Smart Healthcare Management Framework

D. Vidyadhara Reddy and Divakar Harekal

Abstract Healthcare IT has emerged as one of the basic necessities of life. Information technology could provide the solutions for various health ailments. It is done by processing numerous health parameters of the individual. These parameters could be measured using different electronics devices to keep up the health record and notify the individual and the doctor about any aberrations. Due to growing population and urbanization, various life style health problems are on the rise. Majority of the healthcare devices work in silos. Hence health vitals recorded remain locally stored and enhance the chances of data getting loss. By interconnecting these devices, we could maintain the health records centrally and derive insights. This could be incorporated with the advanced wireless technology. Smartphones could be leveraged for smart functionalities like voice recognition and Google services available. In this project, we are integrating the glucose meter monitors with the wireless communication to take advantage of the IoT technology and collect the blood sugar readings from the different individual, store them and provide the insights based on the health of the individual.

Keywords Healthcare · Communication system · Insights

1 Introduction

Healthcare systems, that measure, monitor and provide solutions for various types of health issues. With the help of these healthcare systems there has been a greater improvement in the quality of our life of each individual. Due to the advancement in electronics from past several years, various healthcare devices that help in

D. Vidyadhara Reddy (✉) · D. Harekal
Department of Computer Science, MS Ramaiah Institute of Technology, Bangalore, India
e-mail: vidhureddy02@gmail.com

D. Harekal
e-mail: divakar.h@msrit.edu

M.S. Reddy et al. (eds.), *International Proceedings on Advances in Soft Computing, Intelligent Systems and Applications*, Advances in Intelligent Systems and Computing 628, https://doi.org/10.1007/978-981-10-5272-9_28

monitoring and tracking our health parameters are developed, used, and have found considerable success.

Even though these devices help up in maintaining our health vitals they are independent in providing their support. Due to the aging of population, more and more of such devices are being used and they generate the huge health data that is stored individually and possibility of loss of this health data is high, which is critical.

The idea is to primarily integrate and maintain the health data obtained from the various heterogeneous healthcare devices centrally which are inter dependent to each other. Second, by integrating these devices and collecting all the health data we can provide the valuable insights to make it useful and easy for the doctors, caretakers or any health personals to monitor and manage the health of each individual.

With the advances in the networking technologies, the primary task can be easily fulfilled by the new and rigorous growing technology called Internet of Things. Internet of Things (IoT), as the name suggests, is the idea to connect various things (technically devices) to form a network where they can share their individual information. This Internet of Things reflecting its use cases in various fields of the technology can also step into the health care to provide the significant support in the integrating the healthcare devices. As the architecture of the Internet of Things varies with the scenario of the application in which it is implemented, health care can have its own framework to maintain the health data from the different health care devices.

As the data from the various sources grew to be called as a "big" data, also the various analytical methods were developed and implemented to process this structured and unstructured, unused data. The analytical tools integrate, select, and apply the various techniques such as predictive analysis, text analysis, and so on, to process the data into certain form which aid us in proper decision making. This data analysis can be applied on the big health data, which reflects the various health parameters of the individual, to process the health parameters at different times and provide the insights on the health vitals that support the doctors, caretakers, and other family persons to decide on future steps to be taken to maintain the individual's health.

2 Literature Survey

Nowadays people prefer to stay in homely comfort and expect their medications in their homely environment. This healthcare service provided by the organization maybe in the form of prescription, medications, or insights. Maintaining long-term healthcare treatment for the growing elderly population and escalating healthcare expenditure pose a challenge to the current healthcare system.

Due to advancement in the healthcare systems there are different ways to provide healthcare services to the people. In the healthcare information systems using agent

technology [1], they have proposed the architecture that has many agents and these agents are used for obtaining the expertise results. The interface agent will filter the unwanted information provided in the report and will communicate the essential information the user. Doctor agent will receive test result report, receive unread test results alerts, informs about the available test results, query, and receive diagnosis suggestions. Prescription agent will electronically generate the prescription and will search for the availability of medications and will monitor the patient's medication and will eliminate patient's waiting time. Mobile agent will search, retrieve, and deliver data to the other agents or to the user. Lab agent will interface with the equipments and will provide real-time report on the examined. Diagnostic agent will select the method of treating the patient according to the data collected. Mobile device agent will provide an application where the patient's essential data can be entered. Home patient agent is a mediator who will do routine medications and will send the abnormal situations and receive emergency medications to the patient. Schedule agent will schedule the doctor's appointment for the patient and also will reschedule the time according to the emergencies. Electronic Health Record (HER) agent is an integrated database holding patient's relevant digital information.

The advancement in communication, data analysis, and information storage has decreased the mortality rate of the people. The health care is the challenging section for every country, in its social and economic state. The health care is the section where there will be more spiraling of cost for medications. Using IoT there are many devices that are connected, where the devices that connected to internet will exceed the number of people present on earth. The healthcare devices that are connected to the internet can be used by the people who are willing to require the homely comfort and also the doctor's assistance [2].

For the regular monitoring of the patient, these healthcare devices need to be connected to the internet. The IoT is revolutionizing networking in exponential rate over applications, including sensing, enhanced learning, e-health, and automatic applications. The architecture of H3 IoT is used because it is more convenient for e-health, where the homely environment for monitoring health status of the patients is easier [3, 4].

The H3 IoT architecture is confined to very small area where all the healthcare devices are connected to the centrally microcontroller, using Bluetooth or zigbee technology which has the communication range of only few meters and the devices out of this range cannot communicate.

Nowadays we find many patients who are bedridden, paralyzed, suffering from Alzheimer's disease, and they don't have anyone to look after them. They require assistance of any other people and even if they have someone to take care of them they need assistance for home health care. When the patient is in critical condition the people who are with the patient may not know what is actually happening with the patient, for example, high BP, low BP, extremes of sugar level, etc. These cannot be known by the assisting people. The healthcare devices need to be connected to the internet.

One of the approaches to monitor patient's health is by devices connected to android smartphone where there is an application which will monitor the health of the patients and that application will provide the caretaker the daily status of the patient through android smartphone. It has few liabilities like the user should have the android smartphone and the application to which the devices communicate with, and also the android smartphone or the healthcare devices may go out of range of communication [5].

There is much of the raw data related to the health care in today's world. This healthcare data originates from the various sources such as healthcare devices, institutions, and various agencies. They need to be processed with various analytical tools such as Mahout, Pig, and Hive, which can help in the better analysis. The health data should be carried through the analytical phases such as data standardization, data integration, data selection, data analysis, and data visualization. Standardization of the big health data is achieved with the help of standard terminology system such as SONMED, MESH, which yield the consistent interpretable data. Integration and selection can be done by achieved by the various approaches such as the data warehousing approach, virtual data integration, so on. Finally, the system needs to handle various algorithms for data analysis and provide various kinds of graphical data visualization to users [6].

3 Smart Healthcare Management Framework

Healthcare devices that measure and monitor various health vitals are helping the doctors, caretakers, and the individual himself to keep up health. But these devices are in silo and can manage the health vitals locally. On the other hand, the advancement in the wireless communication systems is making the significant progress with a goal to connect each and every thing or person through the evolving IoT. Healthcare can make use of these advances and make the healthcare devices remotely maintain the health data. Various architectures are proposed to connect the healthcare devices which are either dependent on the fixed control system to transmit data or data feeding is done manually. This framework makes the healthcare devices smart by enhancing their independent functionality to communicate with the central system. The central system may be specific to the health vital or to all of the health vitals of the individual. This overcomes the dependency of the healthcare devices on the external device for communication across the internet. The block diagram of the framework is shown in Fig. 2. The overview of the framework explains the different platforms on which the framework works and services carried out on the client/server model (Fig. 1).

The framework aims at making all the healthcare devices individually remote by equipping the devices with the separate communication system, which communicates with the central server that maintains all the health parameters of the individual person which help in maintaining their health in the far better way.

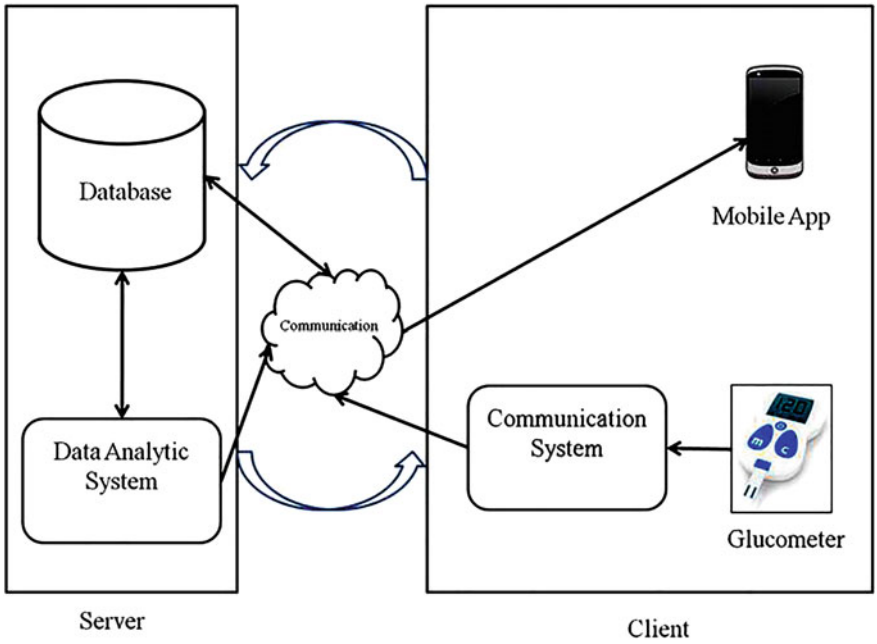

Fig. 1 Overview of the framework

This central system provides the easy access to the doctors and the caretakers with the person's health information and makes their task easy. The architecture proposed in this framework is simple and has five layers of operations. Each of the layers is independent of their platform on which they operate.

3.1 Physical Device Layer

All the healthcare devices that measure various health vitals are part of this layer. Each healthcare device such as blood glucose meter, digital thermometer, weighing scale, and so on, sense and measure different health parameters based on their functionality. This health data is sent to the above layers.

3.2 Physical Processing Layer

This layer is responsible for processing the data that is retrieved from the lower layer. Various microcontrollers with functionality to retrieve the data from the healthcare devices via serial communication or any possible communication

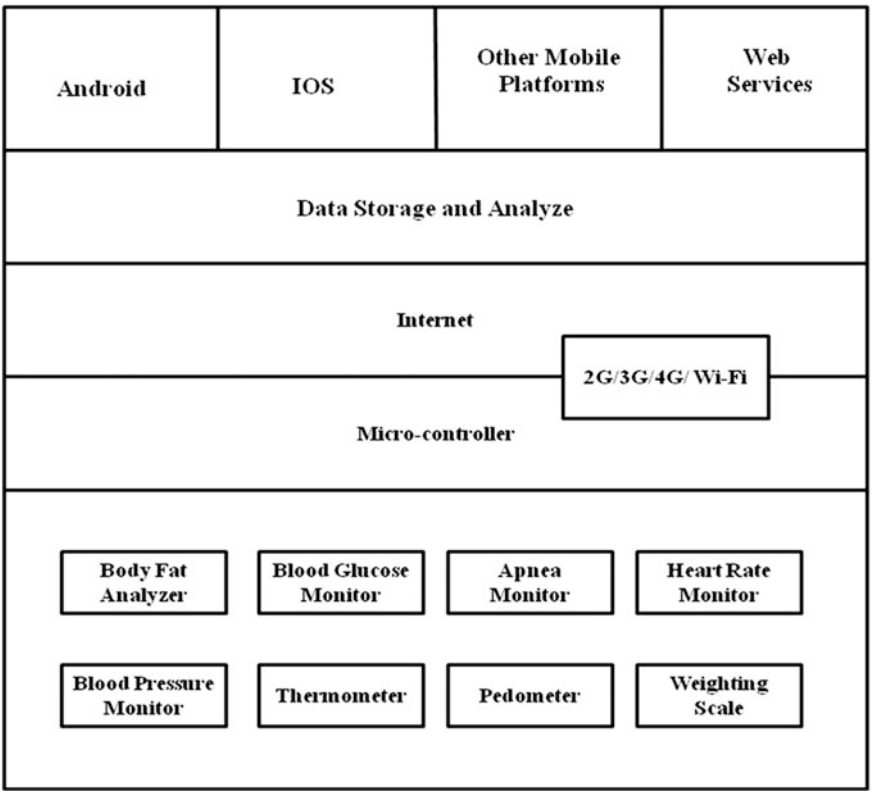

Fig. 2 Layered architecture of the framework

paradigm are being interfaced with devices in lower layer. These microcontrollers should also have the functionality to send the data to the central server through the 2G/3G using the GSM standard. This is the important layer in the framework which acts as the interface between the hardware and the software.

3.3 Internet Layer

Internet of Things, as the name implies, uses the internet as the network to exchange the data between the devices that are in various remote areas. This layer describes the services that act as carrier of the health data obtained from the different healthcare devices that are in the different networks. The health data obtained is transferred to the central server to provide the services of the above layers.

3.4 Data Storage and Analyze

Health data obtained to the server is to be refined and stored in a manner which can be helpful for analyzing the data in the future. Various RDBMS systems such as MySQL, Oracle database, and various cloud service providers such as Amazon S3, Google Drive can be used to store the data. Data that is stored is analyzed by using the various data analytical techniques, based on the requirement, and the insights on the data are being generated. These insights convey the status of the person's health parameters and provide suggestions on further diagnosis to gone through so as to keep up his health.

3.5 Mobile Application Layer

Various mobile application development platforms such as the Android, iOS, Windows, so on can be used to develop the mobile applications to provide the user with fast and easy access to his health status. These applications interact with the user to collect certain basic information from the user and provide the insights on his health. Web services are provided where the user can access his health status, in case if the user is not exposed the mobile applications.

4 Conclusion

Integration of the healthcare devices can be achieved using the various trending technologies like Internet of Things. By integrating, we can collect the health data from all the devices, store, and make the data available to various heath personals who are interested. Also we can provide the insights on the data using the analytics. This framework provides the layered approach of integrating the healthcare devices by making each of the devices to remotely communicate with the central server, which provides the functionality of structured data storage and data analysis to generate the insights on the health data.

References

1. Omar Al-Sakran, Hasan. 2015. *Framework Architecture for Improving Healthcare Information Systems Using Agent Technology*, 17. doi: 10.5121/ijmit.2015.7102.
2. Chiuchisan, Iuliana, Hariton-Nicolae Costin, and Oana Geman. 2010. *Adopting the Internet of Things Technologies in Health Care Systems*. 978-1-4244-8217-7110/$26.00 ©201O IEEE.
3. Ray, Partha P. 2014. *Home Health Hub Internet of Things* (*H3 IoT*): *An Architectural Framework for Monitoring Health of Elderly People*. 978-1-4799-7613-3/14/$31.00 ©2014 IEEE.

4. Memon, M., S.R. Wagner, C.F. Pedersen, F. Hassan AyshaBeevi, and F. Overgaard Hansen. 2014. Ambient Assisted Living Healthcare Frameworks, Platforms, Standards, and Quality Attributes. *Sensors* 14 (4312–4341): 2014.
5. Hennessy, Mark, Chris Oentojo, and Steven Ray. 2013. *A Framework and Ontology for Mobile Sensor Platforms in Home Health Management*. 978-1-4673-6333-4/13/$31.00 c 2013 IEEE.
6. Cha, Sangwhan, Ashraf Abusharekh, and Syed S.R., Abidi. 2015. *Towards a 'Big' Health Data Analytics Platform*. 978-1-4799-8128-1/15 $31.00 © 2015 IEEE.
7. Huang, Yinghui, and Guanyu Li. 2010. Descriptive Models for Internet of Things. In *International Conference on Intelligent Control and Information Processing* 13–15 Aug, 2010—Dalian, China, 978-1-4244-7050-1/10/$26.00 c2010 IEEE.
8. Pedro Diogo, Luís Paulo Reis, and Nuno Vasco Lopes. *Internet of Things: A System's Architecture Proposal*.
9. Syaifuddin, Muhammad, Kalaiarasi Sonai Muthu Anbananthen. 2013. *Framework: Diabetes Management System*. IMPACT-2013, 978-1-4799-1205-6/13/$31.00 ©2013 IEEE.
10. Chen, Jian-xun, Shih-Li Su, Che-Ha Chang. 2010. Diabetes Care Decision Support System. In *2010 2nd International Conference on Industrial and Information Systems*. 978-1-4244-8217-7110/$26.00 ©201O IEEE.
11. Claudio Cobelli, Chiara Dalla Man, Giovanni Sparacino, and Lalo Magni, Giuseppe De Nicolao, and Boris P. Kovatchev. 2009. Diabetes: Models, Signals, and Control. *IEEE Reviews in Biomedical Engineering* 2, 1937-3333/$26.00 © 2009 IEEE.
12. Kustanowitz, Jack. *Personal Medical Monitoring Devices*. CMSC 828.
13. Park, Chan-Yong, Joon-Ho Lim, and Soojun Park. 2011. *ISO/IEEE 11073 PHD Standardiza tion of Legacy Healthcare Devices for Home Healthcare Services*. 978-1-4244-8712-7/11/ $26.00©2011 IEEE.
14. Jung, Sang-Joong, Risto Myllylä, and Wan-Young Chung. 2013. Member, IEEE, Wireless Machine to-Machine Healthcare Solution Using Android Mobile Devices in Global Networks. *IEEE Sensors Journal* 13(5).
15. Bassi, Alessandro, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, and Stefan Meissner. *Enabling Things to Talk: Designing IoT solutions with the IoT Architectural Reference Model*. Heidelberg, New York, Dordrecht, London: Springer. ISBN 978-3-642-40402-3.
16. Amit Sehgal, and Rajeev Agrawal. 2014. *Integrated Network Selection Scheme for Remote Healthcare Systems*. 978-1-4799-2900-9/14/$31.00 ©2014 IEEE.