St-Denis M (2017) LifeLine. Available http://www.mikhailstdenis.com. Last accessed 2017/07/05
11. Angel (2017) Lumo Run—revolutionary smart running shorts. Available at http://www.lumobodytech.com/. Last accessed 2017/07/05
12. Worringham C, Satchwell B (2017) Available http://www.esnc.eu/winner/cardiomobile-remote-monitoring-system-cardiac-rehabilitation/. Last accessed 2017/08/05
13. Curone D, Secco EL, Tognetti A, Loriga G, Dudnik G, Risatti M (2010) Smart garments for emergency operators: the Proetex project. IEEE Trans Inf Technol Biomed 14(3):694–701
14. Rimet Y, Brusquet Y, Ronayette D, Dageville C, Lubrano M, Mallet E (2007) Surveillance of infants at risk of apparent life threatening events (ALTE) with the BBA bootee: a wearable multiparameter monitor. In: Proceedings of 29th annual international conference of the IEEE EMBS, pp 4997–5000
15. Bamberg SJM, Benhasat AY, Scarborough DM, Krebs DE, Paradiso JA (2008) Gait analysis using a shoe-integrated wireless sensor system. IEEE Trans Inf Technol Biomed 12(4):413–423
16. Jagos H, Oberzaucher J (2008) Development of a wearable measurement system to identify characteristics in human gait-eSHOE. In: Proceedings of ICCHP 2008, pp 1301–1304

17. Jayashree S, Kruthika R, Raju Kumar Shankar R (2015) Arduino Lilypad shoes for visually challenged. Int J Sci Eng Res 6(10). ISSN 2229-5518
18. Zubaydi F, Sagahyroon A, Aloul F, Mir H (2017) MobSpiro: mobile based spirometry for detecting COPD. In: Proceedings of IEEE 7th annual computing and communication workshop and conference (CCWC)
19. Muhammad G, Alsulaiman M, Amin S, Ghoneim A, Alhamid F (2017) A facial-expression monitoring system for improved healthcare in smart cities. https://doi.org/10.1109/access.2017.2712788. IEEE Access
20. Boulos M, Wheeler S, Tavares C, Jones R (2011) How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. Bio Medical Engineering Online open access 2011 10:24. https://doi.org/10.1186/1475-925x-10-24
21. Maqbool S, Parkman HP, Friedenberg FK (2009) Wireless capsule motility: comparison of the SmartPill® GI monitoring system with scintigraphy for measuring whole gut transit. Dig Dis Sci 54(10):2167–2174
22. Mossa ASM, Yoo I, Sheets L (2012) A systematic review of healthcare applications for smartphones. BMC Med Inf Decis Mak
23. Solanas A, Patsakis C, Conti M, Vlachos I, Ramos V, Falcone F, Postolache O, Pérez-Martinez P, Pietro R, Perrea D et al (2014) Smart health: a context-aware health paradigm within smart cities. Commun Mag IEEE 52(8):74–81
24. Istepanian R, Laxminarayan S, Pattichis CS (2006) M-health: emerging mobile health systems, vol 1, 624 p. 182 illus. 0-387-26558-9. Springer, Berlin
25. Chen M, Ma Y, Ullah S, Cai W, Song E (2013) ROCHAS: robotics and cloud-assisted healthcare system for empty nester. In: Proceeding of BodyNets, Boston, MA, USA, pp 1–4 (2013)
26. Hariton E. Available http://www.tuvie.com/glucom-wristband-monitors-your-blood-glucose-levels/. Last accessed 2017/07/05
27. Marshall A, Medvedev O, Antonov A (2008) Use of a smartphone for improved self-management of pulmonary rehabilitation. Int J Telemed Appl 2008:5, Article ID 753064. https://doi.org/10.1155/2008/753064
28. Ryan D, Price D, Musgrave S, Malhotra S, Lee A, Ayansina D, Sheikh A, Tarassenko L, Pagliari C, Pinnock H (2012) Clinical and cost effectiveness of mobile phone supported self-monitoring of asthma: multicentre randomised controlled trial. BMJ 344:e1756. https://doi.org/10.1136/bmj.e1756
29. Jourand P, De Clerc H, Puers R (2010) Robust monitoring of vital signs integrated in textile. Sens Actuators, A 161:288–296
30. Hendricks D The history of smart homes.(2014) http://www.iotevolutionworld.com/m2m/articles/376816-history-smart-homes.htm (April 2014). Last accessed 29 July 2017

Review of Software Defined Integrated Satellite-Terrestrial Network

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Abstract SDN worldview has effectively figure out how to prepare toward cutting edge organizing, however the examination on SDN-based incorporated satellite and earthbound system has quite recently begun. SDN enabled administration and arrangement engineering of incorporated satellite terrestrial organize facilitates the multifaceted nature of administration of frameworks also, systems, enhances the keeping up and sending costs, accomplishes proficient asset portion and enhances arrange execution of by and large framework. In this paper, we began presenting the SDN-based coordinated satellite-earthly system design and examine the brought together what's more, straightforward framework practical engineering. At that point we outline the two central parts of incorporated system application capacities.

Keywords Software defined networking · Integrated satellite terrestrial network · Network architecture

1 Introduction

The mix of satellite and earthly systems has been brought into examine and talked about for a considerable length of time [1]. In those days, the satellite system has not been completely built up, the expensive arrangement and data transmission assets restrain it for esteemed utilizations, for example, crisis reaction, military missions, overall activities etc. With the quick improvement of satellite advances, satellite systems discover the way for easy going use, wide applications: correspondence, information exchange, remote detecting and Hi-Fi perception, and even Internet perusing. The satellite system can be incorporated as one high-postpone way, as

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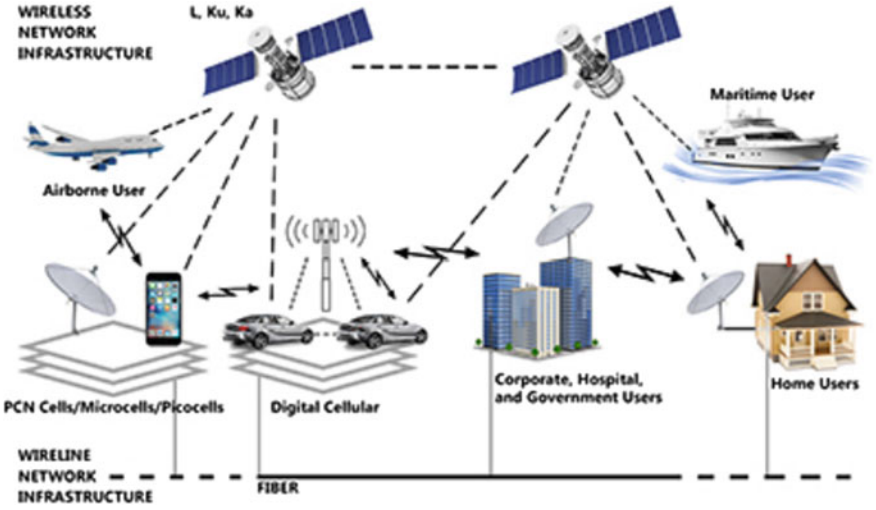

Fig. 1 Illustration of integrated satellite and terrestrial networks

reciprocal to earthly settled and versatile access so that to expand QoS and QoE level conveyed to end-clients. In this specific circumstance, satellite system demonstrates that it is a fundamental part later on heterogeneous systems (appeared in Fig. 1): transmission, back-pulling of information in remote regions, example versatile communication, air ship media transmission administrations, etc.

This paper researches how SDN/NFV advances can improve the activity of satellite systems and the improvement and administration of correspondence benefits crosswise over coordinated satellite-earthly design variations. The progressed and recently raised strategies, plans and the necessities are presented. Furthermore, a few difficulties and conceivable bearings are talked about in this zone. The rest of this paper is sorted out as pursues. In Sect. 2, the system utilitarian engineering is examined. Segment 3 shows the plan angles in arrange applications. Area 4 recognizes some examination difficulties and focuses conceivable headings. At long last, Sect. 5 comes the resolution.

2 Architecture of SDN-Based Integrated Satellite-Terrestrial Network

It is of most extreme significance that cutting edge organize engineering support various layers and heterogeneity of system advances including satellite interchanges, WLANs, cell systems and furthermore sorts of earthly specially appointed systems (appeared in Fig. 1). In this coordinated framework, the correspondences occur in a wide range: interchanges among satellites and earthly, correspondences inside

earthbound diverse systems, and furthermore between satellite correspondences. SDN worldview speaks to a chance to make it simpler to send and oversee diverse sorts of systems, including satellite systems, WLANs, and cell systems. A standout amongst the most strikingly open doors SDN innovation give is the improvement of administration. The new SDN-empowered administration and organization engineering of cross breed satellite-earthly system facilitates the intricacy of administration of foundations and systems, enhances the system execution of by and large framework, and abatements the keeping up and sending cost. SDN based usage of cross breed engineering can bring the suitable control level that present conventions and systems can't proficiently accomplish.

In view of the ongoing inquired about conveyed our, a bound together utilitarian engineering for SDN-based coordinated satellite-earthly system is represented and appeared in Fig. 1. Systems can be partitioned in three planes of usefulness: the information, control, and administration planes. For the most part, the information plane comprises of satellite what's more, earthbound switches and basically performing stream based parcel sending. Administration plane incorporates organizing applications, benefit interfaces, and system status administration. Diverse system characters should be checked in this layer. The control plane comprises of controllers situated in the earth stations also, earthbound systems, which incorporate all the system knowledge and perform arrange control for directing, handover, asset portion et cetera. Fallen inside this range, inquire about works has been centered around various viewpoints, what's more, changes mostly on the structure of controllers and switches.

Paper [2] presents a SDN-empowered satellite/ADSL crossover design. The SDN controller can be facilitated at the administration administrator. For this situation, the system application is running over the controller. In light of the information stream distinguishing pieces of proof and the planned unique sending rules, the information stream can be dispatched to the most proper connection incidentally and progressively to accomplish its QoS necessities, with fulfilling effective use of various transmission joins. For this situation, the specialist co-op allots all it had assets counting both satellite and earthly accessible data transmission for various application prerequisites. In any case, rather than getting worldwide vision, this sort of controller configuration accomplishes just somewhat/locally amendment. Creators in [3] proposed a product characterized satellite system engineering OpenSAN, which contains information plane, control plane and administration plane. Information plane comprises of multilayered satellite foundations (e.g. GEO, MEO and LEO) and terminal switches circulated around the globe. Control plane comprises of the three GEO satellites which covers the entire information plane.

Creators in [4] proposed another mixture control structure with data sending through single layer between satellite connections and GEO satellites broadcasting. Creators in [5] propose the incorporated earthly satellite programming characterized organizing utilitarian design. The change in perspective towards virtualization of framework parts, pushes towards a cloud-based model for system assets and functionalities administration. Control knowledge is unified in the control layer which interprets the upper layer directions to setups furthermore, date structures for

framework layer. Earthbound and satellite system assets are combined in this layer, and the virtualized arrange cuts are given to the application layer clients.

3 Network Functions

This section discusses the networks functions which implement control logic and dictate the behaviour of the forwarding devices. Despite the wide variety of use cases, the most essential and vital two SDN network functions are: resource management and routing mechanism.

3.1 Resource Management

The conventional asset situated asset administration techniques are not any more aggressive for the to a great extent expanding administration prerequisites in the incorporated systems. SDN-based adaptable satellite asset administration has been created to advance the run of the mill satellite broadband access benefit with the client to be ready to progressively ask for and get transfer speed and QoS in an adaptable and versatile way [5]. This is to present greater dynamicity in radio asset administration of the satellite connections. It enhances the usage of system assets, yet additionally makes it conceivable to play out the system arrangement, dimensioning furthermore, change progressively to satisfy the client's desire. Besides, the asset of satellite and earthbound access systems can be combined, which implies the pooling of various assets from at least two heterogeneous spaces in an approach to make one legitimate league of system assets empowering less demanding control also, portion of these assets. In other words, the system assets can be seen to transient among the systems, for example, Wide Area Network (WAN), 5G systems, and satellite system for availability amid a particular day and age for administration arrangement. This technique can be summed up to give the extraordinary QoS and administration classes powerfully and on the fly [6]. Indeed, even in such asset alliance case, the handover among various system areas and unique arrange gets to is as yet essential basic. Creators in [7] propose a consistent handover in programming characterized satellite systems administration, however just in satellite systems.

The fundamental objective the movement building is of limiting force utilization, expanding normal system use, giving improved load adjusting and other nonexclusive activity enhancement strategies. Ongoing work has demonstrated that the advancing standards situation can increment organize effectiveness. Activity designing is a critical issue in a wide range of systems, in this way, up and coming strategies, methods, and developments can be normal with regards to SDN-based incorporated satellite-earthly systems [8].

3.2 Routing Networking

Steering is dependably the fundamental and vital capacity in any system, where the need work is to ensure the conclusion to-end conveyance of information bundles. To accomplish this objective, directing plans are to characterize the way through which bundles will stream starting with one point then onto the next, in light of system highlight input. Also, effective and canny directing convention ought to have the capacity to give adaptable changes in accordance with different system conditions. Decent variety of system participators, the unpredictability also, dynamic system topology raises the test for versatile steering instrument in SDN based coordinated satellite-earthbound system to accomplish the internetworking inside a similar area and crosswise over various system spaces. In customary incorporated satellite-earthbound systems, the interoperability of various conventions is one of the principle issues, while with the SDN worldview, the tenets what's more, controls are the equivalent for the general framework, parts of framework pursue a similar guidance, which eradicate this issue as of now.

The best parts of steering in such framework incorporate manage regularly changing of system topologies, and certification of QoS prerequisites of different administrations [9]. Right off the bat, to a great extent and exceedingly powerful topology evolving prompts dynamic system hubs and control hubs (e.g. generally high speed of satellites and earthbound terminals), which acquires substantially more challenges for the directing instruments. As the topology of both satellite and earthbound organize transforms, it is hard to keep up the security. The static steering is plainly not reasonable for such expansive postpone organize, and the dynamic steering, on the other hand, is very asset devouring. Next to, the allegation of system status is essential in such systems. The control messages, which illustrate the system conditions, should be conveyed crosswise over various planes in SDN-based framework engineering, which builds the control overhead. Subsequently, a plan with exchange off among adaptability and control cost is basic for the SDN-based coordinated arrange [4]. While in coordinated satellite-earthly system, (for example, GEO satellites give long deferral and overall transmission, LEO satellites can convey low deferral to web perusing yet expensive, and the earthbound connections ensure the low deferral and most likely high data transfer capacity). The most effective method to grow such extensive application-mindful steering instruments to accomplish the best utilization of the coordinated arrange is of crucial significance [7].

4 Progressing Research and Efforts

This area features examine endeavors we consider of specific significance for releasing the maximum capacity of SDN, for the most part in three angles: adaptability and adaptability, security, and execution assessment.

4.1 Adaptability and Scalability

System virtualization innovation is to diminish the satellite system administrator costs, this prompts a quick and simple update and substitution of these functionalities yet in addition adaptability to organization of new inventive capacities. Virtualization standards are connected to physical system foundation, abstracting arrange administrations to make an adaptable pool of transport limit that can be distributed, used and repurposed on interest. Basically, arrange virtualization in incorporated satellite-earthly system incorporates framework virtualization and asset virtualization. The virtualization of radio assets is to extract and share various system assets. Virtualization of system capacities empowers the unified update and support of SDN-based design rather than worked on frameworks [10]. For instance, with the system virtualization worldview, PEP (execution improving intermediary) will never again be actualized as a devoted middle box but instead in programming that can be kept running on various gadgets. Along these lines, the PEP capacity can be committed to a correspondence setting [e.g. committed to a ST (satellite terminal)] and can be tuned agreeing to the application prerequisites (security, portability, execution, and so on.). In along these lines, if a ST makes a handover from one satellite center point to another, its devoted virtual PEP will relocate to the new center point and will keep on execution the proper TCP streamlining [11]. Be that as it may, the virtualization of system capacities ought to be created in a bound together and steady way.

4.2 Security

Security is the basic issue in a wide range of systems. There is a significant need to guarantee the protection and security of occupants in such heterogeneous systems. Being exceptionally programmable has the potential effect of strings unmistakably genuine in SDN, contrasted with customary systems. The exploration in SDN-based security is still on the beginning period. In this manner, security is one the best needs in such system and more exertion ought to be placed in future looks into. Conceivable difficulties furthermore, future headings for security in SDN-based coordinated satellite-earthbound system could be characterized in a few gatherings. Initially, some string vectors ought to be distinguished and pursued: faked or manufactures movement streams in information plane, which can be utilized to assault sending gadgets and controllers; flawed or pernicious controllers or applications in controller plane, which can be utilized to reconstruct the whole system and give an assailant the control of the system; absence of trusted assets for crime scene investigation and remediation, which can trade off examinations what's more, block organize recuperation to safe condition. Besides, arranging security arrangements crosswise over heterogeneous systems is essential.

4.3 Execution Assessment

With the advantages SDN worldview speaks to, a developing number of examines furthermore, tries about SDN-based coordinated satellite-earthbound systems are expected sooner rather than later. This will normally make new difficulties, as inquiries concerning execution have not yet been legitimately explored. A few OpenFlow based executions have been produced for reenactment examines also, experimentations for the SDN-based system engineering. Aside from the generally utilized tedious recreation and costly test procedures for execution assessment, expository displaying could, in another way, draw the depiction of a systems administration engineering which makes ready for system fashioner to have a brisk and surmised gauge of the execution of their plan. In spite of the assessment of system design, there are too other planned instruments to be assessed.

4.4 Migration and Integrated Development

A few endeavors have effectively dedicated to the relocation and cross breed SDN built with the current system foundations. The crucial step will permit the concurrence of conventional conditions of switches furthermore, switches with the new OpenFlow-empowered gadgets. Subsequent stage is to guarantee the interconnection of control plane and information plane of heritage and new system components. The underlying SDN operational arrangements are basically founded on virtual switch overlay models or Open Flow based system controls. The controllers are intended to present SDN-like programming capacities in conventional system frameworks, making the reconciliation of inheritance and SDN-empowered systems a reality without symptoms as far as programmability and worldwide system control. Future works are required to devise methods and association systems that boost its acquired advantages while constraining the additional intricacy of the worldview conjunction.

5 Conclusions

Conventional systems are unpredictable and difficult to oversee since the control and information planes are vertically coordinated. SDN makes an open door for settling this issue—decoupling of the control and information plane. The worldwide perspective of arrange is legitimately incorporated in charge plane and parcels conveyance is exceptionally effective in information plane. SDN brings adaptability, computerization and customization to the system, SDN worldview speaks to a chance to make it simpler to send also, oversee diverse sorts of systems, including satellite systems, WLANs, what's more, cell systems. SDN has effectively figure out how to prepare toward cutting edge organizing, yet the exploration on SDN based coordinated

satellite what's more, earthly system has quite recently begun. In this paper, we began presenting the SDN-based incorporated satellite-earthbound system engineering and talk about the brought together and basic framework useful design. We represent the two key parts of incorporated system applications.

References

1. Evans B, Werner M, Lutz E, Bousquet M et al (2015) Integration of satellite and terrestrial systems in future multimedia communications. IEEE Wirel Commun 12:72–80
2. Bertaux L, Medjiah S, Berthou P, Abdellarif S et al (2015) Software defined net-working and virtualization for broadband satellite networks. IEEE Commun Mag 53:54–60
3. Bao J, Zhao B, Yu W, Feng Z, Wu C, Gong Z (2014) OpenSAN: a software-defined satellite network architecture. In: SIGCOMM, Chicago, USA
4. Tang Z, Zhao B, Yu W, Feng Z, Wu C (2014) Software defined satellite networks: benefits and challenges. IEEE
5. Rossi T, Sanctis M, Cianca E, Fragale C, Fenech H (2015) Future space-based communications infrastructures based on high throughput satellites and software defined networking. IEEE
6. Maheshwarappa M, Bowyer M, Bridges C (2015) Software defined radio (SDR) architecture to support multi-satellite communications. IEEE
7. Yang B, Wu Y, Chu X, Song G (2016) Seamless handover in software-defined satellite net-working. IEEE Commun Lett 20:1768–1771
8. Ferrus R, Koumaras H, Sallent O et al (2015) SDN/NFV-enabled satellite communications networks: opportunities, scenarios and challenges. Phys Commun 18:95–112
9. Zhang J, Gu R, Li H et al (2015) Demonstration of BGP interworking in hybrid SPTN/IP networks. In: Asia communications and photonics conference
10. Ali S, Sivaraman V, Radford A, Jha S (2015) A survey of securing networks using software defined networking. IEEE Trans Reliab 64(3):1–12
11. Yang X, Xu J, Lou C (2012) Software-defined satellite: a new concept for space information system. In: IMCCC, IEEE

Approaches to Design Zigzag Drive Detection Model Using Image Processing

Sanjay S. Wankhede, Preeti Bajaj, Anushri Agrawal and Gayatri Lanjewar

Abstract It is required to classify the traffic violation for reducing the rate of road accidents and traffic safety. Driver's behavior is one of the main cause that contribute to increase the traffic accidents, as it leads to degrade the performance of driving pattern. This behaviors need to detected and minimize. The paper presented the model, by using video capturing from road side, the diving pattern can be detected. The models then has tested on multiple videos. Mainly two approaches have presented here. Model developed by Canny edge detection method is giving accuracy of 79.16% and model by centroid & blob method is giving accuracy of 83.33%.

Keyword Image processing

1 Introduction

Intelligent Transportation System (ITS) is getting momentum in India specially to enhance the safety and improving efficiency of overall movement of vehicle and traffic. According to world scenario accidents are increasing in every country. On the basis of Global status report, in 2014, traffic accidents kill's 1.24 million persons a year worldwide and 50 million others are injured [1]. Around 85% deaths are often seen in the developed countries all over the world. As compared to high income countries in low and middle income countries 90% of world's fatalities happen, [2] amongst which India is counted under low-middle income countries. In the United States because of driver's distraction and inattention one quarter of accidents are observed also driver's distraction is the first priority in the North America, japan, and Europe [1]. On the worldwide studies accidents are because of driver's inattentive performance and distraction. Hence the prevention is the better option for minimizing the record of accidents. Driver's distraction is the activity while driving the driver is engaged or busy with certain movement and wrong driving performance. Driver's distraction is mainly falls into 4 categories. Visual (while driving looking off the

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road), Cognitive (talking with person or on phone, not conscious in driving activities), Manual (not serious while driving for example taking hands off the steering wheel), Auditory (listening music).

Driver also include the common distraction related to the accidents are over speeding, avoiding safety rule, overtaking in wrong manner, disobeying the traffic rule, using cell phone, busy with internal activity, using headphones, texting, drunken driving, listening music etc. These are the common distraction are interconnected to the above main four categories of the drivers distractions [3]. The most common causes in every country studied that the disobeying the traffic rules that is jumping of red light, rash driving, not using seat belt and helmets, handling a mobile phone while driving.

Driving task requires drivers to judge, predict, and monitor behavior of other road traffic users (e.g., speed, risk perception), as well as vehicle control, fast and appropriate response to (unpredictable) situations that are permanently presented in road traffic scenario [4]. Day by day increasing accidents in every country not only related to the driver's distraction but also associated to the other factors like road condition, environment (heavy winds, extreme temperature, humidity, impaired visibility, and fog) and traffic density can act as numerous ways on drivers risk which gives to reducing the driving performance and caused crashes on the road. This leads to drivers degraded performance of driving and situational awareness of the driver. Human behavior is the key factor in an accidents risk. Therefore classification of road traffic is the primary importance for decreasing the accidents and safety purpose of road traffic in each region and every country.

India has one of the countries having highest numbers of road accidents in the world. Accidents are quite common in every traffic sector. Over the last 50 years, India's automobile population has grown 170 times while the road infrastructure has expanded only nine times. The rate of traffic accidents in India is amongst the highest in the world. In India according to "Indians for road safety", one person died every 4 min in traffic accidents [5]. Hence the road safety is the major concern regarding the traffic safety. In most transportation scenario, number of increasing population, enormous traffic and number of vehicles are rises in huge way, resulted into the collision on road and increase the accidents. Thus it is very essential to study and monitor the traffic situations especially in tier-2 cities in India. Therefore the classification of road traffic is the major requirements for monitoring the road traffic. Most of the accidents are caused due to the violating the traffic rule in India that is jumping of the traffic signal, over speeding, using mobile phone and rash driving (zigzag driving) [6].

2 Related Work

Nada B. Al Naser et al. studied the behavior of drivers related to the traffic safety. Collected driver's behavior data from the last few years and analyses these data for characterizing the driver's negative behavior. Author calculated the probability of

common driver's negative behavior and joint probability for combining one or more negative behavior [7]. Buchhi et al. [8] analyzed the relations between traffic road safety and human's factor for recognizing the approach and personality of drivers for identifying the driving performance. Fatima Percira et al. propose the study of understanding the driving performance. For analyzing the driving pattern study is based on the two types of drivers are learners and experienced drivers [9]. Richard Rowe et al. described the drivers behavior used over the last 20 years. Measure errors while driving and violations of road traffic [10]. Apoorva Mishra et al. gives the survey on different driver behavior whether the drivers is busy in any visible type of secondary activities or involved in any traffic violation. The data was collected from the installing the CCTV camera on road cross section in three different squares [11]. Bing-Fei Wu et al. proposes monitoring system which is used to provide drivers an indicator of the danger level for accident prevention. This system uses the Hidden Markov Model (HMM) and fuzzy logic. The data receives from a camera, GPS, accelerometer and then the interested feature are extracted. Extracted features are applied to HMM model and identify driver danger level [12].

Tanmoy D. Goswami et al. proposes a rush and drunk driver detection system. It describes that, drunk driver most probably creates improper driving pattern i.e., weaving, drifting, zigzag and turning with a wide radius [13]. Vaibhav Bhoyar et al. proposed a model for detecting the rash driving on a traffic road. In this system mobile phone is used which is placed in the vehicle with accelerometer. The mobile sensor sense the vehicle driving pattern based on the accelerometer and comparison is done [14].

3 Implementation of Zigzag Driving Detection Model Using Canny Edge Detection Method

Figure 1 Shows the Flow chart of detection of zigzag driving using canny edge detection. From the input video multiple frame are extracted. After extracting the multiple frames, if zigzag driving is detected, then the binary conversion is applied on the basis of thresholding technique. Canny edge detection is applied on the specified image. If the vehicle is detected as a straight path then canny edge detection is performed, or it is detected as a zigzag driving Fig. 2a shows the binary conversion of an im age Binary conversion is done using a threshold value as specified between the ranges of 0–1. Using the specific threshold value, conversion is made into light and dark pixels. The pixels value is greater than the threshold value is represented in binary one which is indicated as white pixel and if the value of pixel is less than the present threshold value is represent to binary zero which is indicated as black pixels in an image. The system for detection of zigzag driving uses edge detection techniques. Hence for edge detection processing first of all total number of video frames are converted into binary form using binary conversion operation in the image processing and then the edge detection method is applied. The Edge detection is the

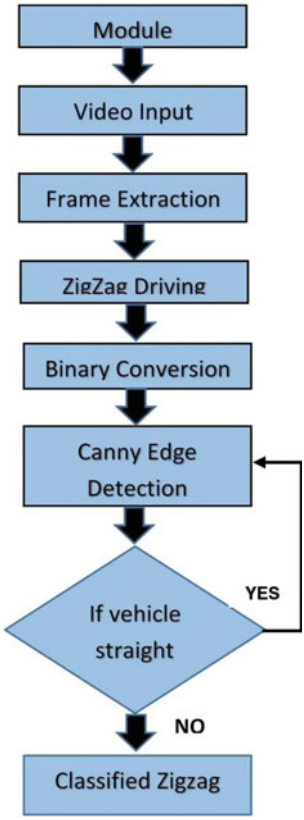

Fig. 1 Flow chart of detection of zigzag driving

techniques in image processing tools which is used to identify the discontinuities from one pixel to another in an input image i.e. sudden change in the input image. The purpose of this detection is to reduce the amount of data in an image while storing the structural properties which can be used for further image processing. The edge detection methods used in image processing are as follows:

- Prewitt Edge Detection
- Sobel Edge Detection
- Log Edge Detection
- Canny Edge Detection.

In this classification canny edge detection method is used, because it is one of the standard edge detection methods. Canny edge detection requires two threshold values to detect strong and weak edges. This uses a multi stage algorithm to detect a wide range of edges in images. Canny edge detector performs the following five steps:

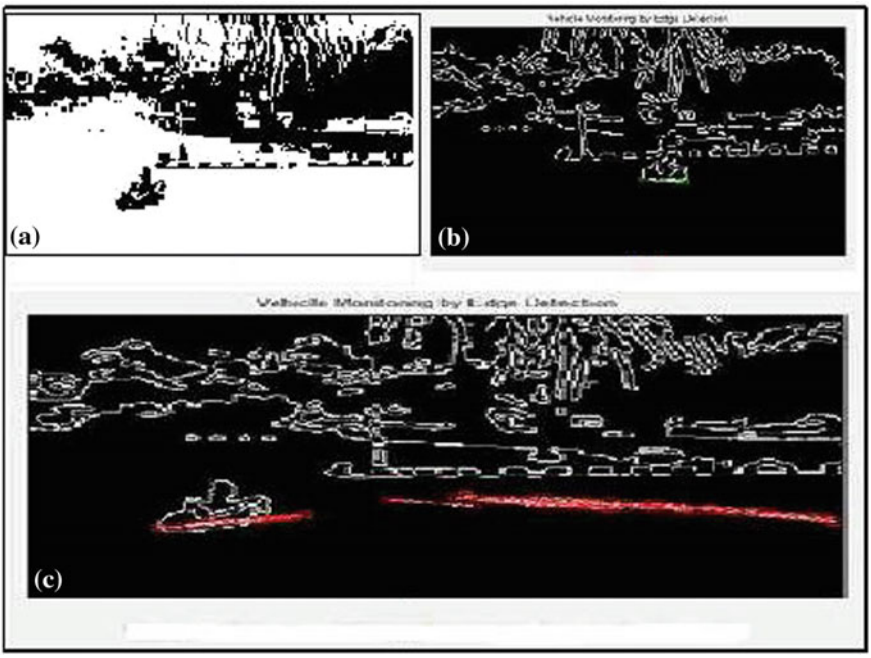

Fig. 2 **a** Binary conversion. **b** Edge detection. **c** Zigzag driving detection

- Smoothing
- Finding gradients
- Non maximum suppression
- Double thresholding
- Edge tracking by hysteresis.

For this classification, vehicles boundary are identified using the edges value. When the vehicle moves in a straight manner on the road, it shows the straight line using the positions of initial and end points of the edges of the vehicles. The edge detection is shown in Fig. 2b. The vehicle who do not follow the straight line it is detected as zigzag driving. Rash driving is the critical factor in the road traffic. Now in the rash driving the most essential factor in young ages are the zigzag driving. When the vehicle is moving in an improper manner or in zigzag path i.e. it does not follow straight line path. The vehicle which does not follow the starting line i.e. the difference of the initial and he end points of the vehicle edges is greater than the specified limit. By using edge detection technique when the vehicle not following the straight line in this process then it will shows the result in zigzag driving violation. The classified zigzag driving violation is shown in Fig. 2c.

4 Implementation of Zigzag Driving Detection Model Using Centroid and Blob-Analysis

The zigzag drive or rash drive detection of vehicles involves the blob analysis method-for centroid location. As soon as centroid is located on moving object. The path will be tracked and graph shows the zigzag path comparing it with reference path, which is explained as follows.

Centroid location using blob-analysis: This technique is mainly utilized to track the vehicles driving zigzag. The technique of blob analysis is based on analysis of consistent image regions. As such it is a tool of choice for various applications in which the objects are being inspected clearly visible from background. Diverse set of Blob analysis methods allows to create tailored solutions for a wide range of tracking problems. Main advantages of this technique are high flexibility and excellent performance. The scenario of the Blob Analysis solution consists of the following steps.

Extraction: To obtain a corresponding region of the reviewed object thresholding technique for image is applied.

Enhancement: Because of poor quality of image and different types of noise, enhancement of image is done by using region transformation techniques on extracted region Analysis: Dimensions and final results are calculated for the refined region. For the multiple objects in the region, it is divided into individual blobs each of which is reviewed one by one.

5 Results

5.1 Using Canny Edge Detection

The resulted zigzag driving pattern is shown in Fig. 3. The models developed were tested in traffic on Nagpur city during day light. Table 1 presented the Accuracy, when model tested on different videos.

5.2 Using Blob-Analysis

The GUI for zigzag drive detection is shown in the Fig. 4. It consists of two axis from which axis one shows the original video with the centroid located on the vehicle detected and tend to follow the path of the vehicles and axis two shows its graph with respect to its reference line (Table 2).

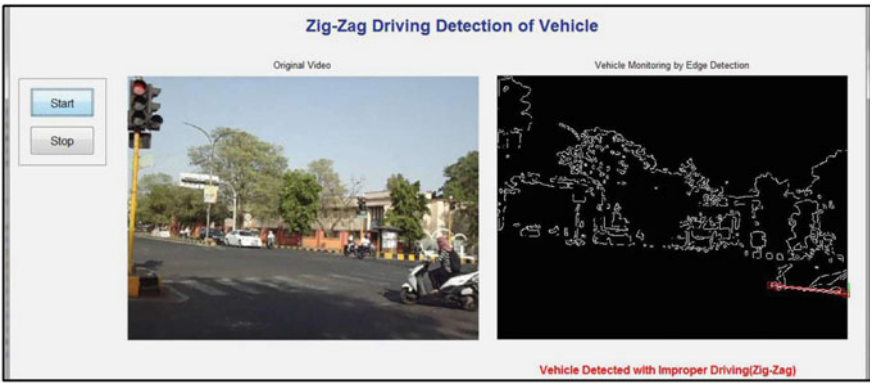

Fig. 3 Zigzag driving detection of vehicle

Table 1 Comparative analysis of actual detection and using canny edge detection

Input video	Total no. of vehicles	Actual zigzag driving	S/W zigzag driving	Accuracy (%)
Video 1	78	2	2	100
Video 2	57	3	2	66.67
Video 3	72	0	0	100
Video 4	21	2	1	50
Average accuracy				79.16

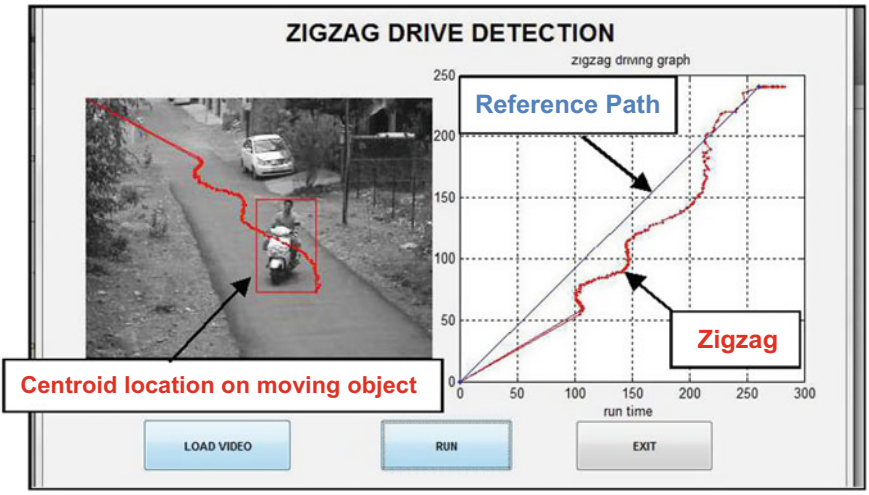

Fig. 4 GUI for zigzag drive detection

Table 2 Comparative analysis of actual detection and using blob analysis

Video clips	Zigzag drive Observed	Zigzag path obtained	Zigzag graph detected	Accuracy (%)
Video 1	1	1	1	100
Video 2	1	0	0	0
Video 3	1	1	1	100
Video 4	1	1	1	100
Video 5	1	1	0	100
Video 6	1	1	1	100
Average accuracy				83.33

6 Conclusion

Author presented the model with different approaches to detect rash/ zigzag driving on road by using video capturing from road side. The models were tested on different video clip and results were computed with the actual/manual observation. The model wherein Centroid and Blob method were use shown improvement in accuracy from 79.16 to 83.33% over canny edge detection system.

References

1. http://www.progressive-conomy.org/trade_facts/traffic-accidents-kill-1-24-million-peoplea-year-worldwide-wars-and-murders-0-44-million/
2. http://www.un.org/ar/roadsafety/pdf/roadsafetyreport.pdf
3. www.NSWMA.org/ Distracted While Driving
4. da Silva FP, Santos JA, Meireles A (2014) Road accident: driver behaviour learning and driving task. Procedia Soc Behav Sci 162:300–309
5. https://en.wikipedia.org/wiki/Traffic_collisions_in_India
6. http://www.jhpolice.gov.in/road-safety/common-causes-of-road-accidents
7. Al Naser NB, Hawas YE, Maraqa M (2012) A survey-based probabilistics statistical approach for characterizing drivers "negative behaviors". Procedia Soc Behav Sci 48:1108–1117
8. Bucchia A, Sangiorgi C, Vignali V (2012) Traffic psychology and driver behavior. Procedia Soc Behav Sci 53:973–980. 1877-0428 © 2012
9. da Silvaa FP, Santosb JA, Meirelesc A (2014) Road accident: driver behaviour, learning & driving task. Procedia Soc Behav Sci 162:300–309
10. Rowea R, Roman GD, McKenna FP, Barker E, Poulter D (2015) Measuring errors and violations on the road: a bifactor modeling approach to the driver behavior questionnaire. Accid Anal Prev 74:118–125
11. Mishra A, Bajaj P (2015) Driver's behavior monitoring in urban roads of a tier 2 city in India
12. Wu B-F, Chen Y-H, Yeh C-H (2012) Fuzzy logic based driving behavior monitoring using Hidden Markov Models. In: 2012 12th International conference on ITS telecommunications
13. Goswami TD, Zanwar SR, Hasan ZU (2014) Android based rush and drunk driver alerting system. Int J Eng Res Appl 4(2)(Version 2):50–53. ISSN: 2248-9622
14. Bhoyar V, Lata P, Katkar J, Patil A, Javale D (2013) Symbian based rash driving detection system. Int J Emerg Trends Technol Comput Sci 2(2)

IOT Based Baby Incubator for Clinic

Pravin Kshirsgar, Varsha More, Vaibhav Hendre, Pranav Chippalkatti and Krishan Paliwal

Abstract Today, technology is progressing every conceivable way, particularly in the field of wellbeing and care items particularly where the necessities are supporting life. Extra care is taken with regards to babies. Particularly if there should arise an occurrence of premature (newborn children that appear on the scene sooner than full-term) babies/Low birth weight (under 1 kg) babies, who wouldn't have built up the thermo-regulatory instrument (i.e. not ready to change in accordance with the outside ecological temperature on account of do not have the muscle to fat ratio) the safety measure is multiplied. The Neonatal Intensive Care Unit (NICU) is intended to give a climate that limits weight on the newborn child and addresses fundamental issues of warmth, nourishment, care and insurance to guarantee legitimate development and improvement. In such cases babies must be kept either stripped/half-exposed in a hatchery (which has the capacity to keep up the temperature inside it and solaces the child).

Keywords NICU · Hypothermia · Heart rate · Respiration · Raspberry Pi

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1 Introduction

Hypothermia is one of the essential parts of the child mortality. Hypothermia is decreased body temperature that happens when a body dissipates more warmth than it holds. In individuals, it is described as a body focus temperature underneath 35.0 °C (95.0 °F). Hypothermia has two central sorts of causes. It customarily occurs from prologue to unbelievable cool. It may in like manner occur from any condition that reduces warm age or extends warm incident. Incubation centers are attracting energy from the restorative calling. They are glass and metal cases warmed to certain Humidity, into which enough air is admitted to take care of life. Until the point that such time as an infant is sufficiently strong for Humidity of room. In NICU, Humidity control is crucial.

Neonatal Intensive Care Incubator (NICI): The Incubator, which is used to keep the infant warm, is an ensured isolate territory in which normal conditions (temperature) can be controlled at levels perfect for improvement, and metabolic reactions to give baby real thought. Incubator is included clear material, and will absolutely envelop infant to keep it warm and to keep up the normal body temperature (i.e. 37 °C), lessens the likelihood of tainting, and limit water mishap by keeping up the moisture level. The Insulated separated zone helps in giving confirmation since Infection is danger to inconvenient infants as they are less ready to fight germs that can cause authentic disorder.

2 Problem Definition

Premature infants are exceptionally touchy and more often than not endure with hypothermia and hyperthermia. A substantial number of newborn children in the creating scene kick the bucket because of rashness inconveniences emerging due to non-accessibility of Infant Incubators. These deaths are frequently caused because of warmth misfortune and parchedness as the rashly conceived children can't direct the temperature as the temperature of the earth changes, this can be anticipated by restorative consideration with the assistance of a hatchery. Available infant incubator suffers from following two problems:

1. The infant incubator is relatively expensive and for this reason many health care centres especially at rural areas can't afford to buy.
2. Most incubators run on electricity, therefore when there is an acute shortage of electricity, this existing expensive baby incubator is of no use.

3 Literature Survey

Hypothermia has for a long while been seen as a real danger to babies, particularly enormously unfavorable and low birthweight infant, for whom hypothermia on admission to the neonatal crisis unit is a self-ruling peril factor for death in made countries. Principles recommend for drying babies, putting them under splendid warmth and using tops to check hypothermia. Despite these measures, various to a great degree awkward infant youngsters are hypothermic on NICU affirmation. Putting newborn child kids in clear polyethylene packs before setting them under splendid decreases evaporative warmth misfortunes while until now allowing splendid warmth (infrared light) to experience [1].

The development of the incubation facility in 1880 contacted off a passionate flooding of pervasive and master vitality over the likelihood of reducing less than ideal infant kid mortality. Anyway the development itself progressed bit by bit and sporadically all through the accompanying 50 years. The story justifies assessing less from the perspective of mechanical headway, yet from the perspective of how commitment with respect to the newborn child moved from mothers to obstetricians and at last pediatricians. It moreover demonstrates how the verifiable scenery of advancement incorporates more than improvement. The development of the incubation center itself was less important than the enhancement of a structure to encourage the device [2].

Neonatal Intensive Care Unit (NICU) is used for better temperature estimation, partition from illness, specific feeding to new-conceived youngsters and to balance hypothermia and hyperthermia. The NICU or incubation facility contains a servo control system including temperature sensor to oversee incubator air temperature. Among the amount of temperature sensors like thermocouples, thermistors, Mercury thermometers, electronic temperature sensor DTS, etc., DTS gives correct results over straightforward temperature sensors. The objective of the work is to interface Programmable ADT7410 DTS to PIC18F8720 Microcontroller to screen the infant kids body temperature. This sensor gauges temperature with exactness, high objectives and fast change. ADT7410 is a MEM based modernized sensor, which is Programmable for High, Low and fundamental temperature limits. The item program is formed in C vernacular and gathered to make Hex record. The all-around requested methodology of the structure is elucidated using flowchart [3].

Innumerable in the making scene kick the basin as a result of thoughtlessness challenges developing due to non availability of Infant Incubators. These deaths are much of the time caused in view of warmth setback and drying out as the thoughtlessly imagined babies can't immediate the temperature as the temperature of nature changes, this can be fore-slowed down by therapeutic thought with the help of an incubation facility. The other issue is that most incubation facilities continued running on power, therefore countries like our very own where there is an extraordinary inadequacy of intensity, this current expensive tyke incubator is of no usage. The high temp water is used as an arranged non-electric warming source in the proposed incubator. The moistness level at 70% RH or more is moreover kept up non-electrically.

In the proposed incubation center structure extraordinary sort of buildup and air particulate cloak are put at the windows of the incubator to clear buildup and air particulate. We have exhibited that a 12 V 100 Ah standard battery available in the market can supply 20 days for sensors and fan drive system. In arranging the incubation center we endeavored to diminish the cost by using locally open materials. We believe that our proposed non electrical sort infant youngster incubation facility will be a mind blowing help in diminishing the destruction of less than ideal newborn children at rural domains in Bangladesh where smallness, cost and power are fundamental concerns [4].

This work is away to develop a device which can be used for multipurpose temperature watching and control. At the center of the circuit is the 8051 microcontroller which controls all of its abilities. A temperature sensor LM7805 is utilized for recognizing the temperature of the earth and the structure demonstrates the temperature on a LCD continuously. This temperature is differentiated and the regard set away by the customer and if the temperature goes past the preset temperature, hotter (handle) kills and if temperature goes underneath the preset regard, radiator switches on. The made temperature controller contraption can be used for different applications [5].

There are four million babies by and large who kick the basin in the vital month of life, one million pass on their first day. Preterm birth is credited, either explicitly or by suggestion, to in any occasion 25% of neonatal passings, and low birth weight (LBW) new-borns are at the most genuine peril. About 1.8 million youngsters each, amazing nonattendance of a solid warmth until the point that they have the muscle to fat proportion and metabolic rate to stay warm. This paper keeps the destruction of such newborn children. The microcontroller based baby incubation center serves to all social orders, the cost this assignment isn't as much as the present tyke incubator which are used in tremendous recuperating office. Along these lines, everyone which has a place with saving backward moreover usage of it. This errand not simply used for checking and controlling the temperature yet what's more give number of focal points, for instance, controlling dampness, watching heartbeat, voice of newborn child [6], oxygen level, weight, etc. [7].

The investigation paper portrays a Development of a Wireless Monitoring System for Neonatal Intensive Care Unit (NICU); which is an isolated space for an untimely/frail new-imagined kid. It gives the natural condition as its mother's stomach. Nonappearance of thought in regards to thermoregulation continues being a child for pointless passings in the neonatal people. Keeping up a consistent body temperature is basic to ensure perfect improvement of inauspicious and weak infant youngsters. As the temperature and stickiness parameters expect a fundamental occupation in the midst of the headway of inconvenient weak infants, this examination work develops a remote system which determinedly screens these parameters inside the NICU. The structure passes on a plan of sensible sensors for the system headway. The basic signs from sensors are readied using a Peripheral Interface Controller (PIC) microcontroller and further transmitted towards the not exactly alluring end with the help of Global System for Mobile Communications (GSM) modem using Application Terminal (AT) bearings [8].

4 Proposed System

In proposed framework DHT11 sensor is utilized to detect mugginess and temperature of hatchery. One warming component and a cooling fan are utilized to control ideal temperature inside the hatchery by detecting DHT11 sensor. Battery segment is utilized to give control supply to the framework. Heart beat and breath sensor are added to screen heart beat and breath rate of baby. Status of the framework can be shown on LCD or send to server with IOT. The framework is associated by means of Wi-Fi so a specialist can screen and control encompassing temperature from far place as well is shown in Fig. 1.

4.1 Block Diagram

Proposed system is divided into three parts as shown in Fig. 2:

Sensing System
Temperature and humidity sensor: DHT11 is used for sensing temperature and humidity since this two is very important factors for development of child.

Heart beat sensor: to monitor heartbeat of neonatal, heart beat sensor is connected near heart of child.

Respiration sensor: for monitoring respiration of child, respiration sensor is used.

Controlling System
Raspberry Pi is used for monitoring and controlling the whole system.

Output System
LCD: LCD is used to display humidity, temperature, heart beat and respiration of neonatal.

Fan and bulb: fan and bulb is operated according to the temperature of infant incubator. If temperature goes above threshold value then fan will turned ON to cool down the incubator. Similarly Bulb makes the incubator hot when temperature goes down.

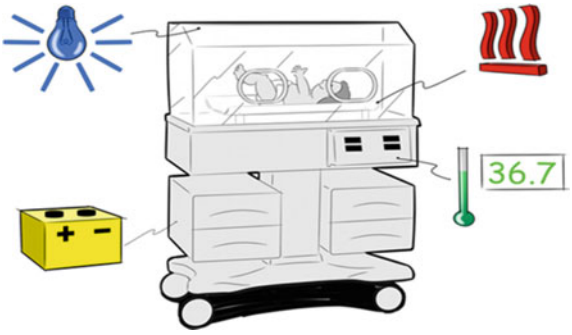

Fig. 1 System architecture

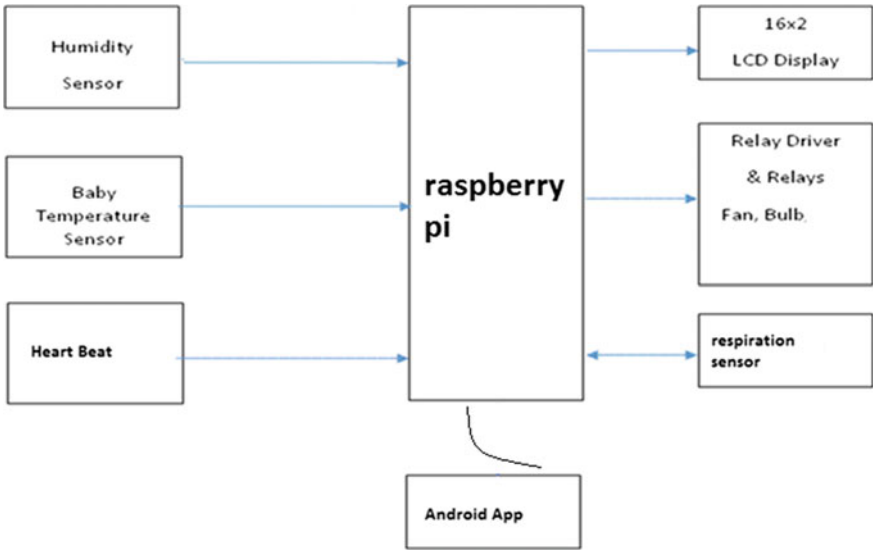

Fig. 2 Proposed systems

Android App: all the sensor values are display on android app from where doctor can control the incubator's temperature.

Ultraviolet light will turned ON manually if required. Proposed project will automatically adjust required atmosphere inside it with accuracy.

5 Conclusion

Considering, this work proposed a model of an infant youngster incubator that is sensible to be used for office in the rustic locale. A moderate, transportable, and essentialness saving infant youngster hatchery was adequately made through this work. The place might provides a correct and condition that over the long-term ready to deflect child that was thought of within the nation district from hypothermia condition. They will have the ability to get the fundamental consideration inside a concise period in the midst of the essential condition, subsequently decreasing the mortality case among them.

References

1. McCall EM, Alderdice F, Halliday HL, Jenkins JG, Vohra S (2010) Interventions to prevent hypothermia at birth in preterm and/or low birthweight infants. Cochrane Database Syst Rev 3
2. Health Informatics Centre (2012) Health facts. Ministry of Health Malaysia
3. Jagadeesh P, Karthick Kumar Reddy G, Venkatramana Reddy S (2014) Design and development of an inexpensive temperature controller for an infant incubator. Int J Adv Res Electr Electron Instrum Eng 3(6):10194 (An ISO 3297: 2007 Certified Organization). Copyright to IJAREEIE www.ijareeie.com
4. Biswas SK, Mia MMA, Islam R, Sinha S (2016) Design of a low cost non electrical type baby incubator for developing country. Int J Sci Eng Res 7(11):1148. ISSN 2229-5518. IJSER © 2016. http://www.ijser.org
5. Umelo N, Amadi A, Obodoeze F, Onyibe C (2017) A multi-purpose hardware efficient temperature regulator with LCD display. Int J Comput Eng Inf Technol 9(10):254–257. Available online at: www.ijceit.org. E-ISSN 2412-8856 (Online)
6. Med AZ, Elyes F, Abdelkader M (2011) Application of adaptive predictive control to a newborn incubator. Am J Eng Appl Sci 4(2):235–243. ISSN 1941-7020
7. Patil DS, Aher AS, Nahata AS (2016) PIC microcontroller based efficient baby incubator. Int J Mod Trends Eng Res. www.ijmter.com e-ISSN No: 2349-9745, Date: 28–30 Apr 2016 @IJMTER-2016, All rights Reserved
8. Joshi NS, Kamat RK, Gaikwad PK (2013) Development of wireless monitoring system for neonatal intensive care unit. Int J Adv Comput Res 3(3). (ISSN-print): 2249-7277, ISSN (online: 2277-7970)

LTE-LAA and Wi-Fi Coexistence on 5 GHz—A Survey

Bhausaheb E. Shinde and V. Vijayabaskar

Abstract Wireless industry is growing exponentially due to the growth and demand of mobile services. The ever increasing demand of wireless services had forever increased the problem of scarcity of spectrum. The demand of data traffic is increasing day by day and 5 GHz unlicensed band is the best solution to meet this requirement pointed out by wireless industry. The 5 GHz unlicensed band is accessed as per the availability by using LTE technology and this is the best example of this operation to enhance the capacity of end user and to provide good quality of access to the users. This paper provides a comparative and vast survey on LTE-LAA and Wi-Fi coexistence on 5 GHz unlicensed band. In the first part of this paper we have discussed about the present scenario of coexistence of LTE-LAA and Wi-Fi tehnology. In second part we had covered the main key features of LTE and Wi-Fi technology. Finally we had discussed about the main challenges of coexistence of LTE-LAA and Wi-Fi Technology.

Keywords Long term evolution (LTE) · LTE uplink scheduling technique · Coexistence · Wi-Fi · 5 GHz unlicensed frequency band

1 Introduction

With the exponential growth of mobile users and its huge applications, wireless service providers are experiencing major growth in mobile data users in the world [1]. The worldwide mobile traffic is increasing in multiples in every year as per the standard reports from wireless industry, and the wireless industry needs to prepared for providing services to all mobile users in future [2]. Such huge mobile data traffic of multimedia services are resulting a big problem on the system capacity and making it challenging for providing quality of service to future mobile communication systems

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[3]. Wireless industry is in search for more advanced and technical solutions to increase its network capacity along with providing higher level quality of service to their customers. Operator's first choice is to use its licenses spectrum more effectively for providing reliable and secure performance from their network as compare to other networks.

For achieving a higher data rate, carrier aggregation technology standardized in LTE standard (Releases 10–12), and in that multiple small band segments can be divided into maximum 100 MHz bandwidth [2]. In order to provide high speed and good quality localized services along with improved inter-cell interference coordination (eICIC) and frequency reuse mechanism is enabled by deploying small cells overlaid with macro cells to improve licensed spectrum efficiency. This process of deployment is known as heterogeneous networks [4] (HetNets) in LTE release 10, which refers to deployment of co-channel of small cells which is sharing same licensed spectrum with macro cells. The licensed spectrum can get easily congested due to large number of small cells available in the dense deployment scenario of HetNets. This motivates the service provider to use the available unlicensed spectrum in operation. In multimedia services LTE/Wi-Fi coexistence are allowing users to use either licensed LTE or unlicensed Wi-Fi networks [5]. In LTE release 13 it has been stated that LTE-unlicensed (LTE-U) technology is initiated to allow users to access both licensed and unlicensed spectrum under a unified LTE network infrastructure.

2 Existing Surveys on LTE, Wi-Fi and This Paper a Comparative Study

In these surveys, a comparative study of present surveys on LTE and this paper has been neatly explained. We had investigated several surveys from different aspects of LTE-related technologies.

The authors first reviews about the evolution of LTE physical layer and control channels [1]. In papers [2, 4, 6], authors focuses on radio resource management (RRM) for LTE and LTE Advanced (LTE-A) networks. To be more in specific, the authors in [4] explained on Heterogeneous Networks (Het Nets). Resource allocation and link adaptation are overviewed in [2] and in [6] authors said about Radio resource management for spectrum aggregation. In papers [5, 7–11], authors have given information about Uplink (UL) or Downlink (DL) scheduling. In paper [5] authors had classified scheduling of LTE UL for Machine-to-machine (M2M) communications. In paper [7], authors explained about the cooperative Uplink transmissions beyond LTE-Advanced system. In paper [8], authors had given information regarding UL scheduling in LTE and LTE-A.

Authors in paper [10] had explained about the downlink (DL) packet scheduling in LTE network. Different mitigation techniques for DL and UL for Multi-cell coordinated scheduling and inter-cell interference are reviewed in [9]. As per [9], multi-cell scheduling strategies of LTE and LTE-Advanced are also reviewed in [11]. Some

surveys said about the techniques for enabling communications in LTE networks. In paper [12], authors described Machine to Machine (M2M) communications of LTE and LTE-Advanced. In paper [13] author had reviewed Device-to-Device communications in LTE networks. Different Security aspects for LTE and LTE-A networks are overviewed in paper [3]. These papers had focused on study of LTE-LAA and Wi-Fi coexistence in 5 GHz unlicensed spectrum.

At present mobile networks are facing network capacity challenges everywhere. The research community have already started to concentrate their research interest in this area due to special benefits given by the coexistence of LTE and Wi-Fi networks in unlicensed spectrum.

In the Table 1 we have done an extensive survey on LTE and our work related to LTE-LAA and Wi-Fi coexistence on 5 GHz band has been highlighted. In the survey the work of other authors has been also highlighted under the description section of the table sequentially.

3 Key Features of LTE-LAA and Wi-Fi Coexistence

In order to achieve coexistence of LTE and Wi-Fi and other unlicensed technologies the three features plays a vital role in the process of coexistence.

a. **Channel selection**: channel selection is very effective in low to medium density scenarios considering that multiple 20 MHz channels are available in 5 GHz unlicensed band. In LTE-U small cells always try to select a clean channel to avoid interference with nearby nodes, based on the continuous channel measurements.
b. **Time-domain coexistence techniques**: are expected when there is unavailability of clean channel. As per the regulations of unlicensed band multiple techniques can be there for sharing the channel properly with the Wi-Fi. In case of non listen-before-talk (LBT) markets such as India, US China and South Korea, without changing Carrier Aggregation protocols (Rel-10) for co-channel coexistence CSAT (Carrier Sensing Adaptive Transmission) can be used. For listen-before-talk (LBT) markets in Europe and Japan, Rel-13 LAA is enabling the channel sharing with Wi-Fi by performing clear channel assessment (CCA) based channel availability sensing and adapting the transmission duration on a timescale ranging from 1–10 ms.
c. **Opportunistic SCell operation**: In the LTE-U, unlicensed carriers are designed to operate as secondary cells (SCells) having the principle that at low traffic load, LTE-U small cells are releasing the unlicensed carriers and are be back on to main carrier of licensed spectrum in the process.

Table 1 Comparison and study of coexistence of LTE license assisted access and Wi-Fi technology and our present work

Reference paper no.	Main keywords	Key findings
Our present work	Coexistence	(a) LTE-LAA and Wi-Fi technology coexistence features
		(b) Present research on coexistence of LTE license assisted access and Wi-Fi technology
		(c) Challenges in coexistence and future directions for research
[1]	Physical layer	(a) Information of control channel of LTE and its challenges
		(b) Information of LTE release 11
		(c) Drawbacks of new released design
[4]	Radio resource management	(a) Challenges in heterogeneous networks
		(b) Different schemes of radio resource management
		(c) Comparison of schemes as per approaches
[2]	Radio resource management	(a) Way of encoding and different modes
		(b) Different link adaption methods
		(c) Control signal encoding and channel state feedback
[6]	Radio resource management	(a) Information of different techniques of spectrum aggregation
		(b) Supporting algorithms for carrier aggregation
		(c) Challenges for aggregation in LTE-Advanced

(continued)

Table 1 (continued)

Reference paper no.	Main keywords	Key findings
[5]	Uplink/downlink scheduling	(a) Efficiency in power
		(b) Quality of service
		(c) Scalability and multi-hop connectivity for users
[7]	Uplink/downlink scheduling	(a) Single carrier FDMA and local FDMA comparison
		(b) Information of single carrier FDMA
		(c) Benefits of LTE-Advanced technology
[8]	Uplink/downlink scheduling	(a) Information of scheduling of LTE and LTE advanced technology
		(b) Scheduling problems and different addressing schemes
		(c) Evaluation methodology for comparison of scheduling
[9]	Uplink/downlink scheduling	(a) Single user MIMO
		(b) Multi user MIMO
		(c) Mitigation techniques for uplink and downlink inter cell interference
[10]	Uplink/downlink scheduling	(a) To design resource allocation algorithm for long term evolution networks
		(b) All information of the most recent techniques
		(c) Comparison of performance of above techniques

(continued)

Table 1 (continued)

Reference paper no.	Main keywords	Key findings
[11]	Uplink/downlink scheduling	(a) Information of interference and interference management
		(b) Information of different scheduling strategies
[12]	Communication techniques	(a) Architecture for M2M services
		(b) QOS requirements in M2M communications
		(c) M2M challenges and issues over LTE/LTE advanced
[13]	Communication techniques	(a) D2D communication of LTE advanced networks
		(b) Standard research activity
[3]	Communication techniques	(a) Information on security of LTE and LTE-Advanced networks
		(b) Network design of LTE and LTE-Advanced
		(c) Information and solution to security issues

4 Challenges of LTE-LAA and Wi-Fi Coexistence

(a) Unable to deal with mutual interference and there is problem in coordination.
(b) Interference management are not designed to work with HetNets.
(c) To design a effective coexistence mechanism where the networks have different channel access techniques and also transmission or interference ranges, incompatible time slots and communication mechanism can coexists properly.
(d) Wi-Fi nodes can differ transmission for a random time in order to avoid transmission collisions happened due to interference from other Wi-Fi node or interference coming from the coexistent LTE network. This situation must be avoided.
(e) Different Simulation results show that performance of Wi-Fi is severely degraded with LTE coexistence and needs to be improved.
(f) Effectives regarding to current coexistence mechanisms are not clear to the Industry.
(g) Doubt is still there regarding successfulness of LTE-LAA spectrum sharing method.
(h) Special new and unique mechanism needs to be developed for LTE-LAA and Wi-Fi Coexistence.

5 Conclusion

We have gone through a huge comparative research survey of several coexistence related features of these two technologies i.e. LTE and Wi-Fi and are reached to the final conclusion that Wireless research Industry needs to adapt or develop some new and special beneficial mechanism for LTE-LAA and Wi-Fi coexistence. Till now such a type of mechanism is not available in the market for the fulfillment of 100% demand of users in coexistence of LTE-LAA and Wi-Fi in 5 GHz unlicensed Spectrum band. This can be the probable solution for fulfilling the ever increasing demand of mobile users for providing different services.

References

1. Wang M et al (2016) The evolution of LTE physical layer control channels. IEEE Commun Surv Tutorials 18(2):1336–1354
2. Ku G, Walsh JM (2015) Resource allocation and link adaptation in LTE and LTE advanced: a tutorial. IEEE Commun Surv Tutorials 17(3):1605–1633
3. Cao J, Ma M, Li H, Zhang Y, Luo Z (2014) A survey on security aspects for LTE and LTE-A networks. IEEE Commun Surv Tutorials 16(1):283–302
4. Lee YL, Chuah TC, Loo J, Vine A (2014) Recent advances in radio resource management for heterogeneous LTE/LTE-A networks. IEEE Commun Surv Tutorials 16(4):2142–2180
5. Mehaseb MA, Gadallah Y, Elhamy A, Elhennawy H (2016) Classification of LTE uplink scheduling techniques: an M2M perspective. IEEE Commun Surv Tutorials 18(2):1310–1335

6. Lee H, Vahid S, Moessner K (2014) A survey of radio resource management for spectrum aggregation in LTE-Advanced. IEEE Commun Surv Tutorials 16(2):745–760
7. Zhang J, Yang L-L, Hanzo L, Gharavi H (2015) Advances in cooperative single-carrier FDMA communications: beyond LTE-Advanced. IEEE Commun Surv Tutorials 17(2):730–756
8. Abu-Ali N, Taha A-EM, Salah M, Hassanein H (2014) Uplink scheduling in LTE and LTE-Advanced: tutorial, survey and evaluation framework. IEEE Commun Surv Tutorials 16(3):1239–1265
9. Li GY, Niu J, Lee D, Fan J, Fu Y (2014) Multi-cell coordinated scheduling and MIMO in LTE. IEEE Commun Surv Tutorials 16(2):761–775
10. Capozzi F, Piro G, Grieco LA, Boggia G, Camarda P (2013) Downlink packet scheduling in LTE cellular networks: key design issues and a survey. IEEE Commun Surv Tutorials 15(2):678–700
11. Pateromichelakis E, Shariat M, Ul Quddus A, Tafazolli R (2013) On the evolution of multi-cell scheduling in 3GPP LTE/LTE-A. IEEE Commun Surv Tutorials 15(2):701–717
12. Ghavimi F, Chen H-H (2015) M2M communications in 3GPP LTE/LTE-A networks: architectures, service requirements, challenges, and applications. IEEE Commun Surv Tutorials 17(2):525–549
13. Liu J, Kato N, Ma J, Kadowaki N (2015) Device-to-device communication in LTE-Advanced networks: a survey. IEEE Commun Surv Tutorials 17(4):1923–1940

Comparative Analysis of Fabric Fault Detection Using Hybrid Approach

Nilesh T. Deotale and Tanuja Sarode

Abstract This paper focuses on the fabric fault detection for variable sized textile images collected from textile industry. This paper presents the comparative analysis of Fabric Detection using hybrid approach where GLCM, Gabor Wavelet technique is used for image extraction and Random Forest Decision technique is used for image classification. The texture is observed as one of the utmost significant feature in the process of analysis of image and recognition of patterns. The incorporation of GLCM and Gabor Wavelet is being applied in order to obtain the best feature images of fabrics. The co-occurrence matrix has better processing effect for global region of images. Similarly, in attaining several level scales. Several level directional and native information in frequency domain Gabor Wavelet results are found excellent in performing the work. To categorize the defective and non-defective images into defective or non-defectiveness of the intended fabric image and in detecting the same the classification phase involves the Random forest classifier involved.

Keywords Fabric defect detection · Gray level co-occurrence matrix · Random density forest

1 Introduction

Forecasting of defects is extremely essential to maintain the quality in the Fabric manufacturing process [1]. Because of the extensive use of variety of fabric in day to day life, therefore the uncovering of the flaw of the fabric becomes an essential parameter to be keenly taken care during the manufacturing process of the textile material. The conventional method still practiced many where in the fabric industry to rectify the defects are usually done manually. It does not provide efficient results due to tiresomeness of the workers in observing the defects acutely [2], which in

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turn provide the unsatisfied outcome in terms of precise results [3–5]. So, to ensure the flawless quality of material, it is recommended to implement the automated inspection during the process of fabric manufacturing. The combination of Gray Level Co-occurrence Matrix and Gabor Wavelet are well-known two methods that has been proposed and implemented to extract these fabric features. Moreover, to detect the defective and defect-free fabric, the RF classifier is utilized by the proposed approach [6].

2 Literature Survey

Jing et al. [7] have proposed that the detection of the flaws in the fabric can be obtained and defined by applying seven categories Their calculated procedures are assessed as per the standard norms of the fabric detection. They have also discussed the methods to calculate various parameters which are essential for efficiently detecting faults in the fabric.

Hanmandlu et al. [8] highlighted diverse methodologies like Gauss MRF, Gabor wavelet and Gabor filter for determining the external irregularities of the textile material. The external irregularities are also known as topology or fractal constraints which provide the details about the unevenness and the similarity in textile material. The author has used the fabric database collected from various textile mills to test four types of defects such as miss pick, wavering textile, lubricant marks and interweaving of tissues.

Based on Low-Rank Representation (LRR) procedure an innovative and effective textile material fault detection strategy was introduced by Li et al. [9]. To get the relating decomposition the LRR technique was connected. With a specific end goal to enhance LRR, the authors introduced LRREB strategy that is applied for the progress operations of LR structure characteristics.

3 Proposed Methodology

This paper examines and explores the defective and non-defective textile material by implementing the amalgamation of Grey Level Co-occurrence Matrix and the Gabor Wavelet techniques which aimed at mining of the characteristics and moreover the proposed technique employed with the proficient mechanism of artificial intelligent termed as Random Density Forest (RDF). Figure 1 shows the detailed description of the system.

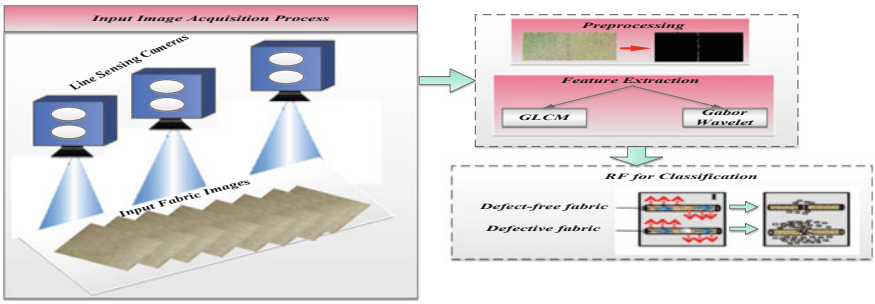

Fig. 1 Computerized textile material fault identification system

3.1 Capturing the Image

Cameras can be used to capture the images of moving fabric material can be either area scan cameras or line scan cameras. The line scans cameras are providing accurate images and are also carries high speed while capturing the moving fabric images [10]. Hence the proposed method describes the advantage of using line scan camera.

3.2 Preprocessing of Images

Preprocessing is an essential aspect; it used to gather the texture features by converting the captured images into the grey scale images [11]. This process is essential to obtain the accurate classification of the intended images as shown in Fig. 2.

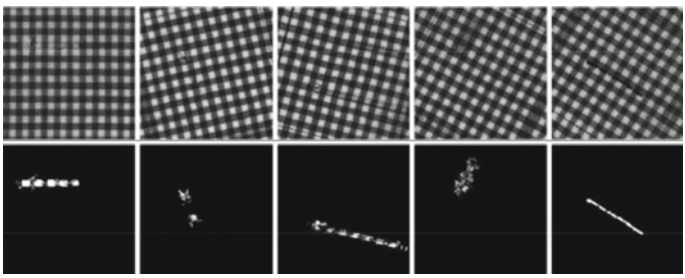

Fig. 2 Pre-processed fabric images for varied defects

3.2.1 Using GLCM

Two factors are comprises by co-occurrence matrix used by GLCM. The pixel space D_p and the placed direction between two pixels θ_p. The GLCM works on four different places directions between two pixels. They are 0°, 90°, 45° and 135° which signifies horizontal, vertical, right diagonal and left diagonal directions. Similarly, distance factor are 0 D_p represents vertical distance; $-D_p$ D_p represents left diagonal distance; $-D_p$ 0 represents horizontal distance and $-D_p$ $-D_p$ represents right diagonal distance [12]. The application of GLCM favors to notify the distance factor and also the additional factors that influence to showcase the quantity of gray levels. The GLCM uses

$$C_{MN} = \frac{\delta_{MN}}{\sum_{M=0}^{n} \sum_{N=0}^{n} \delta_{MN}} \tag{1}$$

Matrix C_{MN} produces six features namely Energy, Divergence, Measures of Disorder, Variance, Correlation and Uniformity which will help to escalate the performance of categorization or classification [6].

3.2.2 Using Gabor Wavelet

Fabric texture surface features are being excerpted by applying the Gabor wavelet function and it is computed as follows,

$$G(p, q) = \left(\frac{1}{2\pi\sigma_p\sigma_q}\right) \exp\left[-\frac{1}{2}\left[\frac{p^2}{\sigma_p^2} + \frac{q^2}{\sigma_q^2}\right] + j2\pi\chi p\right] \tag{2}$$

where, σ_p—Major Width, σ_q—Minor Width and χ is the modulation frequency.

The following equation is used to calculate the Fourier transform of Eq. 2

$$G(a, b) = \exp\left[-\frac{1}{2}\left[\frac{(a-\chi)^2}{\sigma_a^2} + \frac{b^2}{\sigma_b^2}\right]\right] \tag{3}$$

Through feature vector, the mean and standard deviation of individual image is been calculated by Gabor Wavelet technique.

3.3 Classification of Images Using RDF Classifier

The random forest classifier uses a structure for classification. The bottommost layer represents the leaf nodes which contains the class probability values. The individual

leaf node in the tree calculates for individual categorization. The probable expectation is calculated during testing process [13].

The class probability is denoted by $P_k(c|f)$. By summing up the class probability values, it is certain to get the highest probability $P(c|f)$.

$$P(c|f) = \sum_{k=1}^{n} P_k(c|f), \quad n = \#\,of\ \ trees \tag{4}$$

If $P(c_{defect}|f) > P(c_{background}|f)$.

The Eq. (4) shows the probability for two classes, defective fabric and non-defective fabric.

4 Experimental Results

The investigation of the research work is executed by applying seven illustrating faults in the fabric surface. MATLAB language is applied for the development of these programs.

4.1 Description of Dataset Used

For the execution of this work, a Tilda dataset for fabric images has been utilized [14]. The dataset consists of 1200 images, among them 140 are defect free and remaining 1060 have different types of fabric defects as shown in Fig. 3.

4.2 Detection Performance

The performance measure of these two sets decides the efficiency of the classification algorithm. The classification algorithm is used to calculate the classification accuracy (CA).

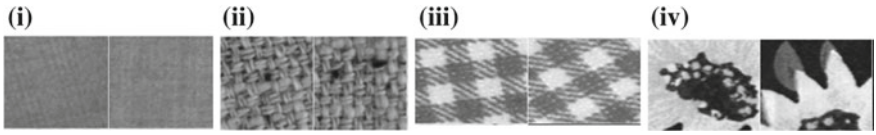

Fig. 3 Diverse categories of datasets (i) Minute or invisible inner structure (Class E1), (ii) Structure with less difference (Class E2), (iii) Structure with notable precision (Class E3), (iv) Printed texture (Class E4)

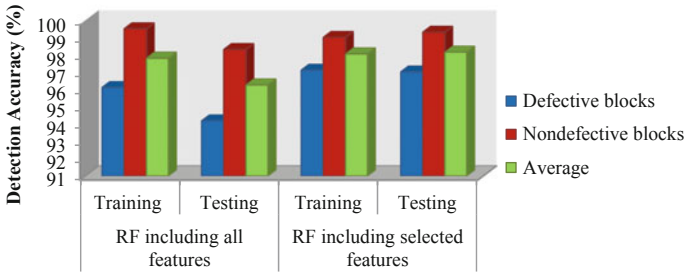

Fig. 4 Specification of structure preciseness

Table 1 Comparative analysis with proposed method

Methods	Features	Classifier	Accuracy [%]
Hanmandlu et al. [8]	Navy Bayes KNN (3 classes)	MLP neural networks	89.48
Yapi et al. [15]	Gabor wavelet filter and gray level neighborhood of each pixel + PCA	Support vector machine	83.4
Rebhi et al. [16]	Back propagation neural network	K-means + ISODATA	97.35
Proposed method	GLCM + GW	Random density forest (RDF)	98.15

$$CA[\%] = \frac{Tp + Tn}{Tp + Tn + Fp + Fn} \times 100$$

This matrix equation is used for the identification of the faulty and unfaulty fabric which is shown in Fig. 4 and Table 1.

$$\begin{array}{ll} & \begin{array}{cc} Surely\ Faulty & Surely\ Fault-free \end{array} \\ \begin{array}{l} Identified\ as\ Faulty \\ Identified\ as\ UnFaulty \end{array} & \begin{bmatrix} True\ positive\ (Tp) & False\ positive\ (Fp) \\ False\ negative\ (Fn) & True\ negative\ (Tn) \end{bmatrix} \end{array}$$

5 Conclusions

In this paper, the combined approach of using Gabor Wavelet and Gray Level Co-occurrence Matrix for feature mining and RDF for feature classification is proposed. The reconstruction of fabric images is done by extracting texture features from textile images. Then by using Random Density Forest, that textile image is categorized into either faulty or non-faulty. This approach works more quickly than the existing methods and efficiently provides more precise results.

References

1. Li Y, Zhang C (2016) Automated vision system for fabric defect inspection using Gabor filters and PCNN. SpringerPlus 5(1)
2. Bissi L, Baruffa G, Placidi P, Ricci E, Scorzoni A, Valigi P (2013) Automated defect detection in uniform and structured fabrics using Gabor filters and PCA. J Vis Commun Image Represent 24(7):838–845
3. Padma A, Giridharan N (2016) Performance comparison of texture feature analysis methods using PNN classifier for segmentation and classification of brain CT images. Int J Imaging Syst Technol 26(2):97–105
4. Yuan X, Wu L, Peng Q (2015) An improved Otsu method using the weighted object variance for defect detection. Appl Surf Sci 349:472–484
5. Tsai D, Wu S, Chiu W (2013) Defect detection in solar modules using ICA basis images. IEEE Trans Industr Inf 9(1):122–131
6. Qu T, Zou L, Zhang Q, Chen X, Fan C (2015) Defect detection on the fabric with complex texture via dual-scale over-complete dictionary. J Text Inst 107(6):743–756
7. Jing J (2015) Automatic defect detection of patterned fabric via combining the optimal Gabor filter and golden image subtraction. J Fiber Bioeng Inf 8(2):229–239
8. Hanmandlu M, Choudhury D, Dash S (2014) Detection of defects in fabrics using topothesy fractal dimension features. SIViP 9(7):1521–1530
9. Li P, Liang J, Shen X, Zhao M, Sui L (2017) Textile fabric defect detection based on low-rank representation. Multimedia Tools Appl 1–26
10. Li Y, Zhao W, Pan J (2017) Deformable patterned fabric defect detection with fisher criterion-based deep learning. IEEE Trans Autom Sci Eng 14(2):1256–1264
11. Wang C, Li J, Chen M, He Z, Zuo B (2015) The obtainment and recognition of raw silk defects based on machine vision and image analysis. J Text Inst 107(3):316–326
12. Yapi D, Mejri M, Allili M, Baaziz N (2015) A learning-based approach for automatic defect detection in textile images. IFAC-PapersOnLine 48(3):2423–2428
13. Kure NU, Biradar MS (2017) Fabric defect detection algorithm based on local neighborhood analysis. Int J Eng Res 6(04)
14. Kwon B, Won J, Kang D (2015) Fast defect detection for various types of surfaces using random forest with VOV features. Int J Precision Eng Manuf 16(5):965–970
15. Yapi D, Allili M, Baaziz N (2017) Automatic fabric defect detection using learning-based local textural distributions in the contourlet domain. IEEE Trans Autom Sci Eng 1–13
16. Rebhi A, Benmhammed I, Abid S, Fnaiech F (2015) Fabric defect detection using local homogeneity analysis and neural network. J Photonics 2015:1–9
17. Jia L, Liang J (2017) Fabric defect inspection based on isotropic lattice segmentation. J Franklin Inst 354(13):5694–5738
18. Böttger T, Ulrich M (2016) Real-time texture error detection on textured surfaces with com pressed sensing. Pattern Recogn Image Anal 26(1):88–94
19. Yildiz K (2016) Dimensionality reduction-based feature extraction and classification on fleece fabric images. SIViP 11(2):317–323
20. Tong L, Wong W, Kwong C (2017) Fabric defect detection for apparel industry: a nonlocal sparse representation approach. IEEE Access 1
21. Tsang C, Ngan H, Pang G (2016) Fabric inspection based on the Elo rating method. Pattern Recogn 51:378–394
22. Jia L, Chen C, Liang J, Hou Z (2017) Fabric defect inspection based on lattice segmentation and Gabor filtering. Neurocomputing 238:84–102

A Review—Hardware Security Using PUF (Physical Unclonable Function)

Shruti Sakhare and Dipti Sakhare

Abstract With the increasing growth in electronic devices, there is equal importance for the circuit to be secured. Thus, hardware security is of great concern. In addition, many attacks have been developed every day. Hence, we need to design a PUF based system which helps us to reduce counterfeiting and avoids cloning of the circuit. A PUF (Physical Unclonable Function) is basically an external device placed in a circuit to avoid cloning. PUF's are easy to evaluate but rather hard to predict. PUF system is designed in such a way that even the manufacturer himself cannot create two copies or clones with same functionality. A PUF circuit promises easy authentication, is robust and has a unique feature that cloning cannot be done. A PUF circuit is considered very important in ongoing market as it has many applications like a circuit identifier, secret key generation and even to generate TRNG (true random number generator). This review discusses about attacks on the chip and concludes with what preventive measures that can be taken to stop cloning of circuits.

Keywords Counterfeiting · Physical unclonable function · True random number generator

1 Introduction

There is much demand for electronic devices, security of these electronic devices is also an issue behind this. So to make the particular circuit a secured one PUF (Physical Unclonable Functions) have been designed. PUF circuits are basically used to avoid cloning of devices and can solve the problem of attacks and counterfeiting. Recent study related to PUF circuit has many advance applications such as secret key generation, TRNG (True random number generator) and used as a circuit identifier,

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even our government accepts this product for security purpose. PUF have a unique feature that they cannot form clones of the circuit. PUF systems are easy to evaluate, hard to predict and are manufacturer resistant. In general sense when an input (challenge) is given to the PUF circuit and we get the output (response). This is commonly known as a CRP that is the challenge response pair. A set of these PUF's can be treated as the finger prints of the PUF circuit. This review discusses about the current state-of-the-art of silicon PUF's, attacks on different circuits, countermeasures, and applications.

2 Physical Unclonable Function

Ravikanth et al. [1] Physical Unclonable Functions (PUFs) are one way fucntions and have gained a lot of attention for hardware security. PUFs use the uncontrollable variations during the fabrication process. PUFs system have variety of applications such as secret key generation, enabling and disabling of integrated circuit, used for generation and cloning of True Random Number Generator (TRNG). PUF system have following specification reliable, unique, random and easy authentication. PUF system has its unique feature that is, delay converter. Due to its uniqueness it saves the circuit from different attacks and counterfeiting issues. Sudhanya et al. [2] every time if we give input (challenge) the PUF based circuit we get different output (response), which is very difficult to predict and analyze. This is known as challenge response pair (CRPs) and the response to a circuit is always digital values. Ayat et al. [3] have discussed about how drastically the PUF changes when damaged by an attacker. With this unclonability property of PUF, makes it interesting for secret key storage. Maiti et al. [4] PUF has the ability that the data which is stored in the non-volatile chip makes this unique signature. Hence, PUF can be used to protect private data and even can secure the Intellectual Property (IP).

2.1 Types of PUF

Zhang et al. [5] in this paper various PUF's have been classified among two categories they are strong PUF and weak PUF. Strong PUF basically has a huge pair of challenge response pair (CRP's) and they are used as authentication protocols. On the other hand there is a weak PUF which has very few number of challenge response pair (CRP's) and they are applicable to authentication Protocols. Table 1 [5] describes about the difference between the strong and weak PUF's, based on the challenge response pairs they have been differentiated.

Table 1 Difference between strong and weak PUF's

S. No.	Strong PUF	Weak PUF
1	These attacks are impossible to duplicate	Impossible to duplicate
2	Supports large CRP's (challenge response pairs) [6]	Supports less number of CRP's (challenge response pairs) [6]
3	Cryptographic key generation but for light weight authentication	Used for cryptographic key generation
4	CRP's are made public	Very good intra and inter differences
5	CRP's exponentially related to number of components	CRP's related linearly to number of components
6	For e.g. Arbiter PUF	For e.g. RO PUF

2.2 Application of PUF

PUF systems have many different applications. Based on hardware cryptography and there applications they have been listed below. Ravi Shankar [7], in their thesis they have discussed about many applications related to PUF such as Key generation and storage, Random number generator, IP protection, secure microcontrollers and processors, Radio frequency identification device (RFID), Hardware Obfuscation of Logic, vehicular security, and wireless sensor network security.

2.3 PUF Taxonomy

There has been a vast study on Physical Unclonable function since past few years. Based on these the PUF's have been classified, Table 2 describes different PUF Taxonomy, that is silicon and Non silicon PUF's. Among these two silicon PUF's are of great interest in terms of cost and fabrication. These are again classified as analog electronic PUF, delay based PUF and memory based PUF. Non silicon PUF's are non-electronic PUF such as optical PUF, paper PUF, magnetic PUF, RF-DNA PUF.

3 Ring Oscillator Physical Unclonable Function

Silicon PUF generates a unique signature for each IC. Based on the variations PUF's are categorized. Thus RO (Ring oscillator) and arbiter PUF comes under delay PUF.

Table 2 PUF taxonomy [5]

Memory based PUF	SRAM PUF, Butterfly PUF, Latch PUF, Flip Flop PUF
Non electric PUF	Optical PUF, paper PUF, RF-DNA PUF, CD PUF, Magnetic PUF
Analog electronic PUF	VT PUF, power distribution PUF, coating PUF [8]
Delay based PUF	Arbiter PUF, RO-PUF

It was built on the delay difference to generate random bit strings. It is the simplest form of PUF and its output is generated in the form of logic "0" and logic "1" and by comparing the frequencies of the pair of ring oscillators. More bits can be generated by multiple RO's. As symmetry is not needed it is easy to implement on FPGA. RO are much preferred than arbiter PUF's as arbiter requires much placement and routing on FPGA platform. Thus ring oscillators are much preferred than arbiter PUF as they are easy to implement.

Silicon based RO-PUF is shown in Fig. 1. This silicon RO-PUF are called as "weak PUF" due to the number of challenge response pairs are minimum that is it depends on the number of components. It generates a response by comparing the two ring oscillators, frequencies of each RO is slightly different due to the process variation of each oscillator. Ravi Shankar [7], in the survey on PUF they have mentioned about silicon RO-PUF which was built on FPGA platform. FPGA (Field programmable gate array) are the reprogrammable devices which can be used according to our requirements. Zhang et al. [5] the RO-PUF is a delay based function. The simplest form of PUF generates the output logic-0 or logic-1 by comparing the frequencies of a pair of oscillator circuits. More bits can be generated in the same way with multiple pairs of RO.

4 Future Scope

Recently PUF's receives attention in the chip market and is becoming a promising way which provides security to many devices and avoiding issues related to counterfeiting. In future performance evaluation of the PUF based system will be done. Rahman et al. [10] have disscued about security primitives like PUF's and TRNG. With the increasing security these systems can be used as creating opportunities and fulfilling the gap or the challenges. The main criteria on which the hardware security rely is randomness, uniqueness and enhanced Security. Large amount of work is recently going on to improve the above criteria. As PUF circuits have not be fully developed so, the cost required for any circuit to be cloned is very expensive. Further if PUF based system becomes mainstream the cost of these systems will lower down with promising results.

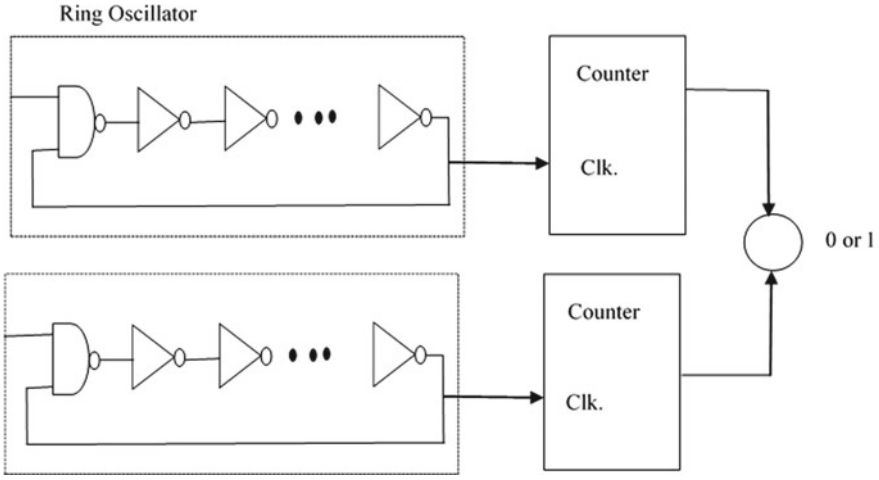

Fig. 1 Basic structure of RO PUF [9]

Zhang et al. [5] discussed about opportunities for generating PUF information from scan chain similar to VLSI-IP protection. Thus by reusing this scan chain as PUF circuit, it is easy to eliminate overhead caused by PUF. But these scan chain will impose new challenges to the PUF information.

References

1. Ravikant Pappu R, Recht B, Taylor J, Gershenfeld N (2002) Physical one-way functions. Science 297(5589): 2026–2030
2. Sudhanya P, Krishnammal PM (2016) Study of different silicon physical unclonable functions. In: International conference on wireless communications, signal processing and networking (WiSPNET), pp 81–85, September 2016
3. Ayat M, Atani RE, Mirzakuchaki S (2011) On design of PUF-based random number generators. Int J Netw Secur Appl (IJNSA) 3(3):30–40
4. Maiti A, Schaumont P (2010) Improving the quality of a physical unclonable function using configurable ring oscillator. In: International conference on FPGA, pp 703–707, April 2010
5. Zhang J-L, Qu G, Lv Y-Q, Zhou Q (2018) A survey on silicon PUFs and recent advances in ring oscillator PUFs. J Comput Sci Technol 29(4):664–678
6. Devadas S. Practical applications of physical unclonable functions. https://cap.csail.mit.edu/sites/default/files/csailiappufs.pdf
7. Ravi Shankar Y (2017) PUFs—an extensive survey. Master thesis, George Manson University, Fairfax
8. Lofstrom K, Daasch WR, Taylor D (2000) IC identification circuit using device mismatch. In: Proceedings of IEEE international solid state circuits conference, pp 372–373, February 2000
9. Anderson JH (2010) A PUF design for secure FPGA-based embedded systems. In: Proceedings of the 15th Asia and South Pacific design automation conference, pp 1–6, January 2010
10. Rahman F, Shakya B, Xu X (2017) Security beyond CMOS: fundamentals, applications, and roadmap. IEEE Trans Very Large Scale Integr VLSI Syst 25(12):3420–3433

Design and Implementation of Automatic Coin Dispensing Machine

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Abstract Availability of coins in exchange of currency notes has been a perennial issue in our day to day transactions. This paper presents the design and development of an automatic coin dispensing machine to resolve this issue. The proposed system constitutes three modules viz. detection of genuine currency note, determining the value of the note and dispensing of equivalent coins. The currency genuineness is evaluated using analysis of security strip with the help of color histogram of image of the currency note captured under Ultraviolet (UV) light. The denomination of the note is then detected by calculating the unique 'width-height' ratio of the currency for each denomination. The machine dispenses coins as per denomination of the note if and only if the note is genuine. The proposed system gives an accuracy of 92.12% for detection of the denomination of the currency note and an accuracy of 90.07% for genuineness of the currency note with FRR of 32.81%. The overall system efficiency to dispense the coins of equivalent value is 100%.

Keywords Automatic coin dispensing machine · Paper currency recognition · Currency denomination detection · Security thread in Indian currency · Arduino uno based system · Feature extraction

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1 Introduction

In the day to day monetary transactions, availability of coins is a major requirement but generally there is a gap between its demand and the available supply of the coins in spite of the emergence of different digital modes of payments. This problem is a major issue in places where the number of banks available is scarce. To address this issue of coin crunch, a coin dispensing system is proposed and presented in this paper. The proposed work aims at the design of a simple, cheap and effective automatic coin dispensing machine. The main purpose of this machine is to accept a currency note and to return coins of equivalent denomination in exchange of that note, provided the note is genuine. The main contributions of the paper are: (1) Simple and effective method to detect the genuineness of a currency note and determine its denomination. (2) The system dispenses coins of up to Rs. 100 on the basis of two dispensing algorithms viz. quick change and specific change.

2 Related Work

Many researchers have attempted to design a robust automatic currency detection and recognition system. These systems use visible features like the serial number, color, denomination, size of note, identification mark, and invisible features like latent image, security strip, micro-letters, intaglio printing and watermark present on the currency notes [1].

Hasanuzzaman et al. [2] proposed an American banknote recognition algorithm with local feature extraction using Speeded-Up Robust Features (SURF). Doush and AL-Btoush [3] used scale-invariant feature transform (SIFT) algorithm for recognition and classification of Jordanian currency. Garcia-Lamont et al. [4] proposed Mexican banknotes recognition using RGB color model and Local Binary Patterns (LBP) for texture features. Youn et al. [5] designed a system for classification of banknotes using size based correlation mapping. Gai et al. [6] used Quaternion Wavelet Transform (QWT) for features extraction with Generalized Gaussian Density (GGD) for banknote classification. Hassanpour and Farahabadi [7] used Hidden Markov Model (HMM) to extract texture features of paper currency to recognize banknote from different countries with more than 100 denominations. Sarfraz [8] proposed Saudi Arabian paper currency recognition system using a radial basis function network. Vishnu and Omman [9] used five features of Indian currency with Principal Component Analysis (PCA) to identify their denomination and classification. Agasti et al. [10] used new 500 and 2000 currency notes for fake note detection.

The system proposed in this paper is simple, cost efficient and effective in terms of currency recognition and coin dispensing.

3 Proposed Design of Coin Dispensing Machine

The proposed coin dispensing system involves identifying the genuineness of the note, recognizing the denomination and then dispensing equivalent coins in exchange. The Indian currency notes have denominations of Rs. 10, 20, 50, 100, 200, 500 and 2000. The prototype design of the coin dispensing system presented in Fig. 1a consists of the Arduino Uno development board interfaced with other modules of system as mentioned below:

Note insertion module. It consists of relays and a DC motor to accept/reject (based on its genuineness) a note of size 160 mm × 80 mm. It also consists of a camera with white light as well as UV light sources.

Currency genuineness detection module. It detects the genuineness of the note as well as its denomination.

Arduino Uno development board. This module plays a vital role in the entire system. As soon as the note is detected, the camera captures images under the white light and UV light with proper time lags. When the control signal is received from the image processing module about the genuineness of the note, its denomination is displayed on the LCD screen as shown in Fig. 1c. It then triggers the coin dispensing module to dispense equivalent coins as per the selected dispensing algorithm.

Coin dispensing module. It is designed with four outlets (one each for Rs. 1, 2, 5, and 10 coins) to dispense one coin at a time as shown in Fig. 1b, unused smart cards and servo motors. The system uses two algorithms to dispense coins—(1) quick change algorithm given in Fig. 2a and (2) specific coin change algorithm to select the denomination as shown in Fig. 2b, which may however result in inefficient disbursement of coins.

Detection of note boundary. The image captured under normal white light is passed through a Gaussian filter for effective smoothing and noise removal. Canny edge

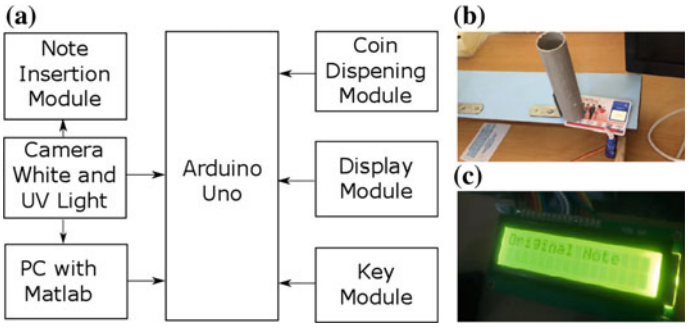

Fig. 1 Prototype design: **a** system configuration, **b** coin dispensing module, **c** display module displaying genuine note

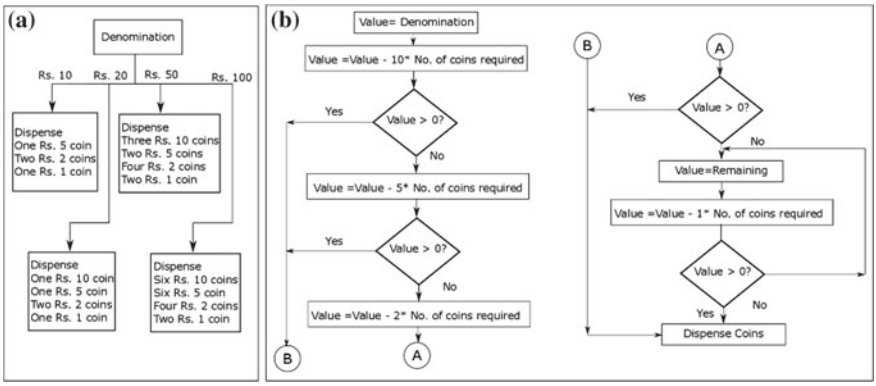

Fig. 2 Coin dispensing algorithms: **a** quick change, **b** specific change

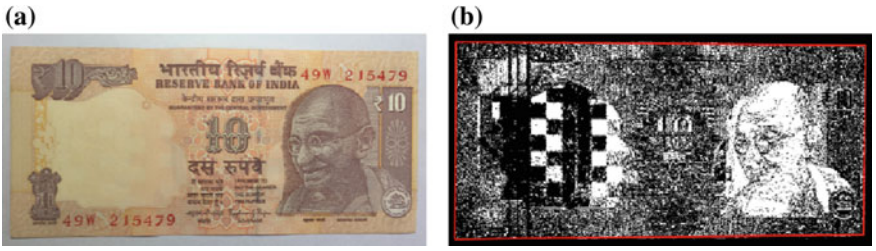

Fig. 3 Corner detection: **a** original Rs. 10 note under white light, **b** boundary of the note is detected

Table 1 Width to height ratio for various denominations

Note	Size in mm (W × H) old note	Size in mm (W × H) new note	Width: height ratio (old note)	Width: height ratio (new note)
10	137 × 63	123 × 63	2.174	1.952
20	147 × 63	–	2.333	–
50	147 × 73	135 × 66	2.014	2.045
100	157 × 73	142 × 66	2.151	2.151
200	–	146 × 66	–	2.212

detection technique is applied for detecting the boundary and thereby finding the 'width' and 'height' of the note. Figure 3a shows a note of Rs. 10 under white light and Fig. 3b shows the note displaying the detected boundaries.

Estimation of denomination of note. The sizes of the notes of different denominations are presented in Table 1. The unique height to width ratio is used to determine the denomination of the note albeit with a tolerance of $\pm 5\%$.

Detection of genuineness of note. The security thread running across the note is captured by illuminating the note under UV light as shown in Fig. 4a. The thresholding

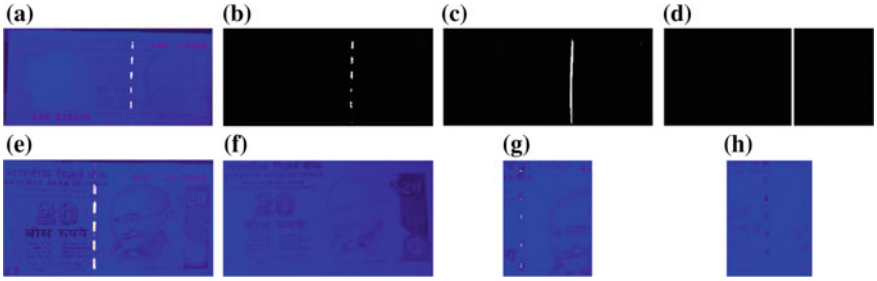

Fig. 4 Detection of security strip and finding genuineness of a note: **a** note under UV light, **b** image after thresholding, **c** result of morphological closing, **d** vertical white strip, **e** Rs. 20 genuine note, **f** Rs. 20 fake note, **g** Rs. 10 genuine note, **h** Rs. 10 fake note

operation is applied on this image to visualize the security strip as shown in Fig. 4b. Suitable thresholds are computed using color histogram with intensity of Red < 90, Green < 40, Blue > 190. The vertical white dots are joined and the 'holes' between the strips are filled using morphological closing operation. The resulting image is as shown in Fig. 4c. Next, the whole column is replaced by white pixels if the number of white pixels are more than black pixels in a column as shown in Fig. 4d. The note is considered as a genuine one if the width of white columns is more than 5 pixels. Few samples of genuine and fake notes are displayed in Fig. 4e–h.

4 Result Analysis

Overall accuracy of genuine notes. Analysis was carried out on a total of 144 genuine notes (36 notes of each denomination) of good quality and 40 fake notes (used in games like "Monopoly" which vary in size and color) and a few worn out notes. Table 2 shows the accuracy of the system for genuine note detection. It was found that the accuracy of the detection of the genuineness of the notes is largely dependent on the quality of the security thread running across the note.

Table 2 Overall accuracy of the system for currency genuineness

Denomination	Genuine notes	Fake notes	# of genuine notes detected	Percentage accuracy
10	36	7	32	88.89
20	36	12	34	94.44
50	36	11	33	91.67
100	36	10	32	88.89
Average	36	10	33	**90.97**

Table 3 Performance evaluation of detection of denomination in various test cases

Denomination	0°	±20°	Corner folded	Average % of detection
10	97.56	97.56	87.81	94.31
20	95.12	95.12	85.37	91.87
50	95.12	95.12	83.47	91.24
100	92.68	92.68	87.80	91.05
Average	**95.12**	**95.12**	**86.11**	**92.12**

Table 4 Overall performance evaluation of the coin vending machine

Note Value	# of notes	Type	# of notes accepted	Correct denomination	Coins dispensed	False rejection ratio	% efficiency
10	36	Genuine	32	21	21	34.38	88.89
	7	Fake	0	–	0	–	100.00
20	36	Genuine	34	22	22	35.29	91.67
	12	Fake	0	–	0	–	100.00
50	36	Genuine	33	23	23	30.30	95.83
	11	Fake	0	–	0	–	100.00
100	36	Genuine	32	22	22	31.25	91.67
	10	Fake	0	–	0	–	100.00

Finding denomination of a note. The denomination of note was found out under various test cases like perfectly aligned notes, placement with a tilt of ±20°, single minor folded corner in the note. Table 3 shows the comparative evaluation of detection of correct denomination. Denomination detection is accurate as long as the rotation is within ±20° of tilt.

Overall system performance. The detection of denomination of the notes is done if and only if the note has been verified for its genuineness. Therefore, the number of notes whose value is detected will always be lesser than or equal to total number of notes tested. Efficiency of the detection of genuineness of the notes depends on quality of the security thread. The average percentage of False Rejection Ratio (FRR) is 32.81%. This is because worn-out notes have faded security threads and therefore are not well illuminated under UV light resulting into rejection of the genuine note. Table 4 shows the overall performance of the proposed system.

5 Conclusion

The purpose of the proposed system is to receive coins in exchange of currency notes. The system utilizes genuine currency detection algorithm based on the security thread under UV light. The proposed system dispenses coins after the note is verified to be genuine and its denomination is computed. The designed machine also provides the flexibility to choose the number of coins of different denomination in the user preference module. The system also has a quick change module for efficient disbursement of coins to save time. The fake currency detection module gives an overall accuracy of 90.97% with a FRR of 32.81%. The denomination algorithm provides correct value detection of 92.12%. The overall system efficiency to dispense the coins for genuine note and as per its correct denomination is 100%.

References

1. Deshpande PD, Shrivastava A (2018) Security features analysis of indian currency for recognition and authentication. Int J Res Appl Sci Eng Technol 6(III):744–751
2. Hasanuzzaman FM, Yang X, Tian YL (2011) Robust and effective component-based banknote recognition by SURF features. In: IEEE conference on wireless optical communication, pp 1–6
3. Doush IA, AL-Btoush S (2017) Currency recognition using a smartphone: comparison between color SIFT and gray scale SIFT algorithms. J King Saud Univ Comput Inf Sci 29(4):484–492
4. Garcia-Lamont F, Cervantes J, Lopez A (2012) Recognition of Mexican banknotes via their color and texture features. Expert Syst Appl 39(10):9651–9660
5. Youn S, Choi E, Baek Y, Lee C (2015) Efficient multi-currency classification of CIS banknotes. Neurocomputing 156:22–32
6. Gai S, Yang G, Wan M (2013) Employing quaternion wavelet transform for banknote classification. Neurocomputing 118:171–178
7. Hassanpour H, Farahabadi PM (2009) Using hidden Markov models for paper currency recognition. Expert Syst Appl 36(6):10105–10111
8. Sarfraz M (2015) An intelligent paper currency recognition system. In: International conference on communication, management and information technology (ICCMIT 2015), Elsevier Procedia Comput Sci 65:538–545
9. Vishnu R, Omman B (2014) Principal features for Indian currency recognition. In: Annual IEEE India conference (INDICON 2014)
10. Agasti T, Burand G, Wade P, Chitra P (2017) Fake currency detection using image processing. IOP Conf Ser Mater Sci Eng 263(052047):1–8

Characterization and System Identification of XY Flexural Mechanism Using Double Parallelogram Manipulator for High Precision Scanning

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Abstract This article represents modeling of double parallelogram flexural manipulator derived from basic classical mechanics theory. Fourth order vibration wave equation is used for mathematical modeling and its performance is determined for step input and sinusoidal forced input. Static characterization of DFM is carried out to determine stiffness and force deflection characteristics over the entire motion range and dynamic characteristics is carried out using Transient response and Frequency response. Transient response is determined using step input to DFM which gives system properties such as damping, rise time and settling time. These parameters are then compared with theoretical model presented previously. Frequency response of DFM system gives characteristics of system with different frequency inputs which is used for experimental modeling of DFM device. Here, Voice Coil Motor is used as Actuator and optical encoder is used for positioning sensing of motion stage. It is noted that theoretical model is having 5% accuracy with experimental results. To achieve better position and accuracy, PID and LQR (Linear Quadratic Regulator) implementation was carried out on experimental model. PID gains are optimally tuned by using Ziegler Nichols approach. PID control is implemented experimentally using dSPACE DS1104 microcontroller and Control Desk software. Experimentally, it is observed that positioning accuracy is less than 5 μm. Further multiple DFM blocks are arranged for developing XY flexural mechanism and static characterization was carried out on it. The comparison of experimental and FEA results for X-direction and Y-direction is presented at end of paper.

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Keywords Flexures · PID control · System identification · dSPACE · Precision scanning · DS1104 · Voice coil actuator

1 Introduction

The demand for high precision positioning has been increased rapidly with the advancement in the domain of mechatronics, control systems and its integration with mechanical systems [1–3]. Nano-positioning stages are widely used in various applications such as biomedical, stereo-lithography for development of prototypes, laser scanning, micromachining and scanning probe microscopy etc. [4–6]. Hence, the use of accurate and precise instruments has almost become inevitable that eventually lead to research work related up to submicron level accuracy and resolution [5–7]. Different XY scanning mechanisms are under development but have several constrains such as limited range of scanning, restricted performance in sense of accuracy, backlash, fixed degrees of freedom, reliance of motion on one another etc. Moreover the main aspect is to design a proper control system and interface it to provide precise control for desirable working [8–10]. In the recent years, more focus has been given to compliant or flexural mechanisms for improving the performance of such devices [11–13]. Flexures are nothing but the bending members which deforms in a particular direction on the application of load. Flexures are more suitable due their distributed flexibility in providing the desired motion in the required direction along with the advantage of absence of development of assembly; no wear/tear hence no need of greasing/oiling and exclusion of backlash [14].

Present work is one of the attempts to design, manufacture, system identification, integration and PID control implementation on basic building block of flexural mechanism i.e. Double Flexural Manipulator (DFM) [15]. Section 2 gives comparative study of fundamentals of flexural mechanisms and applications. Section 3 explains proposed mechanism, its manufacturing, assembly and monolithic structure of XY mechanism (presented in Awatar's Thesis) which uses DFM as building block. Section 4 presents PID control implementation on proposed system. It outlines system integration i.e. interfacing of sensor and actuator to PC via dSPACE DS1104 microcontroller. Further this section explains system identification and comparison of predicted model and experimental results. Section 5 presents the tuning of system using PID control and application on DFM and design and implementation of LQR control strategy. Section 6 presents development of XY flexural mechanism and its static characterization. Section 7 gives concluding remarks and future scope of the work.

2 Review of Flexural Mechanisms

The flexural mechanism yields a relative motion between the rigid links and connection between these rigid links decides a path of motion [16–19]. These connections in case of rigid links are pin joints, roller joints, ball bearings etc. But conventional joints have a friction and backlash during motion and degrade the quality of motion (i.e. smoothness, repeatability, positioning accuracy etc.) [20–22]. Hence new era of flexural mechanism is invented to overcome these difficulties. These flexural mechanisms generate a motion between rigid links via flexible joints. In general, flexural mechanisms classified into two types based on joints used in mechanism. Firstly one domain rely on mechanism with flexural hinges (where compliance is at single point), and another domain uses flexible planar joints (where compliance is distributed over the entire joint) such as flexible plates and beams to achieve desired pattern of motion. Flexural mechanisms with hinges typically used for rotational type of motion and planar type joints are used for linear type of motion [23, 24]. Different types of mechanisms and its building blocks are outlined as below.

Figure 1 shows a flexural hinge (single axis and multi-axis) and mechanisms developed. It also illustrates 3 degrees of freedom tripod mechanism, 2 degrees of freedom motion stage, and positioning stage with six axes. Second domain of mechanism uses flexible plates, beams and its combinations (see Fig. 2) as building block. Compared

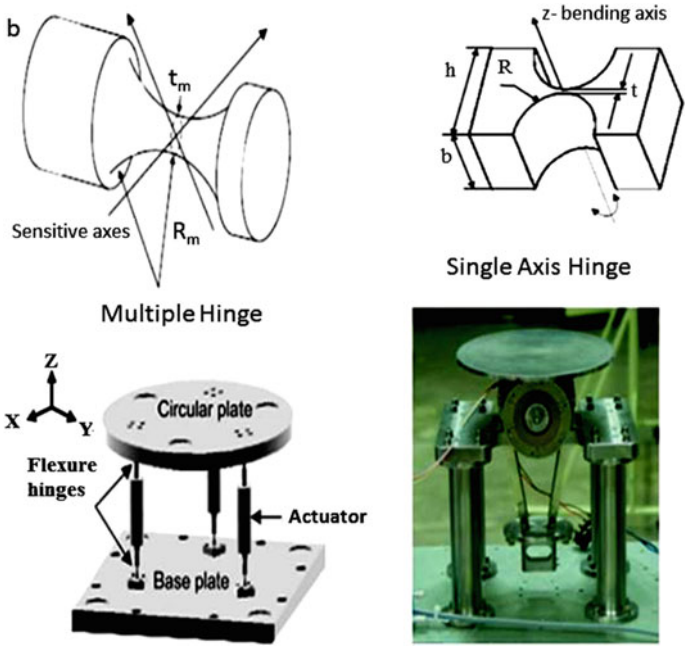

Fig. 1 Various flexural mechanisms

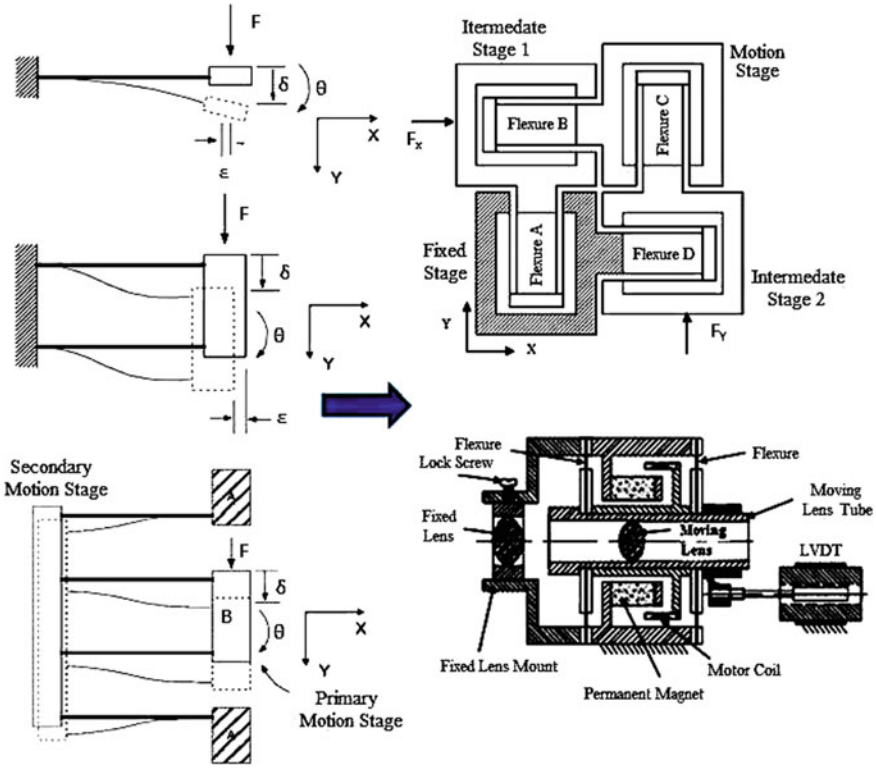

Fig. 2 Mechanisms developed using planar flexible joints

to Flexural hinges, Flexible planar joints have distributed compliance which is more suitable where linear motion is needed. Figure 2 shows flexible planar joints and mechanisms developed. Different flexible planar joints are designed and developed, basically these developments mainly concentrates on reduction or to achieve a zero parasitic motion and rotation of motion stage for linear scanning.

Finite Element Analysis is performed to compare the performance parameters (such as parasitic motion, rotation of motion stage and stiffness of mechanism in orthogonal directions) using ANSYS FEA tool. It is identified that double parallelogram flexural manipulator exhibits zero parasitic error motion theoretically and little amount of rotation. Theoretical and FEA simulations shows cantilever beam has a large parasitic error motion and DFM shows zero parasitic error motion. DFM gives zero parasitic error motion but gives a small rotation of motion stage. DFM is best suitable flexible planar joint for linear scanning type mechanism. Hence, experimental setup for DFM is developed and static and dynamic characteristics have been determined using experimental identification. Next section discusses the DFM experimental setup and its system integration with PC via dSPACE DS1104 microcontroller.

3 Experimental Setup: DFM

Experimental setup for DFM testing, characterization, control implementation is developed. It consists of DFM, sensor (optical encoder with 50 μm positioning resolution from Renishaw Inc.), Actuator (voice coil motor by BEI-Kimco Inc.), dSPACE DS1104 microcontroller, Linear Current Amplifier, and PC. Figure 3 shows DFM with sensor and actuator mounted on it [25, 26]. Figures 4 and 5 shows DFM system integration with PC via dSPACE DS 1104 microcontroller. Figure 5 shows entire setup mounted on optical table [27]. Optical table is used for ground vibration isolations. PC consists of MATLAB, Simulink and Control Desk software which runs in synchronization with each other and collects the data from sensor and generates a signal to actuator according to logic created in SIMULINK model.

A. *Evaluation of Stiffness*:

Stiffness is a system property to be determined at very low speed on operation which is typically less than the three times of its natural frequency. An experimental stiffness characteristic (extension and retraction motion) of DFM Mechanism is shown in graph of deflection versus Force in Fig. 6. An experimental result shows forward path motion and backward path motion having close match. Table 1 shows experimental results i.e. deflection and stiffness; it is observed error between theoretical results and experiments within less than 1%.

B. *Evaluation of Damping Factor*:

Transient force is applied to give initial displacement is given to motion stage and then permitted to pulsate without restrictions up till it arises to end; that is to achieve a Transient Response. Experimental results are obtained and graph of deflection versus time is plotted as shown in Fig. 7 and transient response in Fig. 8. The damping

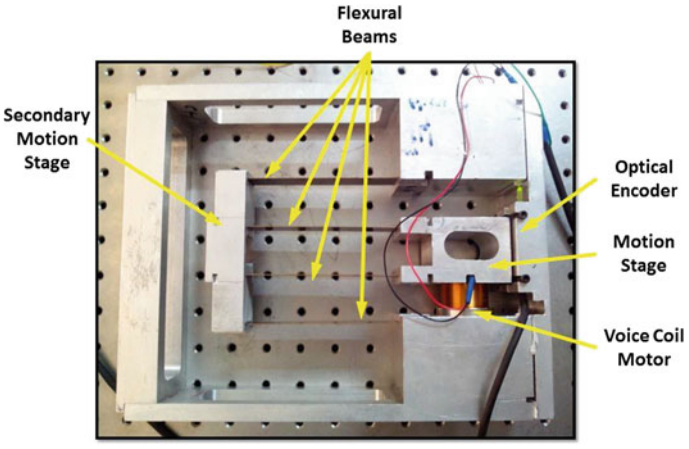

Fig. 3 Manufactured double flexural manipulator (DFM)

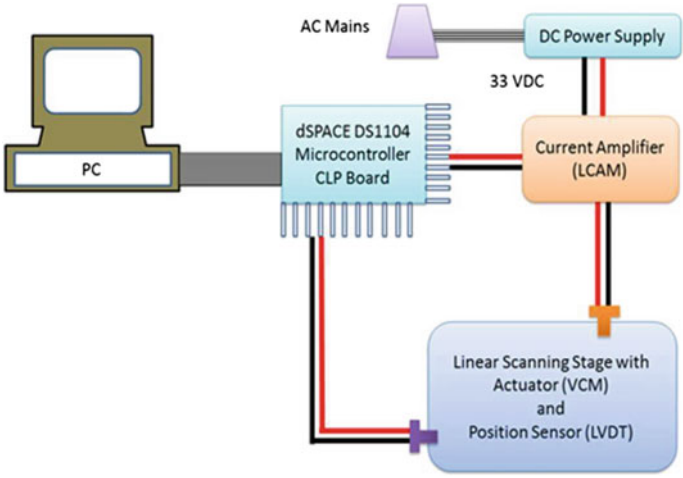

Fig. 4 Mechatronic integration of proposed system

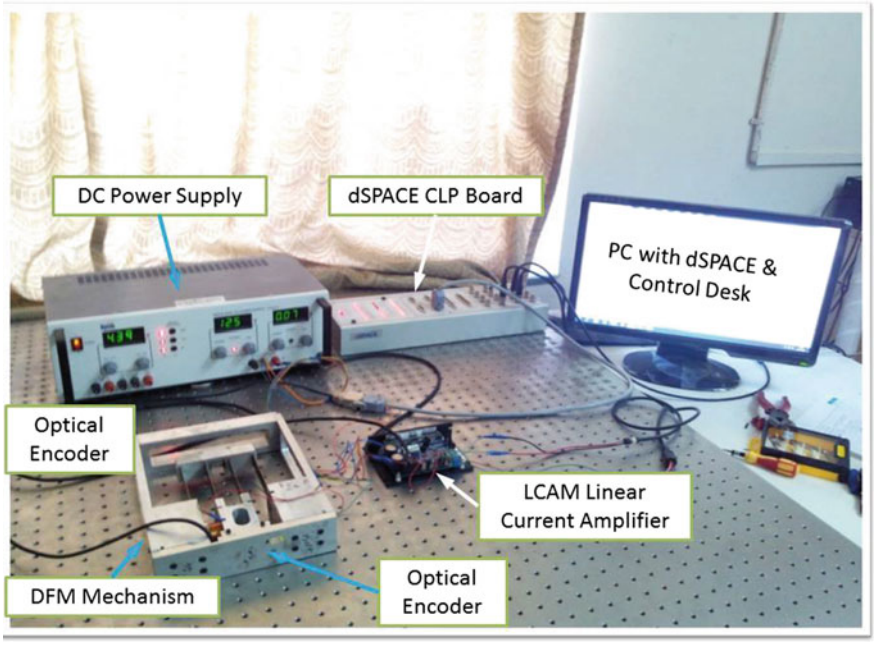

Fig. 5 Development of experimental setup of proposed system

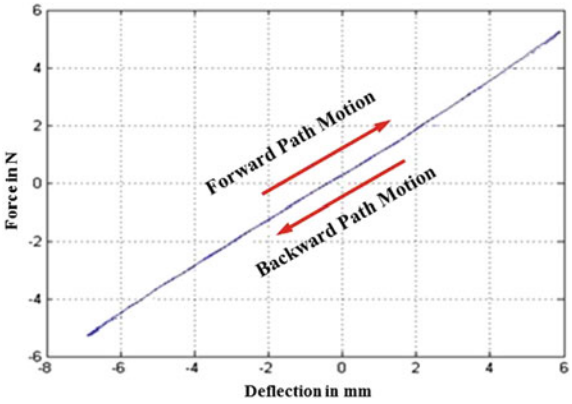

Fig. 6 Stiffness characteristics of DFM

Table 1 Observation table and calculations

Load	Deflection		Stiffness		% error
	Th.	Pr.	Th.	Pr.	
−5	−7.692	−7.73	0.65	0.6468	0.49
−2.5	−3.846	−3.874	0.65	0.6453	0.724
2.5	3.846	3.877	0.65	0.6448	0.802
5	7.692	7.711	0.65	0.6484	0.243

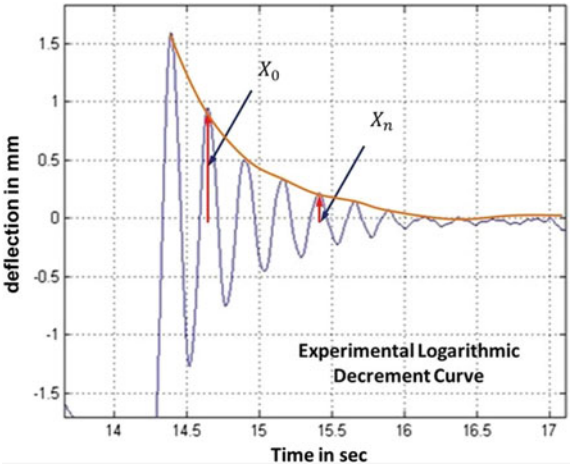

Fig. 7 Logarithmic decrement curve

coefficient is determined from Logarithmic decrement. Equation (1) for Logarithmic decrement is stated as,

$$\delta = \frac{1}{n}\left[\log\left(\frac{X_0}{X_n}\right)\right] \tag{1}$$

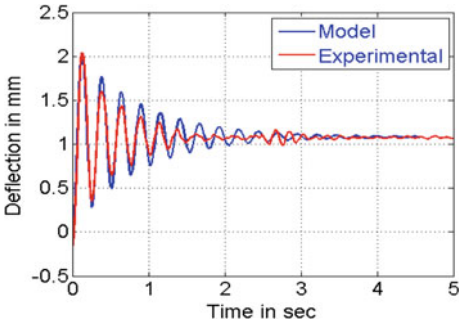

Fig. 8 Comparison of transient response for experimental and model

Equation (2) for damping factor is given by,

$$\xi = \frac{\delta}{\sqrt{4\pi^2 - \delta^2}} \tag{2}$$

The value of Logarithmic decrement was observed as 0.218308 and damping factor as 0.034785 experimentally.

C. *Identification of the System*:

To develop transfer function experimentally it necessitates achieving the system identification for the proposed system. The ratio of actuator input signal to location of motion stage with constant amplitude and variable frequency will give transfer function of the system. Initial conditions are assumed to be zero. The frequency response is obtained by providing input voltage in sinusoidal form and monitoring resultant output positions. For real time monitoring of frequency response, an algorithm is designed in MATLAB Simulink. A frequency response curve as shown in Fig. 7 is used to investigate the natural frequency and the phase change with 0.08 V amplitude as input and 1–70 Hz frequency range. The highest frequency of 24.51 rad s^{-1} is identified.

Here, though we are finding movements in X and Y both directions, we are concerned about double flexural mechanism which is having single degree of freedom (DOF). Therefore only one input output transfer function of is estimated as Eq. (3) below,

$$G(s) = \frac{1}{s^2 + 1.705s + 600.7} \tag{3}$$

Figure 8 shows comparison of experimental and model results of DFM. It shows close matching with each other. Next section onward PID Control design and implementation on DFM is discussed in details.

4 PID Control Implementation

For achieve control of motion stage position in high precision applications the design and implementation of PID controller is carried out on proposed system. PID control consists of three elements proportional element, integral element and derivative element. PID takes care of error in all three tenses (i.e. present, past and future). Tuning of constant parameters gives precise control of position of motion stage. The control equation for PID control system is shown as Eq. (4) below,

$$\boldsymbol{u(t)} = K_p e(t) + K_i \int e(t)dt + K_d \frac{de(t)}{dt} \tag{4}$$

where, K_p: Proportional, K_i: Integral and K_d: derivative gains

$$e(t) = \text{Error and u(t) is controller output.}$$

Ziegler–Nichols approach is adopted for optimal tuning of PID gains. As in the mentioned above, the K_i and K_d gains are set to zero. The output of the loop starts to oscillate when proportional gain reaches the ultimate gain Ku with gradual increment of proportional gain. To set the gains, ultimate gain K_u and oscillation period Pu are used. Tuned PID parameters are applied in real time for precise control of position of DFM motion stage. Figure 9 shows a real-time control of position motion stage and shows a comparison between reference signal and actual signal. Figure 10 shows error between reference and actual position.

PID control strategy further can be used for precise control of position of motion stage. Further LQR is also designed and implemented on DFM and its performance is compared with PID control strategy.

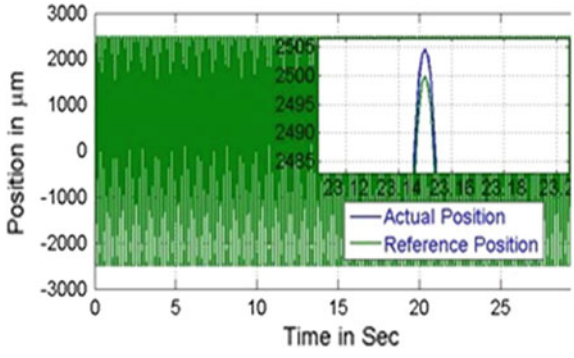

Fig. 9 Comparison of actual and reference position

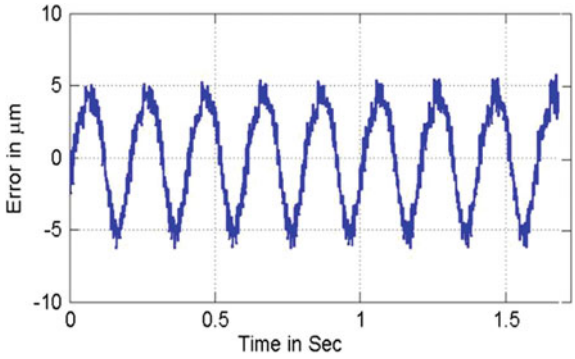

Fig. 10 Actual error signal observed

5 LQR Implementation

The LQR was used on the setup. Full state feedback is central to the LQR designs. Therefore, we use the Kalman Filter to estimate state variables. The aim of the standard LQR problem is to converge the state trajectories to zero in an optimal way.

Choosing $q_1, \dot{q}_1, q_2, \dot{q}_2$ as the state variables, the equations can be written in the form:

where

$$x = \begin{bmatrix} q_1 \\ \dot{q}_1 \\ q_2 \\ \dot{q}_2 \end{bmatrix}$$

and A, B, C matrices are given by

$$\mathbf{A} = \begin{bmatrix} 0 & -1.07e4 & 0 & -5.8e6 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$
$$\text{and } \boldsymbol{C} = \begin{bmatrix} 0 & 58.67 & 0 & 5.55e5 \end{bmatrix}$$

The general criterion used to arrive at the control law is in Eq. (5)

$$\boldsymbol{J} = \int_{t_0}^{t_f} \left\{ x'(t) Q x(t) + u(t)' R u(t) \right\} dt + \frac{1}{2} x'(t_f) P_f x(t_f) \tag{5}$$

Subject to

$$Q \geq 0, R > 0, P_f \geq 0, x(t_0) = x0, \{A, B\}$$

and

$$\dot{x} = AxBu$$

The deviation of x from the desired trajectory is penalized quadratically with a symmetric positive semi definite weighting matrix Q. Also, the input u is quadratically weighted with positive definite (symmetric) matrix R in order to keep all inputs within the range of the particular actuator. The pf term allows the designer to specifically penalize the state trajectory at the final time. The solution of the above problem can be derived to be:

$$u(t) = -R^{-1}B'P(t)x(t) = -L(t)x(t)$$

where,

$$L(t) = R^{-1}B'P(t)$$

$$-\dot{\boldsymbol{P}}(\boldsymbol{t}) = P(t)A + A'P(t) - P(t)BR^{-1}B'P(t) + Q$$

With the boundary condition

$$P(t) = P_f$$

Suppose the designer wishes the system to attain a desired state x ref. The above control law will then have to be modified.

Define a new state variable:

$$\boldsymbol{r} = x_{ref} - x$$

The system equations take the form:

$$\dot{\boldsymbol{r}} = Ar + Bu - Ax_{ref}$$

and

$$\boldsymbol{y} = C\left(x_{ref} - r\right)$$

The optimal control input then becomes:

$$\boldsymbol{u} = +Lr - Lx_{ref}$$

Hence

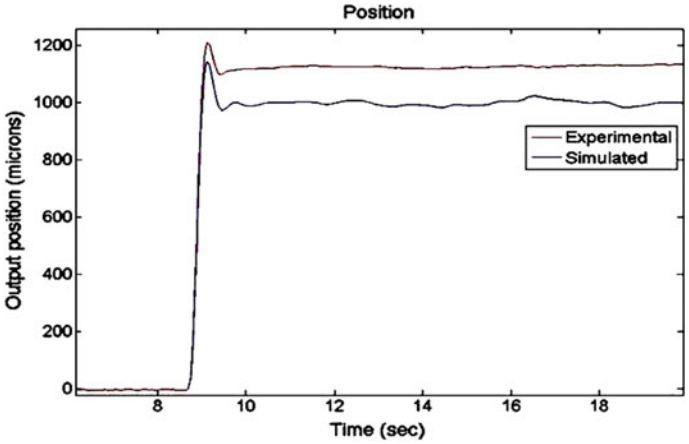

Fig. 11 Position plot for regulation using LQR

$$\dot{\boldsymbol{r}} = Ar - BLr + BLx_{ref} - Ax_{ref} \tag{6}$$

To represent this new system in the standard form, we want equations of the form

$$\dot{\boldsymbol{r}} = Ar + Bu$$

With the input of the form

$$\boldsymbol{u} = -Lr + v*$$

Comparing,

$$\boldsymbol{Bv} = BLxref - Axref$$

Also, since LQR control will take x to zero, the new system output y will approach

$$\boldsymbol{y_{ref}} = Cx_{ref}$$

As seen in the curve (see Fig. 11), there is a distinct steady state error. This is partly because we generated our reference input based on model information which is subject to error. Also, 'zero shifting' due to existence of fields, presence of stiffness in the beams at the y = 0 might have caused this steady state error. The choice of weighting matrices is extremely important. If you choose a Q that gives more importance to the first state variable, you'll see visible oscillations in position after settling. Notice the shape of the curve in the Fig. 12. It can be clearly seen that the position curve closely follows the shape of the amplified and shifted disturbance curve.

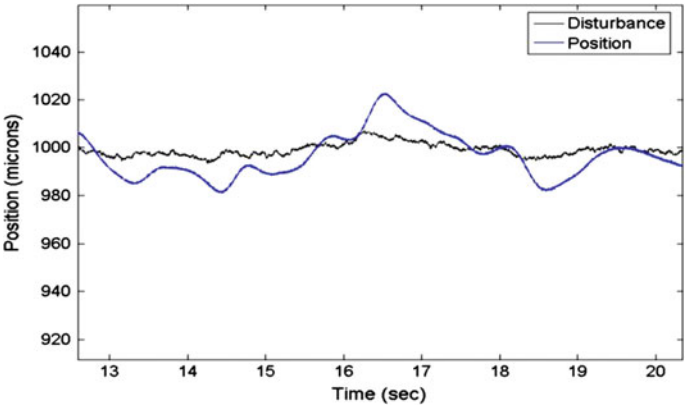

Fig. 12 Simulated response plotted against generated disturbance (LQR)

DFM gives better control performance for linear scanning and accuracy of position of motion stage can be further improved by tightly tuning PID control parameters. DFM can be further used for development of XY flexural mechanism to achieve an orthogonal linear scanning and has numerous applications in precision scanning. Shourya Awtar developed family of such mechanisms and we have used one of the mechanisms for further investigation [1]. Next section discusses about XY flexural mechanism and its static characterization.

6 Development of XY Flexural Mechanism

Multiple DFM blocks are arranged such that XY scanning is achieved. Figure 13 shows a XY mechanism manufactured for XY for precision scanning.

Figure 14 shows a block diagram representation of experimental setup, it consists of sensors (dial gauges), it's mounting and loading platform. Figure 15 shows an arrangement of mounting of XY flexural mechanism on optical table and alignment of dial gauges for recording X and Y direction motions.

Figure 15 illustrates an experimental setup with two dial gauges which measures displacement of motion stage in X and Y directions respectively. These dial gauges have a resolution of 10 m and range of measurement is 25 mm maximum. Red color flexible wires are tied at actuator location to provide an appropriate actuation in X and Y directions. Load is applied using weight pan with an increment of 25 g. For each increment of load deflection of motion stage is recorded. Load in weight pan (maximum 35 N i.e. 3.5 kg) is given such that maximum of 7.5 mm displacement is achieved.

Fig. 13 Developed XY flexural mechanism

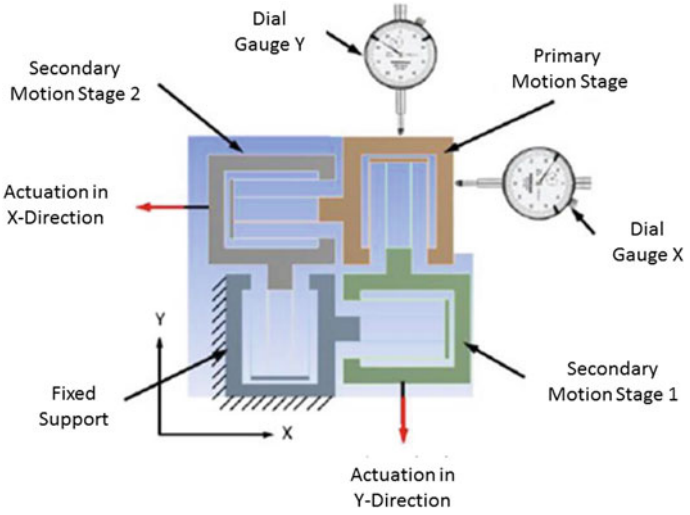

Fig. 14 Layout of experimental setup

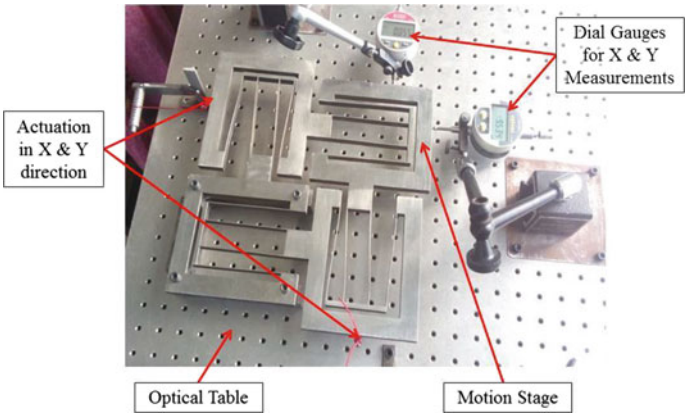

Fig. 15 Developed of experimental setup l

Static Characterization

Figures 16 and 17 shows comparison of experimental results and FEA results. It is noted that the finite element analysis results yields good matching with experimental results. During the actuation of X-stage, Y-stage deflection was recorded continuously by other dial gauge to record motion in X-stage. It is observed experimentally 25 μm motion in X-direction when actuation is given in Y-direction. Further, it is noted that motion is not due to parasitic or cross coupling but due to manufacturing error or surface finish. Similar, results are observed in other direction, hence, it can be concluded that zero parasitic motion in y-direction eliminated for the desired x-direction motion and zero parasitic motion in x-direction eliminated for the desired

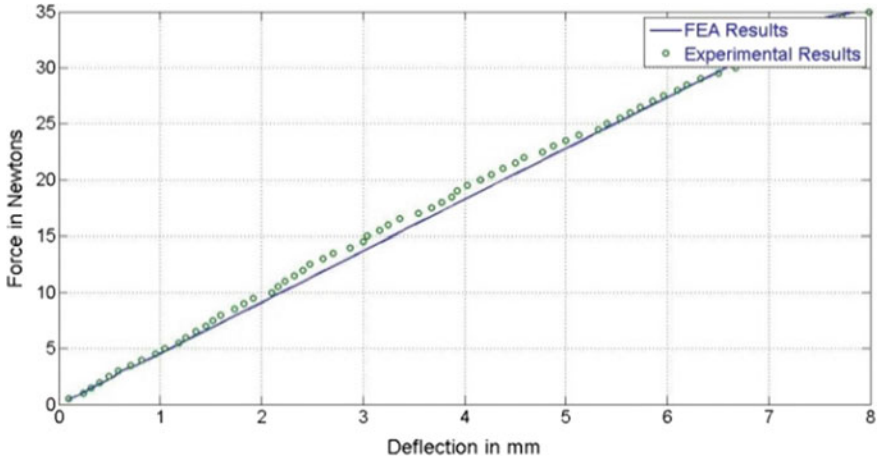

Fig. 16 Comparison of experimental and FEA results for X-direction

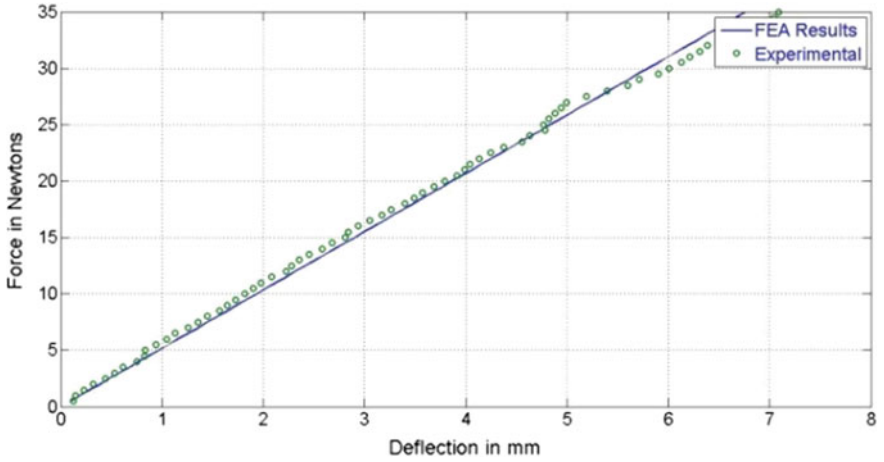

Fig. 17 Comparison of experimental and FEA results for Y-direction

y-direction motion. Slope of force deflection curve is a stiffness of flexural mechanism in the direction of actuation.

7 Conclusion

The modeling of double parallelogram flexural manipulator (DFM) is presented and further experimentally investigated. DFM is characterized in two different domains (1) Static characterization is carried out to determine force deflection characteristics over the entire motion range; (2) Dynamic characterization are carried out using Transient response and Frequency response. Transient response is determined using step input to DFM which gives system property damping. It is noted that theoretical model is having 5% accuracy with experimental results. Frequency response plots for the mechanism denotes behaviour of system for different frequency inputs. This frequency response plot is utilized to model DFM device experimentally. Experimental model i.e. transfer function of DFM with input as analog voltage signal and output as displacement of motion stage is used to obtain frequency response using constrained minimization approach. Experimental model is then compared with analytical model developed using fourth order wave equation and it is seen that results of both the models have very good agreement. PID control implementation was done on developed experimental model. To achieve better position and accuracy, PID and LQR implementation was carried on developed experimental model. PID parameters (Proportional, Integral, Derivative gains) are tuned using Ziegler Nichols Method. PID control is applied using dSPACE DS1104 microcontroller and Control Desk software. Experimentally, it is observed that positioning accuracy is less than 5 μm. XY flexural mechanism was developed by arranging multiple DFM blocks and static

characterization was carried out. It is observed 25 μm motion in X-direction when actuation is given in Y-direction experimentally. This motion is not due to parasitic or cross coupling but due to manufacturing error or surface finish. Hence we concluded that zero parasitic motion in y-direction eliminated for the desired x-direction motion and zero parasitic motion in x-direction eliminated for the desired y-direction motion.

References

1. Awatar S (2004) Synthesis and analysis of parallel kinematic xy flexure mechanism. Ph.D. thesis, Massachusetts Institute of Technology, Cambridge, MA
2. Dejima S, Gao W, Shimizu H, Kiyono S, Tomita Y (2005) Precision positioning of a five degree-of-freedom planar motion stage. Mechatronics 15(8):969–987
3. Deshmukh S, Gandhi PS (2009) Optomechanical scanning systems for microstereolithography (MSL): analysis and experimental verification. J Mater Process Technol 209(3):1275–1285
4. Awtar S, Slocum A (2005) Design of parallel kinematic XY flexural mechanism. In: Proceedings of IDETC/CIE ASME 2005 international design engineering technical conferences and computers and information in engineering conference, Long Beach, California, USA, September 2005
5. Gandhi PS, Sonawale K, Soni V (2011) Development of double parallelogram flexure mechanism via assembly route. In: 15th national conference on machines and mechanisms, pp 1–9
6. Lobontiu N (2003) Compliant mechanisms: design of flexure hinges. CRC Press, Boca Raton
7. Deshmukh S, Gandhi P (2007) A novel optomechatronic focused laser spot submicron scanning system for microstereolithography. Poster presented at international conference on nanotechnology, Bangalore, India
8. Yao Q, Dong J, Ferreira PM (2007) Design, analysis, fabrication and testing of a parallel-kinematic micropositioning XY stage. Int J Mach Tools Manuf 47(6):946–961
9. Kim HS, Cho YM (2009) Design and modeling of a novel 3-DOF precision micro-stage. Mechatronics 19(5):598–608
10. Li Y, Xu Q (2009) Modeling and performance evaluation of a flexure-based XY parallel micromanipulator. Mech Mach Theory 44(12):2127–2152
11. Deshmukh SP, Zambare H, Mate K, Shewale MS, Khan Z (2015) System identification and PID implementation on double flexural manipulator. In: 2015 international conference on nascent technologies in the engineering field, ICNTE 2015—proceedings, pp 1–5, February 2015
12. Patil R, Deshmukh S, Reddy YP, Mate K (2015) FEA analysis and experimental investigation of building blocks for flexural mechanism. In: 2015 international conference on nascent technologies in the engineering field, ICNTE 2015—proceedings, Feburary 2015
13. Tian Y, Shirinzadeh B, Zhang D, Liu X, Chetwynd D (2009) Design and forward kinematics of the compliant micro-manipulator with lever mechanisms. Precis Eng 33(4):466–475
14. Clement R, Huang JL, Sun ZH, Wang JZ, Zhang WJ (2013) Motion and stress analysis of direct-driven compliant mechanisms with general-purpose finite element software. Int J Adv Manuf Technol 65(9–12):1409–1421
15. Lescano S et al (2013) Micromechanisms for laser phonosurgery: a review of actuators and complaints parts. HAL Id: hal-00799755, March 2013
16. Buice S, Otten D, Yang RH, Smith ST, Hocken RJ, Trumper DL (2009) Design evaluation of a single-axis precision controlled positioning stage. Precis Eng 33(4):418–424
17. Liu YT, Li BJ (2010) Precision positioning device using the combined piezo-VCM actuator with frictional constraint. Precis Eng 34(3):534–545
18. Kim W, Verma S, Shakir H (2007) Design and precision construction of novel magnetic-levitation-based multi-axis nanoscale positioning systems. Precis Eng 31(4):337–350

19. Chu L, Fan SH (2006) A novel long-travel piezoelectric-driven linear nanopositioning stage. Precis Eng 30(1):85–95
20. Zhang D, Chang C, Ono T, Esashi M (2003) A piezodriven XY-microstage for multiprobe nanorecording. Sens Actuators, A Phys 108(1–3):230–233
21. Liu H, Jywe WY, Jeng YR, Hsu TH, Li Y (2010) Design and control of a long-traveling nano-positioning stage. Precis Eng 34(3):497–506
22. He L, Fu H, Sun D, Karkee M, Zhang Q (2017) Shake-and-catch harvesting for fresh market apples in trellis-trained trees. Trans ASABE 60(2):353–360
23. Mulik S, Krishnmoorthy A, Deshmukh S (2018) Flexural mechanisms for high precise scanning applications: a review. Int J Mech Eng Technol 9(4):312–327
24. Bhagat U et al (2014) Design and analysis of a novel flexure-based 3-DOF mechanism. Mech Mach Theory 74:173–187
25. Shewale MS et al (2018) Design and experimental validation of voice coil motor for high precision applications. Presented at the 3rd IEEE international conference for convergence in technology, pp 1–6, April 6–7, 2018
26. Shewale MS et al (2018) Design and implementation of position estimator algorithm on voice coil motor. Presented at the 3rd IEEE international conference for convergence in technology, pp 0–4, April 6–7, 2018
27. Mulik SS, Deshmukh SP, Shewale MS, Zambare HB, Sundare AP (2017) Design and implementation of position estimator algorithm on double flexural manipulator. In: 2017 international conference on nascent technologies in engineering (ICNTE), Navi Mumbai, 2017, pp 1–5. https://doi.org/10.1109/icnte.2017.7947904

Biometric Template Protection Scheme-Cancelable Biometrics

Vinit Kumar Gunjan, Puja S. Prasad and Saurabh Mukherjee

Abstract Biometric template is actually digital representation of the biometric features that are extracted by applying different algorithms on the captured images of different types of biometric modalities. This digital information is stored in a biometric database for identification and authentication purposes. The objective of this paper discussed about cancelable Biometric template protection scheme. The idea behind cancelable biometrics is intentionally and repeatedly alteration of biometric features in such a way so that the data or biometric features will be protected.

Keywords Cancelable biometrics · Non-invertible transform · Invertible transform · Bio hashing · Template

1 Introduction

Biometric recognition is one of the most demanding authentication process these days and act as access control systems as well as modern identity management. As due to the personal and permanent link between individuals and their biometric traits, it become very vulnerable to different types of attack. Exposure of already register biometric information to opponents can seriously compromise biometric privacy as well as security. Research have been going on for finding different methods for biometric template protection over the last two decades. As biometrics is a dominant tool against disclaimer and has been broadly used in numerous authentication systems [1]. The features obtained from biometric are primarily incontrovertible, and it results in compromise of permanent biometric data once it is stolen. Number of protection

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scheme are already on research in which one is cancelable biometrics. The main concept of cancelable biometric is that like password it can be cancelled and revoked and remain unique for every application.

Mobile biometrics has also come with new practice of risks. Number of different service providers like bank, financial organizations are now introduced biometric authentication in their apps [2, 3]. They use the concept of integrating fingerprint or face recognition to authenticate customers so that user access their services. But one of the most important concern is that the biometric data is movement of biometric data between user and the bank which creates an issue of compromising of the biometric data [4]. Another important concern is that the image capturing device used on mobile devices is very small in size so as well as low quality to take all the feature appropriately. For example, fingerprint recognition on mobile devices uses partial fingerprint recognition algorithm. The sensor itself is so tiny that it cannot accommodate the whole fingertip. These risks with mobile biometrics can only be mitigated with continuous research and development [5].

One of the main concern of cancelable biometrics is that it needs storage for the distorted biometric template which actually offer very high privacy level by permitting multiple biometric templates to be linked with the same biometric sample [6]. This has one advantage of non-linkability of user's biometric data kept across numerous databases.

Cancelable biometric is one of the major category including biometric cryptosystem for biometric template protection scheme [7, 8]. As cancelable feature is compromised, the distortion features are changed and this biometric is mapped to a new template and used afterwards (Fig. 1).

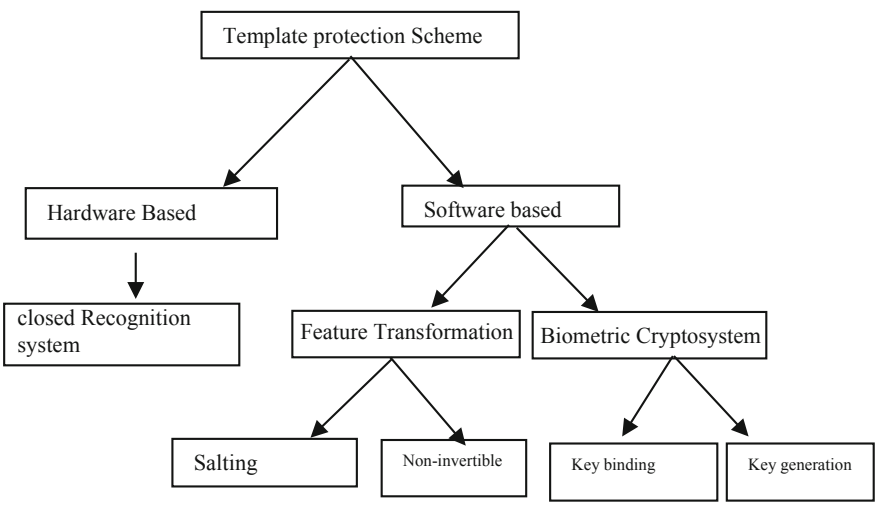

Fig. 1 Types of biometric template protection scheme

Template protection schemes generally categorized as Helper data based schemes also called biometric cryptosystems and feature transformation called cancelable biometrics [9]. Both of these schemes has to meet two main requirements-

(i) **Irreversibility**: Reconstruction of original biometric template should be computationally hard from the already saved reference data or we say protected template, but it would be easy to make the protected biometric template.
(ii) **Unlinkability**: From the same biometric data different version of biometric template created called renewability but cross matching should not have allowed.

2 Cancelable Biometric

Cancelable biometric alters are the result of systematically and intentional distortion of biometric features in order to shield subtle user biometric data. The transform biometric aimed in a way that it should be computationally very hard to recuperate the original biometric data [10, 11]. The main strength (individuality) of biometric features or characteristics should not be reduced when applying transforms while on the other hand transforms should be tolerant to intra-class variation (Fig. 2) [9].

Correlation of numerous transformed templates essentially not disclose any evidence about the distinctive biometrics (unlinkability) [12]. As soon as transformed biometric compromised, transformation parameters are changed, and the corresponding biometric template is updated. There are two key technique of transformation in order to protect from imposter and to make more robust biometric template scheme.

A. Non-invertible Transform-Non-invertible function are applied to construct the transform biometric template. Main benefits of smearing non-invertible function

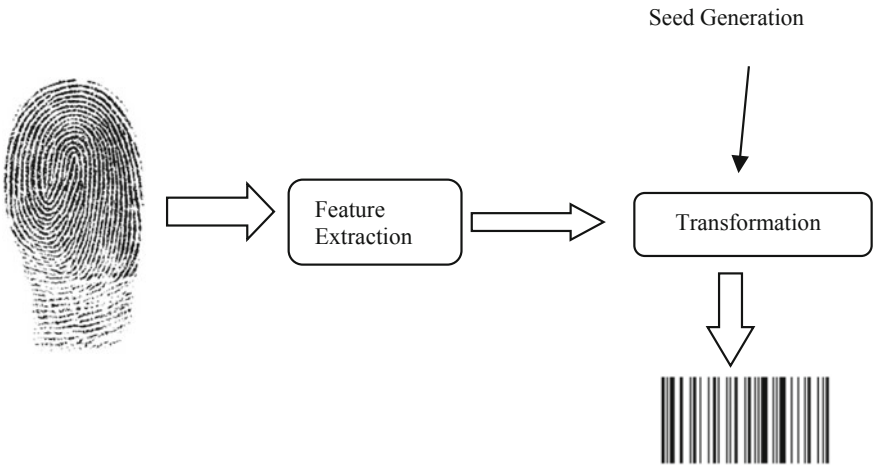

Fig. 2 Seed generation and transformation for biometric template protection

are potential imposter as well as not able to rebuild original biometric data once biometric datasets compromised. One of the disadvantage of non-invertible transform is it reduces accuracy of the overall system. Performance of the system reduces as less information regarding biometric feature are there for comparison.

B. Invertible Transform- Also called biometric salting. It involves transformation of biometric template using invertible function which means biometric template is transformed into original form. As a result, the parameters of the transform have to be kept secret. In case user-specific transforms are applied, the parameters of the transform have to be presented at each authentication [13, 14]. If the transform parameters are compromised the impostors may be able to recover the original biometric template which result a possible performance decrease of the system in case primary biometric algorithms do not deliver high correctness without undisclosed transforms.

3 Invertible Transforms

Biometric Salting comes under Invertible transformation. Biometric salting is very much alike to password salting used in cryptography. It consists of random bits R_b which is combine with secret key K and it is taken as input factor (Fig. 3) [9].

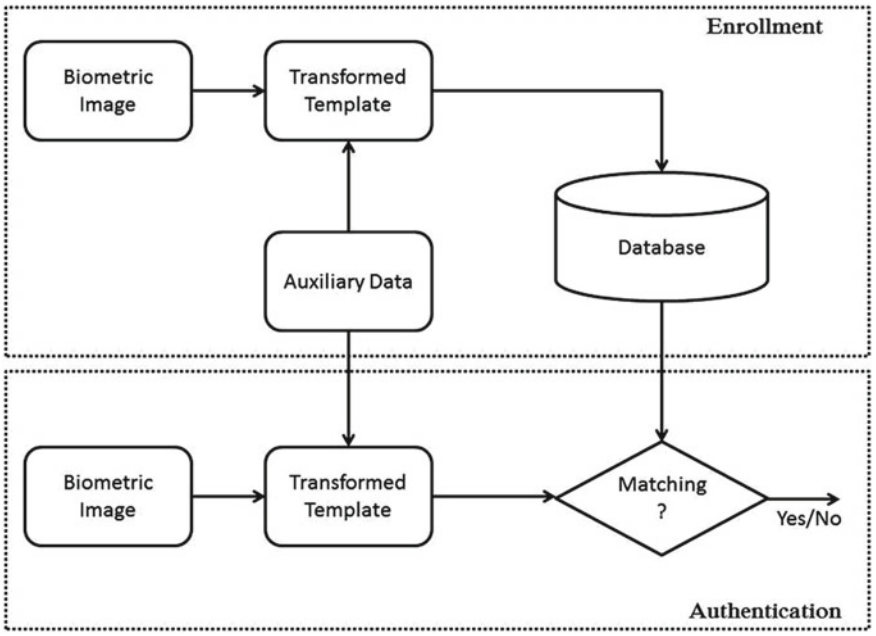

Fig. 3 Biometric salting

The output is repeatedly stored as Hash $H(R_b + K)$ as template. In this process Distorted Biometric template is obtained by combining user specific independent input factor with the biometric data, by using biometric salting process [2]. This data is invertible in nature so it easily revoked and changed so it requires maximum security protection.

Biohashing is one of the example of biometric salting which uses random projection [7, 12].

In this a random matrix R having size $a * b$ is generated in which Gram-Schmidt process of orthonormalization is carried to make b column orthonormal and finally extracted feature vector is projected with the threshold value. This techniques are used with many modalities like speech, face, fingerprint. But the performance of the Bio hash degrades when the token is stolen. For this reason, bio hashing is basically a quantized under-determined linear equation which would be partially solved using pseudo-inverse operation.

Teoh and Chong proposed Multistage random projection was also there that address the problem of performance of stolen token in both theoretical and experimental analysis [15].

Lumini et al. perform Bio Hashing under different threshold value for Stolen token scenarios by fusing the scores [16]. Different researcher works on biometric salting scheme on different biometric features. In one of the technique which uses feature vectors of face image extracted from Principal Component Analysis and Independent Component Analysis from a face image and these are then normalized and then permuted using token-derived permutation. Once it was compromised, by changing permutation matrix new feature vector can be generated.

4 Non-invertible Transform

Non-invertible transformation process involves many-to-one function. The function F is used to modify an unrefined biometric data purposely into a new type within the framework of signal space. The function F has act as main agent that transform the biometric template into non-invertible form which is reused and have diverse in nature. As f does not have directly deals with raw biometrics, the main benefit of this technique is that F does not need to be kept secret.

An understanding of non-invertible transform was first discussed Ratha et al. in which biometric fingerprint data is altered by a sequence of three non-invertible transformation functions. The three transformation functions are based on Polar, Cartesian

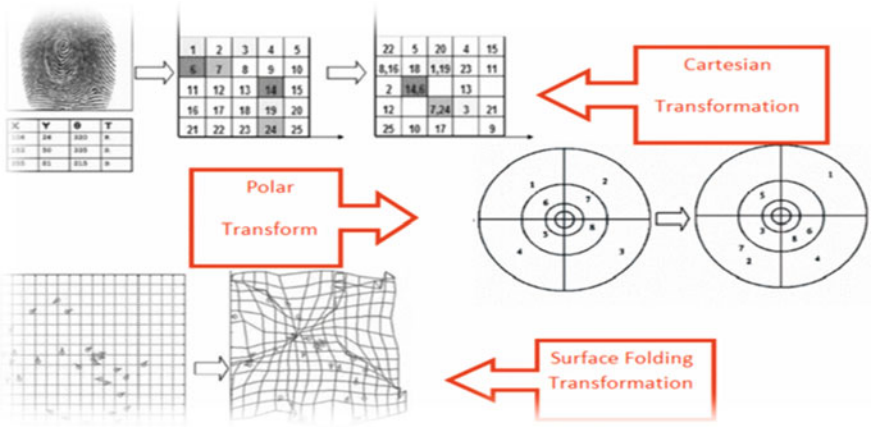

Fig. 4 Cancelable templates from different transforms (adopted from [9])

and surface folding transformation of the minutiae positions. The fingerprint minutia is arranged into rectangular grid in Cartesian transformation, with reference to positions of singular points. In polar transformation image is arrange into polar sectors and is similar to the Cartesian transformation. A mixture of 2D electric potential field and 2D Gaussians distributions are used in surface transformation to translate the minutiae points (Fig. 4).

5 Conclusion

Biometric Technology is one of the authentication techniques that uses different biometric feature for authentication of a person. It grows exponentially during last decades. As biometric is permanently associated with person there is more concern towards security of biometric template. In this paper we discuss about different biometric template protection scheme. One scheme is related to cryptography and other is related to the transformation techniques also called cancelable biometric. We also discuss different invertible and non-invertible transformation techniques. Salting or bio hashing algorithm are also applied in different biometric features for their protection. In this paper we also discuss the effect of performance of the biometric system after applying different protection mechanism. One of the future scope is to develop a non-invertible function for biometric feature transformation that assure non-invertibility requirements as well as performance.

References

1. Prasad PS, Devi BS, Reddy MJ, Gunjan VK (2018) A survey of fingerprint recognition systems and their applications. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 513–520
2. Rathgeb C, Uhl A (2011) A survey on biometric cryptosystems and cancelable biometrics. EURASIP J Inf Secur 2011(1):3
3. Ratha N, Connell J, Bolle RM, Chikkerur S (2006) Cancelable biometrics: a case study in fingerprints. In: IEEE 18th international conference on pattern recognition (ICPR'06), vol 4, pp 370–373
4. Jain AK, Nandakumar K, Nagar A (2008) Biometric template security. EURASIP J Adv Signal Process 1(2008):113
5. Prasad PS (2016) Efficient secure authentication using multi biometric cryptosystems
6. Bringer J, Chabanne H, Kindarji B (2008) The best of both worlds: applying secure sketches to cancelable biometrics. Sci Comput Program 74(1–2):43–51
7. Kong A, Cheung KH, Zhang D, Kamel M, You J (2006) An analysis of Bio Hashing and its variants. Pattern Recogn 39(7):1359–1368
8. Zuo J, Ratha NK, Connell JH (2008) Cancelable iris biometric. In: IEEE 2008 19th international conference on pattern recognition, pp 1–4
9. Ratha NK, Chikkerur S, Connell JH, Bolle RM (2007) Generating cancelable fingerprint templates. IEEE Trans Pattern Anal Mach Intell 29(4):561–572
10. Connie T, Teoh A, Goh M, Ngo D (2005) Palmhashing: a novel approach for cancelable biometrics. Inf Process Lett 93(1):1–5
11. Ang R, Safavi-Naini R, McAven L (2005) Cancelable key-based fingerprint templates. In: Australasian conference on information security and privacy. Springer, Berlin, Heidelberg, pp 242–252
12. Teoh AB, Ngo DC (2006) Biophasor: token supplemented cancellable biometrics. In: IEEE 2006 9th international conference on control, automation, robotics and vision, pp 1–5
13. Prasad PS, Baswaraj D (2018) Iris recognition systems: a review. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 521–527
14. Prasad PS, Devi BS, Preetam R (2018) Image enhancement for fingerprint recognition using Otsu's method. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 269–277
15. Chin CS, Jin AT, Ling DN (2006) High security iris verification system based on random secret integration. Comput Vis Image Underst 102(2):169–177
16. Teoh AB, Yuang CT (2007) Cancelable biometrics realization with multispace random projections. IEEE Trans Sys Man Cybern Part B (Cybern) 37(5):1096–1106

Analyzing Correlation Based Matching in Biometric System

Puja S. Prasad, Rashmi Pathak, M. Janga Reddy and Vinit Kumar Gunjan

Abstract Authentication is one of the very important phase of security. Biometric authentication is now becoming more demanding as it authenticates people by using biometric traits like fingerprint, face, iris etc. Biometric authentication method is different from the traditional method of authentication in which we have to remember password or having identification card for authenticating a person. Biometric authentication is more reliable and convenient. But the performance of the biometric system is fully depending on the true matching of the feature extracted and that stored in a template. In this paper we discuss about different matching techniques that are applied in the template and the extracted feature for authenticating a person. Three different techniques that is Ridge based matching, Minutia based matching, and correlation based matching are explained in the paper. In minutia based matching is done by using minutia. Minutia is actually a specific pattern present in the fingerprint like ridge, bifurcation etc. In Correlation based matching correlation function is applied for matching and in Ridge Based Matching finger ridge feature is used for matching purpose.

Keywords Minutia · Template · Correlation · Ridge · Primary fingerprint · Secondary fingerprint

1 Introduction

Biometric System these days now become one of the powerful tool for authenticating person. A fingerprint-based authentication system is becoming more popular biometric authentication system is basically combination of image processing as well

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as pattern recognition system. In this system the individual identity is find by the unique patterns of the biometric traits. Biometric Recognition System works on two different mode depending on the application used.

Verification System-In this type of recognition an individual is recognized or authenticated by comparing their own biometric data pre-stored in template.

Identification System-In this type of authentication mode particular individual recognized by comparing biometric of an individual with each and every biometric template database. It performs one to many comparisons to establish the identity of a person. In this paper recognition word is used which is used for both identification and verification system. As fingerprint verification is an important biometric technique for personal identification [1].

In identification system no enrolment pin is present and the identification of a person is done by searching all the biometric templates. Search process is expensive in this type of authentication as in identification system each and every biometric data is compared. To reduce the cost certain classification and indexing techniques are used. Identification system are actually beneficial for a situation where certain person is to identify for certain unsocial work [2]. Identification of a person is one to n comparison in which identification is said to be successful if matching between the template and biometric sample are within the threshold. Very realistic fingerprint images are obtained after the final noising-and-rendering stage [3].

Fingerprint matching one of the crucial step for authentication person is basically divided into three ways.

Correlation Based Matching Techniques—Correlation based matching is based on the value of correlation between two grey-scale fingerprint are used. This process gives the similarity ratio between the two images by applying correlation technique.

Minutia Based Techniques—In minutia based method the matching of two fingerprint are done on the basis of minutia selected from the fingerprint. Minutia are the important features of fingerprint that are used for matching two fingerprints [4]. Two most important minutia are Ridge Ending and Ridge Bifurcation that are mostly used for recognition purposes. Number of mathematical model is developed to finding different minutia position [5].

Ridge Based matching—In ridge based matching, finger ridge feature is used for matching purpose. Different researcher has different view to extract ridge feature. In this model for efficient identity verification based on the ridge orientation has done [6].

2 Correlation Based Matching

As gray level image of fingerprint contains rich information about fingerprint, correlation based matching is using grey level image for matching purpose [7, 8]. In minutia based matching the sometimes it is very difficult to extract exact minutia locations, gray level image provides much richer as well as more discriminatory,

information about the fingerprint. There are especially three steps involved in correlation based matching-

Template Selection
Template Matching
Elementary Decision.

2.1 Template Selection

The first step in correlation based technique is the selection of template. Template is actually the machine or digital representation which is distinct and unique characteristic of a biometric sample extracted from the individual biometric. In the template selection method, the first step is the selection of primary template as good selection will easily have localized in the secondary fingerprint. The size of template is the first property to consider. The size of the template must be optimal. Problem of misalignments of specific position when the entire fingerprint is taken during matching of template due to shape distortions.

Number of experiments are carried out for finding the exact size of images in which size of one by one pixel has not given good result whereas 24 by 24 has better result. There are mostly three methods for template selection-

(a) Coherence- based template selection
(b) Minutia based template selection
(c) Correlation based template selection.

In coherence based template selection the orientation pattern of ridge and furrows are seen or to measure how well the local gradients are pointing towards same direction. The method not only computes the direction in any pixel location, but its coherence as well [9]. Coherence is very high if ridge and valley structure are only parallel line and not contain noisy area otherwise it is low. Though, at locations that is around minutiae, more gray-scale gradient orientations are present, that results in significantly lower coherence. Only by representation information can be captured and made available to decision [10]. Therefore, the coherence method can also be used as a appropriate measure that states the occurrence of minutiae as well as an extent that shows how well a template can be placed in the secondary fingerprint. Oriented patterns, like those produced by deformation, propagation, accretion are mutual in nature and therefore a significant class for visual study as well as biomedical engineering [11, 12].

In Minutia based template selection minutia is used. On the other hand, if template contain one or more minutia it is very easy to locate this minutia in the secondary print. Minutia verification stage based on analysing the gray-scale profile in a detected minutia's spatial neighbourhood in the sensed image can improve the matching performance [7].

For this method we have to extract template from the fingerprint region that are closer to the minutia so that matching will be easy. One of the main drawback of this type of template selection is many false minutiae are extracted and this makes the template unreliable.

In correlation based template selection the main criteria for selecting template is how well the selected template is fit in other position of the same fingerprint. If the template fits in their original position as well as at other position also then it is worst template and it does not give the good result. Since the correlation based technique requires primary and secondary image position are about in same position.

2.2 Template Matching Process

At first templates have been carefully chosen in the primary fingerprint. By means of regular template matching algorithm the selected template is placed over the secondary fingerprint pixel wise. For each position, the gray-level distance among the template and the equivalent area in the secondary print is obtained by summing the squared gray-level differences for individual pixel in the template. This is a very computationally demanding technique [13].

(a)Primary fingerprint (b)Matching fingerprint (c)Non matching fingerprint

Suppose I (ΔX, ΔY, θ) gives a rotation of the input image I by an angle θ round the origin (usually the image centre) and shifted by ΔX, ΔY pixels in directions X and Y, correspondingly; Then correlation coefficient between two images gives the idea of similarity between two images and is calculated by the equation:

$$S(I, T) = \max CC(T, I(\Delta X, \Delta Y, \theta))$$

where CC is the cross-correlation value between I and T.

One of the problem with this equation is rarely give acceptable result. The reason behind is that image of the same finger is slightly different from due to Non-linear distortion [14, 15]. The use of block-wise or local correlation can help to deal with this problem of Nonlinear distortion. Skin moisture or type and finger pressure on the sensor also cause varying of image brightness, contrast, and ridge thickness.

But the use of more refined correlation techniques may solve the contrast and brightness variations to some extent. Reliable and accurate fingerprint recognition is a challenging problem, requiring algorithms that must be robust in many contexts [16]. Use of proper combination of enhancement, binarization, and thinning process on both secondary and primary fingerprint may solve the ridge thickness problem also. One more problem is that it is computationally very expensive as it requires billion and billions of multiplication and summation for general pixel range [17, 18]. Fourier or local correlation improves efficiency to some extent.

3 Conclusion

Fingerprint feature extraction is very challenging problem. In number of cases the fingerprint is poor quality due to some skin problem, old age or heavy physical work. This type of problem create problem during matching of primary and secondary fingerprint during authentication. In this paper we discussed about different fingerprint matching techniques.

Different techniques have their own advantages and disadvantages. Minutia based techniques are more popular in which minutia is extracted and then compare with the template. Minutia is actually a unique pattern present in fingerprint image called ridge ending and ridge bifurcation. One of the main problem with this technique is that due to noises the minutia position are distorted ant it leads to increase in unreliable result. As noises are common and poor quality images also create problem. There is another matching technique called Correlation based techniques are now become very popular these days in which correlation coefficient are calculated for primary and secondary fingerprint template which give the value of similarity between two templates. One of the drawback with this technique is that it is computationally very expensive. Number of research are going on improve the matching techniques of fingerprint.

References

1. Jain, AK et al (1997) An identity-authentication system using fingerprints. In: Proceedings of the IEEE 85.9:1365–1388
2. Maio D, Maltoni D (1999) Minutiae extraction and filtering from gray-scale images. Intelligent biometric techniques in fingerprint and face recognition. CRC Press, Inc.
3. Cappelli R et al (2000) Synthetic fingerprint-image generation. In: IEEE Proceedings 15th international conference on pattern recognition, vol 3

4. Prasad PS (2016) Efficient secure authentication using multi biometric cryptosystems
5. Sherlock BG, Monro DM (1993) A model for interpreting fingerprint topology. Pattern Recogn 26(7):1047–1055
6. Vizcaya Pedro R, Gerhardt Lester A (1996) A nonlinear orientation model for global description of fingerprints. Pattern Recogn 29(7):1221–1231
7. Prabhakar S et al. (2000) Minutia verification and classification for fingerprint matching. In: IEEE Proceedings 15th international conference on pattern recognition, vol 1
8. Jain AK et al (2000) Filter bank-based fingerprint matching. IEEE transactions on image processing 9.5:846–859
9. Bazen AM, Gerez SH (2000) Directional field computation for fingerprints based on the principal component analysis of local gradients. In: Proceedings of ProRISC2000, 11th annual workshop on circuits, systems and signal processing. Veldhoven, The Netherlands
10. Lindeberg T, Romeny BMH (1994) Linear scale-space I: basic theory. Geometry-driven diffusion in computer vision. Springer, Dordrecht, pp 1–38
11. Kass M, Witkin A (1987) Analyzing oriented patterns. Readings in computer vision, pp 268–276
12. Schrijver M, Bazen AM, Slump CH (2000) On the reliability of template matching in biomedical image processing. In: Proceedings of the 2nd IEEE Benelux signal processing symposium (SPS-2000)
13. Bazen AM et al (2000) A correlation-based fingerprint verification system. In: Proceedings of the ProRISC2000 workshop on circuits, systems and signal processing
14. Prasad PS, Baswaraj D (2018) Iris recognition systems: a review. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 521–527
15. Prasad PS, Devi BS, Preetam R () Image enhancement for fingerprint recognition using Otsu's method. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 269–277
16. Maio D et al (2002) FVC2000: fingerprint verification competition. IEEE Trans Pattern Anal Mach Intell 3:402–412
17. Wayman JL (1999) Technical testing and evaluation of biometric identification devices. Biometrics: personal identification in networked society, pp 345–368
18. Siegal J, Rowell S, Hintz T (2018) Method and system for providing online authentication utilizing biometric data. U.S. Patent No. 9,911,146
19. Prasad PS, Gunjan VK (2018) Deep learning based iris recognition system. HELIX 8(4):3567–3571

Deep Learning Based Representation for Face Recognition

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Abstract Face Recognition is one of the challenging process due to huge amount of wild datasets. Deep learning has been provided good solution in terms of recognition performance, as day by day this have been dominating the field of biometric. In this paper our goal is to study deep learning based face representation under several different conditions like lower and upper face occlusions, misalignment, different angles of head poses, changing illuminations, flawed facial feature localization using deep learning approaches. For extraction of face representation two different popular models of Deep learning based called Lightened CNN and VGG-Face and have reflected in this paper. As both of this model show that deep learning model is robust to different types of misalignment and can tolerate localizations error of the intraocular distance.

1 Introduction

In the last few decade, CNN or convolution neural network has turn one of the best popular methods for computer vision. Numerous vision tasks, like classification of image [1], object detection [2], recognizing face [3–5], have aided from the robust CNN models.

Face recognition is a challenging task due to several factors like expressions, illuminations, using accessories like glasses, scarves that causes partial occlusions[6]. Deep learning provides a very good results in terms of pre-processing and recognizing faces. In this methods we input raw data in a convolve filters in different multiple levels that automatically discover or detect underlying high levels of representation from labelled or unlabelled data [7–9].

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CNN approaches for face verification can be usually classified into three sets. The first group helps to multiclass classification [10, 11] to extract face feature vectors and then processes these vectors by classifiers or multipath collective models. Some approaches in this set are often based on strong conventions of data scatterings that may not make consequence on various circumstances, such as Gaussian Processing and Joint Bayesian [2, 12]. Although multipath collective improves robustness of features from multiclass classification, and it's a time consuming process. The second group goals is to directly enhance the proof loss for non-matching and matching pairs [3, 5, 13]. One of the benefits using this method is that it directly reduces or eliminate the bottleneck problem of multiclass classification. But one constraint of these techniques is that it is challenging for negative pairs to select training dataset as well as threshold in the verification loss is manually obtained. The third and last group works for combined identification and verification constraint to improve deep face models [14–16]. Multi-task learning delivers an well-organized way to improve the oversimplification skill of face representation. However, convergence is quiet challenge for CNN based on multi-task. The trade-off among verification and identification is manually resolute and it depends on the training set.

2 Literature Survey

Before Deep learning the common algorithm used for face recognition methods used extract shallow structures from facial images are Scale (SIFT), Invariant Feature Transform, (LBP) Local Binary Patterns as well as (HOG) Histogram of Oriented Gradients, Nearest Neighbours (Support Vector Machines (SVMs)) [1, 3, 8, 17] are used to classify identity. Though, with the accessibility of the latest computational resources and having rush in entree to huge datasets, results given by deep learning is extraordinary for dissimilar visual recognition jobs including biometric face recognition [10, 11].

One of the network Deep Face [16] that give outstanding results having deep nine-layer Convolutional Neural Network model having two convolutional layers and having higher than 110 million parameters that is skilled on facial images of three million of 3000 different identities. This technique, in which position of images is built on three dimensional models as well as use of collective of Convolutional neural networks, and could attain precisions of around 96.75 and 92.4% on LFW and YTF datasets, correspondingly. Deep Hidden Identity Features [18] is also a different type of popular Deep learning technique for recognition of face as well as verification having four convolutional layers and nine-layer network. This method first acquires weights from identifying face as well as mines features by means of the preceding hidden layer outputs, and after that generalizes them for verifying face. Deep ID bring into line faces by parallel transformation built on two eye centres as well as corners of two mouth [19]. Training for this network is done on the Celeb

Face dataset also called CelebFaces [14] and attained an accuracy of 98.45% on the LFW dataset. Face Net [12] is a deep CNN based on Google Net [20] and the network suggested in and trained on a face dataset with 150–200 million images of about nine million identities. This algorithm actually uses triplets of unevenly associated faces got from an online trio mining approach and it directly learns to plot face images to a dense Euclidean space for measuring similarity in face. FaceNet has been assessed on YTF and LFW datasets and has attained accuracies of 99.73 and 96.12%, correspondingly.

3 Approaches for identifying face

Two approaches are defined in this paper first is effective Convolutional Neural Network designs for biometric face recognition and then we explain face plan based on two models.

3.1 VGG-Face Network

A deep convolutional network or VGG-Face [10] is projected for face recognition by using the VGG Net structural design [21]. It is trained on approximately 2.6 million images of face of 2522 individualities getting from the web. The network comprises 16 convolutional network layers, three fully connected layers, five max-pooling layers, final linear layer having Softmax activation. VGG-Face take input color image covers of size 224×224 pixels and utilizes regularization [22] in the fully-connected layers. Moreover, it relates ReLU activation to wholly convolutional layers. Crossing 145 million parameters obviously proves that the VGG network is a computationally costly design [23].

3.2 Lightened CNN

In this model having little computational complexity proposed for biometric face recognition [37]. Max-Feature-Map (MFM) activation function is uses to extract more theoretical illustrations in divergence with the ReLU. Lightened Convolutional Neural Network is acquainted in dual different models. The AlexNet model having 3962 K parameters with four different convolution layers using the four max-pooling layers, MFM activation functions, two fully-connected layers, and a linear layer

with Softmax activation in the output. The second network, (B), is encouraged by the Network in Network model [24] and it involves 3245 K parameters having five different convolution network layers that uses MFM activation functions, five max-pooling layers, four convolutional layers for reducing dimensionality, linear layer having activation using Softmax having output two fully-connected layers.

4 Tests and Results

This segment, deliver the truths of already used datasets as well as experimental systems. Moreover, give different the situations used for assessment of deep CNN-based face representation and deliberate the obtained results (Table 1) [25].

The AR face database [25] have 5000 frontal face images having size of 764 × 574 pixels having diverse facial expressions, occlusions illuminations, and occlusions from 126 subjects. In this each subject had contributed in two sessions having difference of two weeks and having no limits on any accessories like scarf, make-up, headwear, hairstyle etc. Meanwhile the main goal of this test is to target the robustness of deep CNN-based features against occlusion, one image per subject with the neutral expression from the first session is used for training. For testing purpose per session two image per subject used for testing purpose and the posture is one for testing impact of upper face occlusion having sunglasses while another wearing scarf to test lower face occlusion. These samples are completely taken from 112 subjects. Later all selected image is cropped, aligned, square facial patch and then scaled to 128 × 128 pixels or either 224 × 224 pixels. The mean image obtained subtracted from the training set of VGG-Face to establish the presentation of the similar image transforms smeared on pre-tained models. Figure 1 shows how different expression of images associated with single subject of the AR database used for the experiment. Five experiments are accompanied on the AR dataset. First two experiments involves training and testing within the first session though the rest are trained with samples of the first session and then tested on images obtained from second session.

Table 1 Classification results in percentage using deep features against different occlusion conditions (AR database) [25]

Testing set	Lightened CNN		VGG-face
	FC7	FC6	
Scarf session 1	85.78	89.80	12.56
Scarf session 2	85.98	87.79	10.06
Sunglasses session 1	33.58	35.78	6.56
Sunglasses session 2	23.78	28.76	5.95

Fig. 1 Images from the AR face database recorded at different sessions having different facial expressions

5 Conclusion

Deep learning is now a days very emerging field. The recognition of face images shows good results by using deep learning algorithm. In this paper we presented two different models for face recognition. It has been shown that deep learning based representations provide promising results. Face recognition is a challenging task due to several factors like expressions, illuminations, using accessories like glasses, scarves that causes partial occlusions. Deep learning provides a very good results in terms of pre-processing and recognizing faces. In this paper we input raw data in a convolve filters in different multiple levels that automatically discover or detect underlying high levels of representation from labelled or unlabelled data. The performance gap is weighty for the circumstances in which the tested conditions are infrequent in the training datasets of CNN models. Besides that, one of the important remarks, in this study has discovered that an advantage of deep learning based face representations is more robustness to misalignment facial images.

References

1. He K, Zhang X, Ren S, Sun J (2015) Delving deep into rectifiers: surpassing human-level performance on imageNet classification. In: Proceedings of the IEEE international conference on computer vision, pp 1026–1034
2. Szegedy C, Reed S, Erhan D, Anguelov D, Ioffe S (2014) Scalable, high-quality object detection. arXiv preprint arXiv:1412.1441
3. Sun Y, Chen Y, Wang X, Tang X (2014) Deep learning face representation by joint identification-verification. In: Advances in neural information processing systems, pp 1988–1996
4. Taigman Y, Yang M, Ranzato MA, Wolf L (2014) Deep face: closing the gap to human-level performance in face verification. In: Proceedings of the IEEE conference on computer vision and pattern recognition, pp 1701–1708

5. Yi D, Lei Z, Liao S, Li SZ (2014) Learning face representation from scratch. arXiv preprint arXiv:1411.7923
6. Zhao W, Chellappa R, Phillips PJ, Rosenfeld A (2003) Face recognition: A literature survey. ACM comput surv (CSUR) 35(4):399-458
7. Hinton GE, Osindero S, Teh YW (2006) A fast learning algorithm for deep belief nets. Neural Comput 18(7):1527–1554
8. Kavukcuoglu K, Sermanet P, Boureau YL, Gregor K, Mathieu M, Cun YL (2010) Learning convolutional feature hierarchies for visual recognition. In: Advances in neural information processing systems, pp 1090–1098
9. Krizhevsky A, Sutskever I, Hinton GE (2012) ImageNet classification with deep convolutional neural networks. In: Advances in neural information processing systems, pp 1097–1105
10. Yosinski J, Clune J, Bengio Y, Lipson H (2014) How transferable are features in deep neural networks? In: Advances in neural information processing systems, pp 3320–3328
11. Sivic J, Everingham M, Zisserman A (2009) "Who are you?"-Learning person specific classifiers from video. In: 2009 IEEE conference on computer vision and pattern recognition, pp 1145–1152
12. Schroff F, Kalenichenko D, Philbin J (2015) FaceNet: a unified embedding for face recognition and clustering. In: Proceedings of the IEEE conference on computer vision and pattern recognition, pp 815–823
13. Prasad PS, Gunjan VK (2018) Deep learning based iris recognition system. HELIX 8(4):3567–3571
14. Sun Y, Wang X, Tang X (2013) Hybrid deep learning for face verification. In: Proceedings of the IEEE international conference on computer vision, pp 1489–1496
15. Prasad PS, Baswaraj D (2018) Iris recognition systems: a review. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 521–527
16. Xiang ZS, He WR, Sun Z (2015) A lightened cnn for deep face representation. arXiv:1511.02683
17. Phillips PJ, Flynn PJ, Scruggs T, Bowyer KW, Chang J, Hoffman K, Marques J, Min J, Worek W (2005) Overview of the face recognition grand challenge. In: 2005 IEEE computer society conference on computer vision and pattern recognition (CVPR'05), vol 1, pp 947–954
18. Huang GB, Mattar M, Berg T, Learned-Miller E (2008) Labeled faces in the wild: a database for studying face recognition in unconstrained environments. In: Workshop on faces in 'Real-Life' Images: detection, alignment, and recognition
19. Prasad PS, Devi BS, Reddy MJ, Gunjan VK (2018) A survey of fingerprint recognition systems and their applications. In: International conference on communications and cyber physical engineering 2018. Springer, Singapore, pp 513–520
20. Jia Y, Shelhamer E, Donahue J, Karayev S, Long J, Girshick R, Guadarrama S, Darrell T (2014) Caffe: convolutional architecture for fast feature embedding. In: Proceedings of the 22nd ACM international conference on Multimedia. ACM, pp 675–678
21. Simonyan K, Zisserman A (2014) Very deep convolutional networks for large-scale image recognition. arXiv preprint arXiv:1409.1556
22. Srivastava N, Hinton G, Krizhevsky A, Sutskever I, Salakhutdinov R (2014) Dropout: a simple way to prevent neural networks from overfitting. J Mach Learn Res 15(1):1929–1958
23. Zhou SK, Aggarwal G, Chellappa R, Jacobs DW (2007) Appearance characterization of linear lambertian objects, generalized photometric stereo, and illumination-invariant face recognition. IEEE Trans Pattern Anal Mach Intell 29(2):230–245
24. Lin M, Chen Q, Yan S (2013) Network in network. arXiv preprint arXiv:1312.4400
25. Martinez AM (1998) The AR face database. CVC Technical Report 24

Normalization Techniques in Multi Modal Biometric

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Abstract The key objective of the paper is to summarize different process that are used in multimodal biometric system for fusion of biometric traits. The main focus is on different fusion techniques that are used for fusion having different biometric traits like palm and face, iris and fingerprint, fusion of instances of same biometric model etc. Fusion are of two types, Post Classification and Pre Classification. In Post classification method integration of information occurs after matching or classification stage. In Pre-classification information fusion, integration of information takes place before matching or prior to classification. Feature level and Sensor level fusion comes under Pre-Classification Information fusion. In this paper, we also emphasis on different normalization techniques which are very essential for fusing matching score obtained after matching process. As matching scores are of different dimensions so before taking decision normalization has to be done so that fusion will be easy.

Keywords Score-level fusion · Post classification · Borda count · Feature vectors

1 Introduction

Biometric system is of two main types- Multimodal and Unimodal. Multimodal biometric system involves fusion of the biometric features that are collected from different or instances of same biometric occurs [1]. The main aim of multimodal biometric is to enhance performance in terms of recognition and identification. In

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multimodal biometric system fusion of features extracted from different module or instances of same module occurs at different phases in biometric recognition system. Fusion occurs just after collecting data from sensor that is called sensor level fusion or after extracting features called feature level fusion. Some fusion occurs matching level and some at decision level [2]. This type of fusion is called post classification fusion. Among all of them fusion at matching level is considered to be one of the most effective and reliable fusion. In matching level fusion, the scores generated after matching are fused together. This fused output is then used for taking decision. The Score generated are of two types first is homogeneous and another one is heterogeneous. Homogeneous scores are easily fused, but fusion of heterogeneous score requires normalization process before fusion. The statistical values of the score generated are from different biometric module and also not in the same numerical values. Output of the matchers i.e. matching scores have different statistical distributions. System Information fusion in biometric is divided into two types:

- Post–Classification and
- Pre-Classifications.

Fusion of information in Pre-classification takes place before matching or prior to classification. Feature level and Sensor level fusion comes under Pre-Classification Information fusion. The data obtained directly from sensor are integrated in sensor level fusion [3]. For example, palm image taken from different input devices are combined to form single palm image. But one of the big issue with integration is that compatibility of different sensor [4]. If the cameras are of different resolution, then it is difficult to fuse data. In feature level fusion biometric features obtained from different by using multiple sensors or by applying different matching algorithm on the similar sensor data. Feature vectors are of two types, first is homogeneous and another one heterogeneous.

Homogeneous feature vectors are multiple impressions of a single biometric instance from which we calculate single resultant feature vectors by evaluating the weighted average of individual feature vectors [5]. Heterogeneous Feature vectors are obtained by taking different biometric modalities or by applying different feature extraction technique on same biometric. After that we can join them so that single feature vector obtained.

Post–Classification Fusion

In Post classification method fusion of information occurs after matching or classification stage. Post classification integration is group into four stages:

- Abstract level fusion
- Score level fusion
- Dynamic classifier selection
- Rank Level fusion.

In Abstract level fusion or fusion at decision level integration takes place at each decision output of individual matcher [6].

Dynamic classifier method selects the result of different classifier input which is applied on different input data.

In Rank level fusion the output obtained from individual biometric matcher are arranged to form subset of actual feasible matches that are sorted in higher to lower order of confidence called Rank. Ho et al. [7] define three different methods to integrate the ranks allocated by the diverse matchers [8].

The method called Borda count uses the summation of the ranks that are given by the each matchers for calculating the individual rank. Matching score level fusion also known as confidence level or measurement level fusion in which fusion of matching score can be performed at matching score level [9]. Measurement level fusion contain rich set of information about input pattern nextto feature level fusion. This is one of the widely used techniques in multimodal biometric.

For fusing the matcher score two different approaches are taken:

(1) As classification problem
(2) As combination problem.

In classification problem two classes called Accept and Reject are made using the matching scores obtained by different matcher [10].

Accept class consists of group of genuine user and reject class consists of imposter.

As two different classes are there the classifier are able to learn decision boundary. Hence the output scores generated by different modalities does not affect in classification problem.

In combination problem when the matching score are generated from different matchers we need to change the scale and location parameters into common domain so that they go for decision phase. This process is called Score Normalization.

2 Literature Review

Authentication is one of the important process for recognizing and identifying a person. Physiological, physical and behavioural characteristics is one of the way for recognizing people. Password, identity card, smart card is also a way for recognizing people. Fingerprints is one of the oldest method of biometric to identify a person. Bertillon's [11] uses fingerprint in his anthropometry for identification of a person but this process as cumbersome and does not have shown good performance. Rattani et al. [12] fuses face and fingerprints which uses feature level fusion technique. Fusion that occurs before matching or feature level fusion is the fusion before matching but it is very complex and tedious process as feature extraction involves different type of algorithm. Feifei et al. [13] fuses the feature of finger vein and fingerprint does not perform feature level but score level fusion is performed. The on the whole accuracy of the system before fusing the features if accuracy of fingerprint is 96.4%, finger vein is 93.72% but after that result changes having accuracy of the system is 97.74% with False Acceptance Rate of 1.21%, and FaRR of 0.75%. Krishneswari et al. [14] fused palm print as well as fingerprint in which fusion occurs at feature level and by

means of wavelet based image fusion method with minimum approximation. IG or information gain were used to extract features. The average accuracy of verification is 97.33% and the False Acceptance Rate of 1.03%, False Rejection Rate of 0.89% and accuracy of 98%. Good fusion technique is important for fusing information from numerous single biometric systems. In this paper they discusses the performance of sum rule-based score level and support vector machine fusion. The author considered: face, fingerprint and finger vein. A new strong scheme of normalization also called reduction of high-scores Effect normalization which is obtained from corresponding Max–max normalization techniques. By using four dissimilar multimodal databases predicts that high accuracy is formed when we integrates the proposed scheme in SVM-based fusion and sum rule-based fusion. Jameer Basha et al. establish a fresh new idea for fingerprint and iris fusion technique not based on decision level but rank level, After conduction of number of experiments using three fusion methods and regression method i.e. logistic highest rank method, count method or Borda count.

3 Score Normalization

Different Techniques of Normalization:

- Normalization using Min–Max
- Normalization using Biweight estimators
- Normalization using Tanh-Estimators
- Normalization using Decimal Scaling
- Normalization using Median and MAD
- Normalization using Double Sigmoid
- Normalization using Z-Score.

4 Scorelevel Fusion

The Score Level technique of fusion of the matching scores are acquire by the unimodal classifiers in the system. Four different types of classifiers have been taken: weighted Product (Π), weighted Sum (Σ), Support Vector Machines (SVM) and Neural Networks (NN), but in certain state these dissimilar classifiers have complemented with a method called DSS or Dynamic score selection [1].

A. Weighted Sum Techniques—In weighted sum techniques input scores are fused using simple algorithm that uses weighted sum to output final score.

B. Weighted Product—It is little bit a similar to weighted sum. In this technique the fused score is achieve by multiplying weighted scores of unimodal biometric. By comparing resultant score with the threshold decision score is calculated.
C. Neural Network (NN)—Neural network process information like brain. It consists of number of neurons having weight associated with it [15]. Neural Networks help into classification as well as clustering. It is connected with large number of neurons interconnected with each other that performs a certain specific task.
   Neural network consists of three layers one input which takes normalized scores and send it to hidden layer for processing and computation. Neural network performs this task after training by using input vectors taken from different authorized users and from imposters.
D. Support Vector Machine (SVM)—Support Vector Machine algorithm classify the data points distributed in N dimensional plane. The main purpose is to draw a hyperplane and to classify data into distinct classes. In multimodal biometric the input for SVM are matching scores of unimodal biometric modal and the output is the final decision of the user identity. Support Vector Machine also require training to function properly.
   The main component in Support Vector Machine the kernel, which is actually list of algorithm used for complex computation of a problem [16]. The working of SVM is same as Neural Network as it also requires training before taking decision about genuine and imposter.
E. Dynamic Score Selection (DSS)—DSS is a very easy process, added to the end of the classification process to improve the process.
   It consists of two sets of data first is training-set and another one test-set used in Enrollment process and Testing respectively. The "Training" and "Test" blocks correspondingly signify the training and test algorithms of the designated classifier. The result of the test, is set that contains the scores confidences and after that decision result obtained. Threshold value for taking decision calculated in training process.

5 Methodology

Our main aim in this paper is to perform match score fusion of face and fingerprint for verification not for identification, using the Biometric Scores Set Release data set 1 [17]. BSSR1 is actually a set of similarity scores output of one fingerprint system as well as two face recognition systems. This output score is obtained by working on frontal faces and right and left index fingerprints respectively. The statement includes accurate multimodal score numbers, i.e. similarity scores from comparisons of fingerprints and faces of the similar people. In our work we prepared use of Set 1 from BSSR1, which comprises fingerprint scores from the same 317 subjects (Fig. 1).

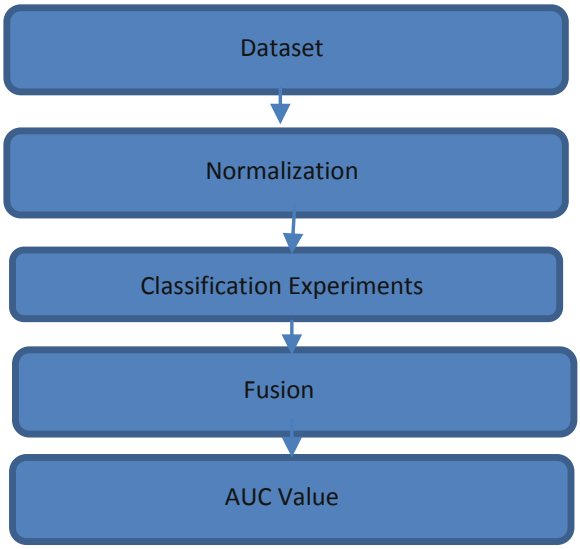

Fig. 1 Methodology of score level fusion

6 Conclusion

Due to constantly decrease in hardware costs or sensors popularity of multi biometric system increases as the need multiple sensors for data acquisition does not incur cost. Due to this the concept of multimodal biometric become popular as it allows getting multiple samples of a single biometric called multi-sample biometrics and/or samples of multiple biometric models like iris fingerprint palm etc. The use of multimodal biometric or multi-sample biometric solve the problem of non-universality and is very useful for a user who does not have a particular biometric, thus enrollment problem is eliminated thus making it universal. In this paper discussed about different levels of fusion technique. As we also consider normalization technique that makes the fusion easy. Fusion techniques occurs prior to matching and afterward matching. Before matching fusion is a difficult process as biometric data are collected from different types of sensor or different types of feature extraction algorithm. In after matching fusion is comparatively easy. But in this fusion of score generated after matching also called score level fusion, is easier compare to fusion after decision. In Score level fusion technique fusion of the matching scores that are obtained by the unimodal classifiers in the system. Four different classifiers have been chosen: Weighted Product (Π), Weighted Sum (Σ), Support Vector Machines (SVM) and Neural Networks (NN). For taking decision threshold value is set and decision are taken on the basis of value nearer to threshold value.

References

1. Nandakumar K, Chen Y, Dass SC, Jain A (2008) Likelihood ratio-based biometric score fusion. IEEE Trans Pattern Anal Mach Intell 30(2):342–347
2. Ulery B, Hicklin A, Watson C, Fellner W, Hallinan P (2006) Studies of biometric fusion. NIST Interagency Report 7346
3. Ross A, Jain A (2003) Information fusion in biometrics. Pattern Recogn Lett 24(13):2115–2125
4. Ho TK, Hull JJ, Srihari SN (1994) Decision combination in multiple classifier systems. IEEE Trans Pattern Anal Mach Intell 16(1):66–75
5. Ross AA, Govindarajan R (2005) Feature level fusion of hand and face biometrics. In: Biometric technology for human identification II, vol 5779. International Society for Optics and Photonics, pp 196–205
6. Joshi T, Dey S, Samanta D (2009) Multimodal biometrics: state of the art in fusion techniques. Int J Biometrics 1(4):393–417
7. Monwar MM, Gavrilova ML (2009) Multimodal biometric system using rank-level fusion approach. IEEE Trans Syst Man Cybern Part B (Cybern) 39(4):867–878
8. Yao YF, Jing XY, Wong HS (2007) Face and palmprint feature level fusion for single sample biometrics recognition. Neurocomputing 70(7–9):1582–1586
9. Snelick R, Indovina M, Yen J, Mink A (2003) Multimodal biometrics: issues in design and testing. In: Proceedings of the 5th international conference on Multimodal interfaces. ACM, pp 68–72
10. Rodríguez LP, Crespo AG, Lara MP, Mezcua BR (2008) Study of different fusion techniques for multimodal biometric authentication. In: 2008 IEEE international conference on wireless and mobile computing, networking and communications, pp. 666–671
11. Fahmy MS, Atyia AF, Elfouly RS (2008) Biometric fusion using enhanced SVM classification. In: 2008 international conference on intelligent information hiding and multimedia signal processing, pp. 1043–1048
12. Ma Y, Cukic B, Singh H (2005) A classification approach to multi-biometric score fusion. In: International conference on audio-and video-based biometric person authentication. Springer, Berlin, Heidelberg, pp. 484–493
13. Fiérrez-Aguilar J, Ortega-Garcia J, Gonzalez-Rodriguez J (2003) Fusion strategies in multimodal biometric verification. In: 2003 international conference on multimedia and expo ICME'03. Proceedings (Cat. No. 03TH8698), vol. 3, pp. III–5
14. Panchal T, Singh A (2013) Multimodal biometric system. Int J Adv Res Comput Sci Softw Eng 3(5)
15. NIST (2015) NIST Biometric Scores Set. 2006. [Online]. Availablehttp://www.nist.gov/itl/iad/ig/biometricscores.cfm. Accessed on 10 May 2015
16. Hall M, Frank E, Holmes G, Pfahringer B, Reutemann P, Witten IH (2009) The WEKA data mining software. ACM SIGKDD Explor Newsl 11(1):10
17. Galbally J, Marcel S, Fierrez J (2014) Image quality assessment for fake biometric detection: application to iris, fingerprint, and face recognition. IEEE Trans Image Process 23(2):710–724

DOA Estimation Considering Mutual Coupling with Fractal Based Array Using Model Based Approach

Priyadarshini Raiguru, R. K. Mishra and Mihir Narayan Mohanty

Abstract The performance of DOA estimation majorly depends on array geometry, SNR and use of Adaptive algorithm. Mutual coupling between the elements has adverse effect on DOA estimation. The sparse array such as MRA (minimum redundancy array), NA (Nested Array), CA (Co-prime Array) gives better accuracy with reduced mutual coupling as compared to ULA. But these sparse arrays are applicable with an assumption of perfect knowledge of signal co-variance matrix. This paper deals with fractal based antenna array optimization using model based approach considering mutual coupling.

Keywords Triabic cantor linear array · Mutual coupling matrix

1 Introduction

Accurate estimation plays a significant role in many defence and civil application. Therefore DOA estimation is an active research area in signal processing. In last few years sparse array processing has received significant attention by increasing numbers of degree of freedom (DOF). Various linear sparse array such as MRA [1], NA [2], CA [3] are used for DOA estimation to enhance degree of freedom. NA is more preferable as compared to others sparse array as it is a hole free non-linear array. However NA approach would lead to mutual coupling problems as compared to other sparse array. Again this sparse array approach can be applied with an assumption of power source for DOA estimation [4].

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In general, the subspace method such as MUSIC and ESPRIT [5, 6], is used for DOA estimation as it gives accurate estimation as compared to other conventional methods. But the application of these technique is limited to real system as it requires precise knowledge of the received signal impinge on array.

Mutual coupling generally affects the array manifold which influences on performance of system. Under this challenging scenario Model based method may provide reasonable DOA estimation. In model based approach the model parameters are estimated by different adaptive algorithm such LMS, NLMS and RLS algorithm [7–9].

Fractal antenna array is a compact and multi-band antenna element design technique. The analysis and design of fractal elements is given more importance in literature survey and it's theory is applied to design antenna array, radiation pattern computation and adaptive beam-forming scheme [10–12].

This paper focuses on performance of Triadic Cantor linear fractal array for DOA estimation considering mutual coupling by using model based.

In this paper Sect. 1 reviews on Cantor linear fractal array approach, Sect. 2 outlines on signal model with mutual coupling and model based approach using NLMS algorithm is focused in Sect. 3. Section 4 provides simulation results to compare the performance of Triadic Cantor linear array considering mutual coupling and Sect. 5 concludes the paper.

2 Triabic Cantor Linear Array

The basic triadic Cantor array is one of the most common method to construct fractal array which follows cantor set. It can be formed by constructing a generating subarray.

A generating subarray consists of three elements with inter-element spacing $d = \lambda/4$. The centre element is turned off. 1 represents existence of element and 0 represents non-existence of element As shown in Fig. 1. The larger fractal array can be formed recursively by replacing 1 as '101' and replacing 0 as '000' at each growth stage of the construction. The array geometry can be formed at second stage as 101000101 and at third stage as 101000101000000000101000101.

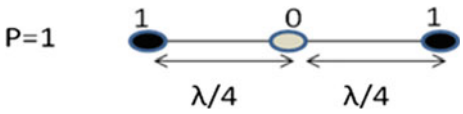

Fig. 1 Geometrical representation of generating array

The array factor of deterministic fractal array may be expressed as

$$AF_P = \prod_{p=1}^{P} g(\delta^{p-1}\psi) \tag{1}$$

where $g(\psi)$ is the array factor of generating subarray, δ is the scale or expansion factor and P is the numbers of growth stages.

The array factor of Cantor linear array by choosing $\delta = 3$ and at third stage (P = 3) can be expressed as

$$AF_p = \prod_{p=1}^{3} GA(3^{p-1}\psi) \tag{2}$$

where

$$\psi = kd(\sin\theta - \sin\theta_0) \tag{3}$$

And

$$k = 2\pi/\lambda \tag{4}$$

This array factor in (2) can be simplified as

$$AF = I_m^p \sum_{m=1}^{M} e^{j(m-1)(kd\ \sin\theta+\beta)} \tag{5}$$

where M represents numbers of elements, p denotes different growth stages and β is progressive phase shift constant. Equation (2) is the simplified mathematical expression of array factor which can be effectively used to estimate direction of arrival of sources using different adaptive techniques.

3 Signal Model with Mutual Coupling Matrix

It is assumed that array receives L numbers of narrow band sources from $\theta_1, \theta_2, \ldots \theta_k$ directions, where θ is azimuth angle. Considering mutual coupling, The received signal is given by

$$x(t) = CAs(t) + n(t) = \widetilde{\mathrm{A}}s(t) + n(t) \tag{6}$$

where *s(t)* is a $L \times 1$ signal vector and $n(t)$ is an $M \times 1$ white Gaussian noise vector. $\widetilde{\mathrm{A}} = CA$ and A is the array manifold given by,

$$A = [a(\theta_1), a(\theta_2), \ldots a(\theta_k)] \tag{7}$$

where $a(\theta)$ is the steering vector and C is the $M \times M$ mutual coupling matrix. The mutual coupling matrix C can be obtained as follows,

$$\langle C \rangle_{b1,b2} = \begin{cases} c_{|b_1 - b_2|}, \; if |b_1 - b_2| \leq B, \\ 0, \qquad otherwise, \end{cases} \tag{8}$$

where $b_1, b_2 \in S$ and coupling co-efficient $c_0, c_1, \ldots c_B$ satisfy $1 = c_0 \rangle c_1 \rangle \ldots \rangle c_B$. The coupling coefficients are used as follows: $c_0 = 1, c_l = c_1 e^{-j(l-1)/8}/l, 2 \leq l \leq B$. For weak mutual coupling $c_1 = 0.1e^{j\pi/3}$ and $c_1 = 0.3e^{j\pi/3}$ can be considered. In the matrix c_0 is self-coupling and l denotes the coupling between the elements. For eight element Cantor linear array by considering $l = 2$ the mutual coupling matrix is given by

$$C = \begin{bmatrix} c_0 & c_1 & c_2 & 0 & 0 & 0 & 0 & 0 \\ c_1 & c_0 & c_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & c_2 & c_0 & c_1 & 0 & 0 & 0 & 0 \\ 0 & 0 & c_1 & c_0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & c_0 & c_1 & 0 & 0 \\ 0 & 0 & 0 & 0 & c_1 & c_0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & c_0 & c_1 \\ 0 & 0 & 0 & 0 & 0 & 0 & c_1 & c_0 \end{bmatrix} \tag{9}$$

4 Model Based Approach for DOA Estimation

The received signals is assumed as stationary process and synthesized by the AR processor for model parameter estimation as shown in Fig. 2. The first element of array is taken as reference and the signal received by reference antenna is $d(n)$ [13]. The signal received by others antenna, $x_q(n)$ is considered as input to the model to predict desired signal.

The mathematical expression of output signals and error is given by

$$y(n) = \sum_{q=1}^{M} w_q x(n-q) \tag{10}$$

$$e(n) = d(n) - y(n) \tag{11}$$

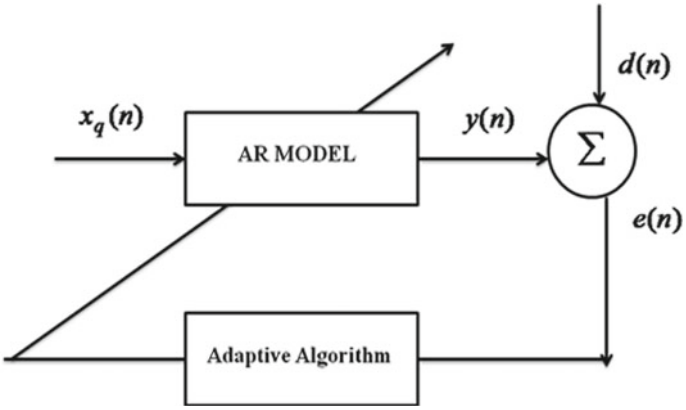

Fig. 2 Model based structure

As NLMS algorithm gives faster converges, in this paper NLMS algorithm is used to update the set of model parameters W and also to minimize the error [13].

The power spectrum $S(\theta)$ can be computed as

$$S(\theta) = \frac{1}{W^H \widetilde{\mathrm{A}}(\theta) \widetilde{\mathrm{A}}^H(\theta) W} \tag{12}$$

where $W = [1 - x^T]^T$

Power spectrum can be computed by scanning a scan vector over all possible angles.

When it matches with the DOA of received signal the denominator of power spectrum becomes very small which results sharp peak corresponding to the DOA.

5 Result Analysis

The performance of the Cantor linear array with mutual coupling is analyzed by using model based approach.

Case: 1

The basic triadic Cantor array is considered for DOA estimation. The radiation pattern of normalized array factor for different growth stage is of the array is plotted in Fig. 3.

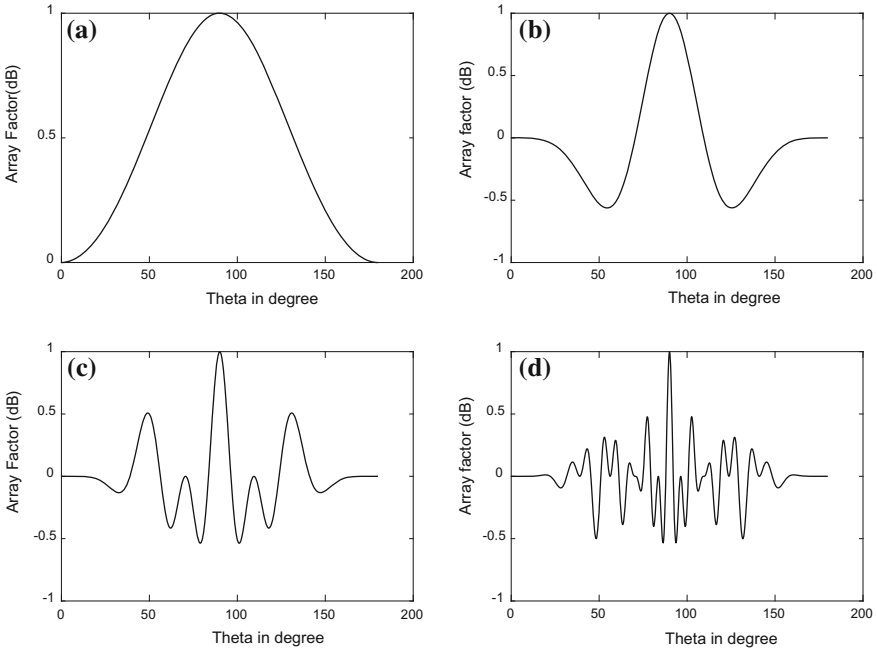

Fig. 3 Normalized far field radiation pattern of triadic Cantor array for **a** first stage, **b** second stage, **c** third stage, **d** forth stage

Case: 2

A Cantor linear array consists of $M = 8$ elements is considered and seven signals from different direction such as $\theta = [10°, 20°, 30°, 40°, 50°, 60°, 70°, 80°]$ are impinging on array. Figure (4) shows the DOA estimation of 7 signals on the array at 0° dB SNR without mutual coupling.

As shown in Fig. 4 NLMS algorithm can resolve 7 sources sufficiently well at low SNR. But practically closely spaced antennas are affected by mutual coupling. So DOA estimation of 7 signals are observed with the presence of weak and strong mutual coupling at low SNR.

Figure 5 shows the affect of mutual coupling on DOA estimation. In weak mutual coupling 5 DOA can be estimated accurately. Performance of DOA estimation is poor in the case of strong mutual coupling as compared to weak mutual coupling.

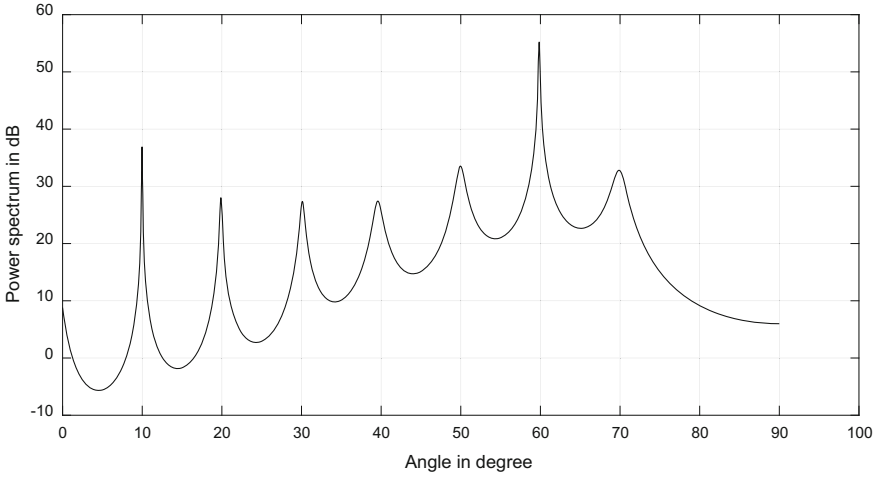

Fig. 4 DOA estimation of 7 signals without considering Mutual coupling using NLMS algorithm at SNR = 0 dB

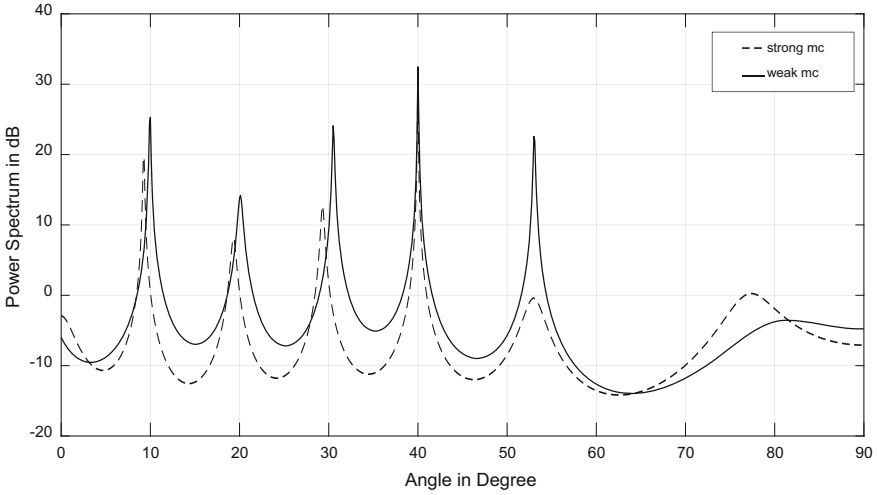

Fig. 5 Plot of DOA estimation with presence of weak and strong mutual coupling at SNR = 0 dB

In this case two signals with small angle separation impinge on Cantor linear array. Figure 6 shows the resolution between two impinging signals at different mutual coupling conditions.

As shown in Fig. 6 with 5° separation DOA can be accurately estimated without mutual coupling using NLMS algorithm. But as the mutual coupling is considered, resolution is affected.

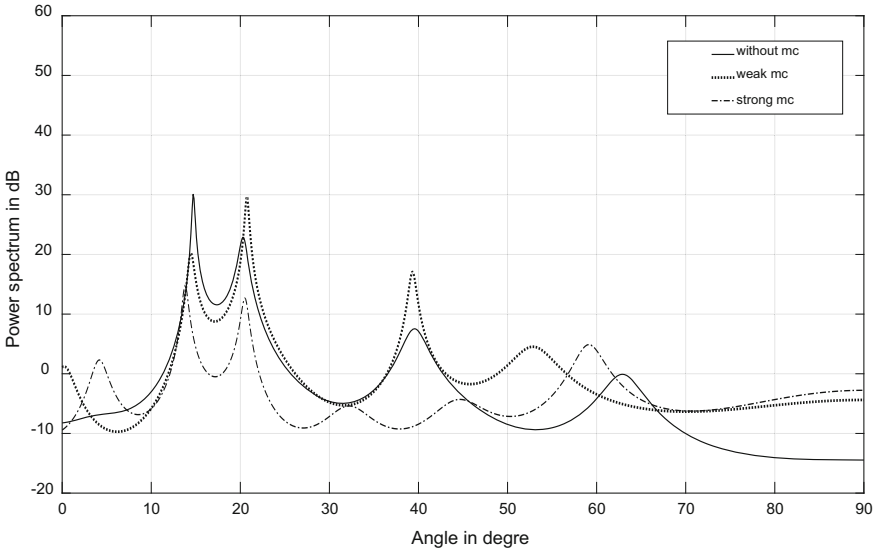

Fig. 6 Resolution of DOA estimation of Cantor linear array in the presence of different mutual coupling at SNR $= 0$ dB

6 Conclusion

This paper is based on the DOA estimation of signals, impinge on fractal based array by considering mutual coupling. Model based approach using NLMS algorithm is applied at low SNR. The simulation results shows that array factor is affected by mutual coupling.

References

1. Moffect A (1968) Minimum–redundancy linear arrays. IEEE Trans Antenna Propag 2:172–175
2. Vaidyanathan PP, Pal P (2010) Nested array: a novel approach to array processing with enhanced degrees of freedom. IEEE Trans Signal Process 2
3. Vaidyanathan PP, Pal P (2011) Sparse sensing with co-prime samplers and arrays. IEEE Trans Signal Process 2
4. Yang M, Haimovich AM, Yuan X, Sen L, Chen B (2018) A unified array geometry composed of multiple identical subarrays with hole free difference coarrays for underdetermined DOA estimation. IEEE Access 6:14238–14254
5. Rangarao KV, Venkatanarasimhan S (2013) Gold- MUSIC: a variation on MUSIC to accurately determine peaks of the spectrum. IEEE Trans Antennas Propag 4
6. Roy R, Kailath T (1989) ESPRIT-estimation of signal parameters via rotational invariance techniques. IEEE Trans Acoust Speech Signal Process 7
7. Haykin S (2002) Adaptive filter theory, 4th edn. Prentice Hall

8. Shengkui Z, Zhihong M, Suiyang K (2006) Modified LMS and NLMS algorithm with a new variable step size. In: IEEE 2006 9th international conference on control, automation, robotics and vision, pp 1–6
9. Jianhua L, Jing L (2010) A novel based variable step size LMS algorithm based on decorrelation. In: 2010 3rd international congress on image and signal processing (CISP), pp 3291–3294
10. Werner DH, Haupt RL, Werner PL (1999) Fractal antenna engineering: the theory and design of fractal antenna arrays. IEEE Trans Antenna Propag 41:37–59
11. Karmakar A, Ghatak R, Mishra RK, Poddar DR (2015) Sierpinski carpet fractal-based planar array optimization based on differential evolution algorithm. J Electromagn Waves Appl:247–260
12. Basikolo T, Ichige K, Arai H (2018) A novel mutual coupling compensation method for under-determined direction of arrival estimation in nested sparse circular arrays. IEEE Trans Antenna Propag:69909–69917
13. Grice M, Rodenkirch J, Yakovlev A, Hwang HK, Aliyazicioglu Z, Lee A (2007) Direction of arrival estimation using advanced signal processing. In: 2007 3rd international conference on recent advances in space technologies, pp 515–522

Estimation of Solar Irradiance on a Contoured Platform for Optimized Solar Power Generation

Kuntal Ghosh, Smriti Gupta, Sabita Pal and Sirshendu Arosh

Abstract Now-a-days, applications of flexible solar photovoltaic technologies are emerging in the fields of portable applications (solar tent, solar canopy, solar aircraft etc.). Easy integration with any contoured surface and lightweight property makes flexible solar PV technology (Amorphous Silicon, thin-film Silicon, Dye sensitized solar cell) to be a potent solution for multipurpose conditions. However, contour surface produces variable tilt on the SPV modules which causes non-uniform illumination on the integrated SPV array. Further, this leads to significant loss in power generation which requires optimization. This article carries out a numerical study to investigate the effect of surface contour on the incident solar irradiance and a devise a methodology for solar PV array layout strategy to reduce the power loss due to non-uniform illumination.

Keywords Non-uniform illumination (NUI) · Contour angle · Solar photovoltaic (SPV) · Dynamic module fill factor (DMFF)

1 Introduction

Rapid advancement of photovoltaic technology over the period of time leads to integrated SPV based applications in the fields of solar vehicle, solar tent, solar aircraft, solar textile etc. These automated technologies require technology aware unconventional PV system design and complex integration process to fulfill operational

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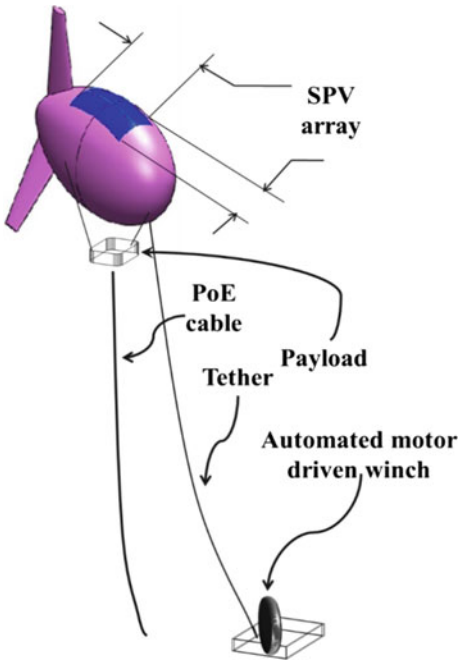

Fig. 1 System diagram of Solar PV integrated lighter-than-air platform

power requirements. Here unconventional PV system means where solar PV modules are experiencing variable tilts and orientations around the installation structure. Predominantly, two important parameters solar irradiance and PV module temperature determine the power generation. However, incident solar irradiance over the area of PV system installation plays an effected role while harnessing maximum power. Hence solar irradiance forecasting becomes an omnipotent task for optimized power generation on unconventional PV system. In this context, flexible PV module technologies are widely explored to mount on a contoured surface. Solar powered lighter-than-air platform is found to be major application where PV modules are mounted on the contoured surface. These platforms are often stationed over cloud region under clear sky conditions to carry reconnaissance and surveillance at coastal and international border areas, communication link setup in remote areas, exploration of rare earth minerals and water for geological survey and geographical information system setup for geographical mapping of forest, rural, urban and semi urban areas. Steady and uninterrupted electrical power supply is required for these applications which is practiced to be generated in situ, i.e. on the airship or aerostat, preferably through a solar photovoltaic (SPV) modules (Fig. 1).

The concept of power generation deploying a low altitude airborne platform has first been explored by Glaser et al. where the feasibility of harvesting solar energy using large satellites and transmitting it to the ground via microwave radiation have been investigated [1]. Further, this idea has been consolidated by Mankins et al. for low earth orbit (LEO) satellites and geo-stationary satellites (GEO) [2]. However,

technical issues pertaining to the losses in the energy conversion and transmission and implementation cost have been figured out to be disadvantageous. Then Aglietti et al. [3] proposes the concept of high altitude aerostatic platform (HAAP) deployed at 6 km altitude to harness solar power [4] which overcomes the aforementioned problems. Since this HAAP generates power above the clouds and transmits it to the ground through a cable to harness the advantage of higher solar irradiance compared to ground based PV systems. This has a significant advantage in high latitude countries where peak sun hours are only between 2.5 and 4.85 h [3, 5]. Further research in this area explored power transmission losses, control strategy for positioning the aerostat at a certain location and orientation along with its economic viability [3, 5–7].

Previous research in this area includes a feasibility study of power generation by integrating a flexible amorphous-Si solar module on a curved surface [8–10]. They have explored the effect of surface contour angle on power generation of an amorphous-Si SPV module. However, this phenomenon is yet to be explored in the context of incident solar irradiance on the contoured surface to estimate its maximum power generation ability. Non-uniform illumination (NUI) is an inevitable phenomenon which solely affect the onboard power generation on the SPV integrated lighter-than-air platform (LTAP). This work conducts a numerical study to characterize incident solar irradiance on a contoured platform in the context of LTAP.

2 Methodology

Sharma et al. demonstrated the concept of contour angle which nonetheless an inclination angle w.r.t horizontal plane where SPV modules are mounted [9]. This angle could be taken mean reference point of the SPV module, represented in the following figure (Fig. 2).

These different angles on a contoured surface receive distinct solar irradiance across the entire surface, which incurs significant losses in P-V performance. These

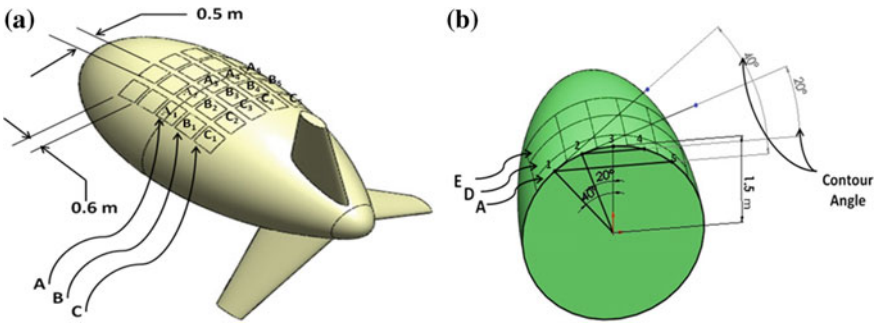

Fig. 2 Representation of contour angle on SPV-LTAP

angles are termed as contour angle (CA). Hence the study of structural morphology is the first step to estimate characteristics overall solar insolation on a contoured plane.

Next, Effective solar insolation on any tilted surface is an integration of 3 types of irradiance which are

(a) Beam radiation (I_b): This radiation is main source of incident solar irradiance on SPV array which contributes 85% of the total irradiance.
(b) Diffused radiation (I_d): Diffuse solar radiation attributes to aerosol, suspended particles present in the surrounding climatic conditions.
(c) Reflected radiation (I_r): The radiation which cannot penetrate the medium and got reflected to be known as reflected radiation.
Each radiation is compounded by corresponding factors to estimate incident solar insolation on a tilted surface which are categorized below.
d) Tilt factors for,

- Beam radiation (r_b)
- Diffused radiation (r_d)
- Reflected radiation (r_r)

Total incident solar irradiance on a particular tilt is given by [11],

$$I_t = I_b r_b + I_d r_d + I_r r_r \tag{1}$$

Furthermore these r_b, r_d and r_r is denoted by

$$r_b = \frac{\sin\emptyset(\sin\delta\cos\beta + \cos\delta\cos\gamma\cos\omega\sin\beta) + \cos\emptyset(\cos\delta\cos\omega\cos\beta - \sin\delta\cos\gamma\sin\beta) + \cos\delta\sin\gamma\sin\omega\sin\beta}{\sin\emptyset\sin\delta + \cos\uparrow\emptyset\cos\delta\sin\omega} \tag{2}$$

$$r_d = \frac{1+\cos\beta}{2} \tag{3}$$

$$r_r = \frac{\rho(1+\cos\beta)}{2} \tag{4}$$

where,

δ = Declination angle, β = Tilt angle, ϕ = Lattitude, ρ = Reflectivity of the surface, γ = Azimuthal angle, ω_s = Hour angle.

Using the above empirical equations, distribution of solar irradiance on a contoured plane can be estimated. Further this solar insolation information helps to characterize power generation by mounted solar PV array mounted on such architecture.

3 Result and Discussion

This section incorporates findings on distributed solar irradiance on a contoured architecture. In this work it is found that change in solar irradiance is minimum on 0° contoured region in comparison with rest of contoured region. However, maximum

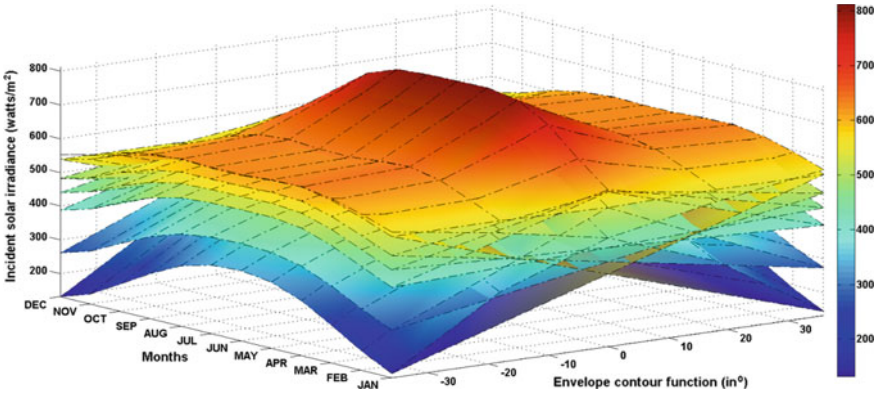

Fig. 3 Distribution of solar irradiance on a symmetric contoured plane ranging from 0° to 40°

solar irradiance is received if the SPV architecture is placed at locations latitude. Following result depicts that 0° contoured or horizontal surface receives higher daily average solar irradiance with respect to tilted surface. In this result, the solar irradiance distribution for each month in a calendar year has been shown (Fig. 3).

Furthermore, this study has been carried forward to measure daily average solar insolation on a contoured architecture ranging from 0° to 60°. This result shows the precedence of 0° contoured region which receives maximum solar insolation throughout the day irrespective of sun's position. In addition, the following result also finds the daily average solar irradiance is also limited near the 0° contoured region in against other contour angles. Post 15° contoured region solar irradiance is drastically reduced by more approximately ~30%. This study estimates the daily average solar irradiance for each month at Bhubaneshwar, India having the latitude 20.29° N (Fig. 4).

In order to consolidate the impact of solar irradiance on a contoured plane, a power generation study of solar PV modules is characterized at such contour. It has been found that a SPV array mounted on a contoured structure where each SPV modules are mounted at distinct contour would receive different solar insolation. This phenomena leads to distinct fill factor generation at solar PV modules mounted at different contours depicted in the following Fig. 5. In that result, power loss of 20% has been recorded at 15° contour angle. This result records exponential power generation due to contour. Due to non-uniform structural layout, imbalanced power generation is observed. Predominantly power generation of SPV array is characterized by fill factors (FF), which can be distinguished at every contour angle irrespective sun's position and module temperature. Because the impact of irradiance is felt in short duration against the module temperature, fill factor predominantly controlled by solar irradiance. Hence these fill factors are defined as Dynamic module fill factor (DMFF) which are scheduled to change with the positioning of the sun.

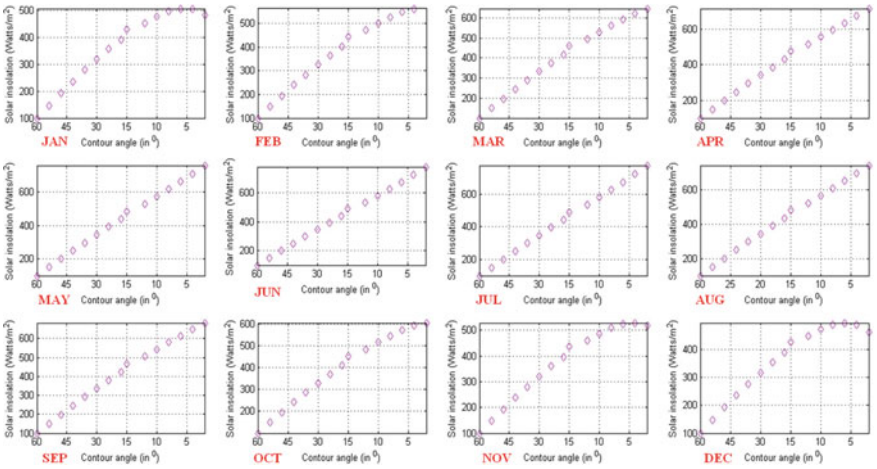

Fig. 4 Daily average solar irradiance on a contoured plane ranging from 0° to 60° at Bhubaneshwar, India

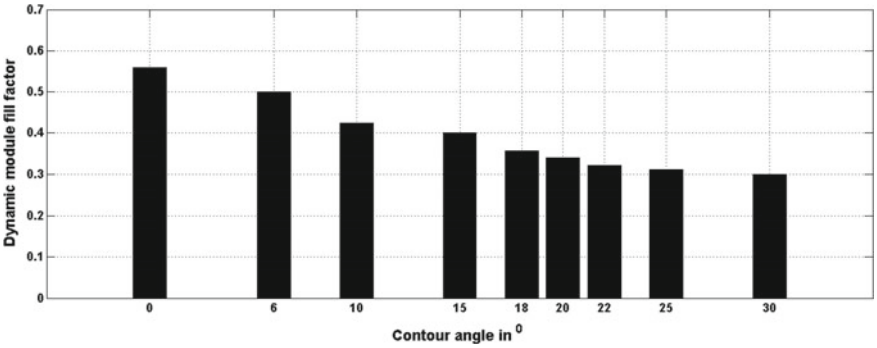

Fig. 5 Dynamic module fill factor of SPV array mounted on a contoured plane

4 Conclusion

The above study concludes that structural layout of SPV modules on any contoured surface in the context of LTAP system plays a significant role in power generation ability on that architecture. Non-uniform illumination (NUI) is an inevitable phenomenon on a contoured surface, which has to be incorporated in the performance of mounted SPV modules on it. The NUI on a contoured layout is represented in terms of contour angles. Moreover this NUI on SPV array causes non uniform power generation with respect to positioning of sun which is described in terms of dynamic

module fill factor (DMFF), which is further compared with the contour angles. The performance of piecewise linear SPV array layout on a contoured surface is a cumulative effect of those individual dynamic module fill factor (DMFF) for entire SPV array. Overall this study helps to plan a SPV array layout on a variable tilted surface to reduce the loss due to the NUI.

References

1. Glaser PE, Maynard OE, Mackovciak JJR, Ralph EI (1974) Feasibility study of a satellite solar power station
2. Mankins JC (1997) A fresh look at space solar power: new architectures, concepts and technologies. Acta Astronaut 41:347–360
3. Aglietti GS, Markvart T, Tatnall AR, Walker SJ (2008) Solar power generation using high altitude platforms feasibility and viability. Prog Photovoltaics Res Appl 16(4):349–359
4. Aglietti GS, Markvart T, Tatnall AR, Walker SJ (2008) Aerostat for electrical power generation—concept feasibility. Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering 222(1):29–39
5. Aglietti GS, Redi S, Tatnall AR, Markvart T, Walker SJI (2010) Aerostat for solar power generation. In: Solar Energy. InTech
6. Aglietti GS, Redi S, Tatnall AR, Markvart T (2008) High altitude electrical power generation. WSEAS Trans Environ Dev 4(12):1067–1077
7. Aglietti GS, Redi S, Tatnall AR, Markvart T (2009) Harnessing high-altitude solar power. IEEE Trans Energy Convers 24(2):442–451
8. Gajra KM, Pant RS (2014) SoPTAS: solar powered tethered aerostat system. In: IEEE 2014 1st international conference on non conventional energy (ICONCE), pp 65–68
9. Sharma P, Patnaik B, Duttagupta SP, Agarwal V (2010) Dynamic power optimization of contoured flexible PV array under non-uniform illumination conditions. In: 2010 35th IEEE photovoltaic specialists conference (PVSC), pp 968–972
10. Ghosh K, Duttagupta SP, Guha A (2017) Power generation with a solar photovoltaic module-integrated lighter-than-air platform at low altitudes. Energy Convers Manag J 154:286–298

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