International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

A SURVEY ON IOT BASED PATIENT VITAL MEASURING SYSTEM

Ashwini R Hirekodi[1], Bhagyashri R Pandurangi[2], Uttam U Deshpande[3], Ashok Magadum[4]

[1]*M.Tech Student, Department of Electronics and Communication, KLS Gogte Institute of Technology, Karnataka, India*
[2]*Assistant Professor, Department of Electronics and communication, KLS Gogte Institute of Technology, Karnataka, India*
[3]*Assistant Professor, Department of Electronics and Communication, KLS Gogte Institute of Technology, Karnataka, India*
[4]*Project Manager, Osteos India Pvt.Ltd, Karnataka, India*

Abstract - *Technologies have been improving day by day where all the works are being done digitally. Health specialists and doctors are using the old method of storing the data which is the manually writing which can being out a lot of errors. There can be improved ways for doing this where we can store the readings of the vital parameters such as pulse sensor and ECG digitally. This step avoids errors encountered due to the manual entry of the data in the EMR system and related application. The readings of the pulse will be published to Node JS application once the patient ID is received via kafka message broker topic. Node JS then stores the readings to MongoDB database along with the patient's ID. The key objective of this automatic update of pulse or ECG measurements of patient and it prevents any errors caused due to the manual entry of the pulse or ECG readings.*

Key Words: *Pulse sensor, ECG, Node JS, MongoDB database, Internet of things, Raspberry pi, EMR.*

1. INTRODUCTION

The vital parameters like pulse and ECG readings of a patient are measured using the sensors that are connected to a Single Board Computer such as Raspberry Pi. The Raspberry Pi has been chosen for collecting sensor data as it has all the necessary resources and powerful CPU to run multiple applications on a standalone board.

IoT was first proposed by Kevin Ashton in 1999 [1]. This is the physical communication network where billions of data are collected from the very different devices we use and transforms them into usable information [2]. IoT can be used in the medical field so that the doctors can monitor the patients from anyplace at any time. This system can be used for the patients who need continues monitoring of their health. By 2020 unprecedented growth in the Internet of Things (IoT) technologies will make it possible to talk about 50 billion connected devices through the internet [3]. IoT can be used in the medical field so that doctors can monitor patients from anyplace at any time. This system can be used for patients who need continuous monitoring of their health. A systematic review of various mobile healthcare approaches was carried out by [4]. A mobile cloud-based ECG monitoring service was presented [5].

IoT establishes bridge between the 'Digital world (Internet)' and the 'Real world (physical device)'. The devices are connected to the cloud-based services (e.g. distributed micro services or monolithic application) and create unique identification over the internet [6]. Low power programmable Systems on Chip (SoC) is built in microcontroller which integrates and controls all of the programmed components [7]. Raspberry pi is used to interact with outside world and transfer the data. The transferred data is stored in the private cloud. Here the obtained data is in the analog output. The ADS1115 is a 16-bit ADC chip is used for the conversion the data from analog to digital which are obtained from the sensors. The digital data which are obtained are sent to the Raspberry pi where the python application runs and the samples are sent to the Node JS web server which is the open source of the cloud.

These digital samples are then stored in the MongoDB database along with the patient ID. The data's obtained from the patients are stored in their respective ID's. After submitting the form, the vital parameters pulse and ECG values will be sent to controller via REST API and stored in respective patient's collection in the MongoDB database. When the doctors need any health details of the patients, they have to just enter the patients ID then the EMR trigger start pulse and ECG measurements which are updated in the websocket can be obtained.

1.1 Parameter Readings

The parameters which have been considered are the pulse sensor and the Electro cardiogram. These parameters are obtained using the sensors which can give the accurate readings of the patient. Readings are

taken in the analog form which is later converted into the digital samples.

1.2 Analog to Digital conversion
The samples which are obtained are in the analog form. These are converted from analog to digital using the analog to digital conversion circuitry. The ADS1115 is a 16-bit ADC used for conversion. And the digital samples are then sent to the Raspberry pi.

1.3 Raspberry Pi
The digital samples which are received from the conversion are stored in the Node JS web server where the python application is running continuously. Here we use the Kafka message queue so that the data which are obtained are not over lapped.

1.4 Database
MongoDB database is a document-oriented database which is classified as NoSQL database. All the readings of the parameters are stored in this database with the patient's ID.

1.5 Websocket
Updated digital samples which are stored in the database are received by the doctor when patient's ID is typed.

2. LITERATURE SURVEY

Researchers have worked on this subject for a long time. Here is a brief summary of the related work.

Shola Usha Rani, Antony Ignations, Bhava Vyasa Hari, et al [8], This project was proposed for the gathering of the readings of various important indications of the patients. Later send the readings to the doctor or the individual about the health condition. In this project MQTT communication is used to send the data to the cloud platform. The patient's vital sense is transmitted with the help of the pictorial representation.

Mehmet Tastan [9], In this project a wearable sensor is used which keeps the track of the patient's heart beat and the blood level. The patient who has the critical health situations can be continuously monitored using these techniques. If there is a fluctuation of the health in the patient then the information/details of his health conditions are sent to the family members or the doctor through the mail or twitter notifications. The purpose of this project is to give medical treatment as soon as possible in case of the heart diseases. So, there will be an increased chance of the survival of the patients.

Syed Misbahuddin, Junaid Ahmed Zubairi, Abdul Rahman Alahdal, et al [10], This paper proposed the system for the victims of mass disasters and emergencies. MEDTOC is a real time component used for the holistic solution. The proposed system sends the details of the effected victims to the doctor or to the central database about their health condition even before the arrival of the patient. By this the medical staff can prepare the necessary treatment and can operate as soon as the patient is arrived. In this the data of the patient which is transferred is stored without the identification of the patient. But this project can only be useful if the disaster area has the cellular network. If the cellular network is having issues then the alternate connectivity such as Wifi can be directed in the future.

Dvarte Dias, Joao Paulo Silva Cunha [11], The wearable devices which are used in the project are all based on the broadband network which is only helpful if connections are good. As they have mentioned in the paper, countries like France where there is less usage of the Internet the system won't be helpful. The sensors which are used in this are a long-term stability, resiliency and biocompatibility. Large sensors as well as small sensors are used for monitoring of the vital signs.

K.Satwik, N.V.K.Ramesh, S.K.Reshma [12], This model was created for the low effect and can be used for less power. NodeMCU is used for the small-scale controller. This framework can be used for the aged people or for those who have lots of health conditions. The patient or the family member can check the vitals of the patient anytime through web. This can further adjust for sending the information only to the particular person without leaking of the information.

Faisal Jamil, Shabir Ahmad, Naeem Iqbal et al [13], This proposed platform is based on the permissioned blockchain network and addresses the inherent challenges. Hyperledger Caliper is used for accessing the performance evaluation. Blockchain technology allows a significant increase in the overall throughput and also reduces the latency.

Mehak Chhabra, Manik Kalsi [14], In this paper the authors have proposed a system where the details of patients are acquired even before patient is admitted in hospital. This can be installed in ambulance where medical staff can send details of patient to doctor through internet which gets stored in cloud. AD8232 sensor is used which supplies ECG signal to the controller section.

The advantages of this is the doctor can remotely operate on patients, the device is useful for real-time monitoring, the

size of system is small so it can be carried easily. But there are some limitations like the surrounding noise can affect the readings and the most important is network connections, if there is no proper internet then readings cannot be sent.

Zhe Yang, Qihao Zhou, Lei Lei, Kan Zheng [15], The authors have proposed a method for ECG monitoring based on Internet of Things (IoT) techniques. In this device sends all the necessary readings directly to the IoT cloud using Wi-Fi. This provides visual and ECG readings through HTTP and MQTT protocols in IoT cloud. This system detects the noise from surroundings and removes it which gets stored with ECG readings. At least one copy of readings is stored for disaster recovery. The three electrodes, real-time ECG signals can be collected with accuracy in a wearable monitoring node.

But the ECG signal still needs to be improved for more reliable disease diagnosis.

Jorge Gomez, Byron Oviedo, Emilio Zhuma [16], This paper points out the advantages of mobile health (M-Health) and E-Health which help in improving, helping and assisting patient's health. This article aims at developing a architecture based on an ontology capable of monitoring the health and workout routine to patient with heart disease. The ontology components like person, time, devices, types of diseases, types of exercises and location are considered. Where for every specific person there is different device considering disease, depending on which the diet and workout is given.

This was developed so that lifestyle of patient can be improved and not just monitored. And the dieting and working out of patient can be changed considering their disease.

Jeevan Kharel, Haftu T Reda, Soo Y Shin [17], This paper proposes an architecture using IoT concept under Fog computing. The problem of deficient clinic-centric health system can be changed into smart patient-centric health system. Fog computing is introduced for monitoring of health. This enables the end user device to collaborate for task of storing, management and network communication. The tasks done near or at the end will decrease the latency since getting of data from cloud takes longer time. So, in fog computing data is fetched from network edge itself.

The architecture provides efficient health care facility. Providing Seamless health service where there is no proper internet connectivity or no internet connectivity is the major advantages of this paper. This not only helps to monitor the patients with health issues but also normal person to track his body vital regularly. With this project the burden on cloud is reduced.

Revathi Sundarasekar, M Thanjaivadivel, Gunasekaran Managaran, Priyan Malarvaizhi Kumar, R Varatharajan, Naveen Chilamkurti, Ching-Hsien Hsu [18], This paper was proposed to check changes of R waves in the noisy input of ECG signal. The MODWT is used for handling the arbitrary changes in the input signal. The R wave detected is used by doctors and medical staff for taking necessary steps in patient's treatment. MATLAB Simulink is used for simulation for MODWT method. MIT-BIH Arrythmia databse is used for this paper. To compute R-peaks in input ECG signal MATLAB singal processing is used. The result of enhanced R Peaks detected from the wavlet transform produces thehit rate of 100% and no false positive. Heartbeat of 88.60bpm is calculated for wavelet transformation whereas 88.72bpm is calculated for annotated waveform. With this system only batch data is obtained so for future work of this paper the author is going to obtain streaming data.

Jemal H. Abawajy, Mohammad Mehedi [19], Healthcare costs in many countries are increasing. Factors accounting for the increasing healthcare spending include chronic diseases, unnecessary tests and procedures, waste, and inefficiencies such as over-treatment. Remote pervasive patient health monitoring (PPHM) framework that leverages the combined strong synergy of IoT, Cloud computing, and wireless technologies for efficient and high-quality remote patient health status monitoring. With these technologies a case has been studied, where a patient suffering from congestive e-heart failure using ECG, the experimental results show that the proposed PPHM infrastructure is flexible, scalable, and energy-efficient remote for a patient health monitoring system.

In this paper inexpensive but flexible and scalable remote health status monitoring system that integrates the capabilities of IoT and cloud technologies are remote monitored of patient's health status. But there is shortage of security and privacy in this paper which can be considered for future work.

Zhendong Ai, Zihan Wang, Wei Cui [20], In this paper, ECGM is designed based on Ferroelectric microprocessor. This has ultra-low power consumption and contains four parts MCU, BLE, Sensors and Power. MCU is core of ECG, BLE is used for wireless transmission of collected bio-signal data, Sensors are used for monitoring bio-signals and motion of

patient, while Power is used for battery circuit, charging and power supply. ECGM collects the ECG data from the chest area and removes unwanted noise which is present and transmits output data to patient's hand held mobile phones through Bluetooth.

Improving of design and ECG classification algorithm is to be studied in the near future.

Haron Ren, Hailong Jin, Chen Chen, Hemant Ghayvat, Wei Chen [21], Wireless Cardiac Auscultation is used for continuous cardiac monitoring of an individual without 24*7 manual healthcare services. This system monitors and analyses cardiac condition and sends report to the caretaker and medical staff. IoT and signal analysis is uploaded from scratch. Bluetooth is used for the transmission of data. An integrated system from scratch to information uploading for storage, asynchronous analysis, heart sound acquisition has been developed, through IoT and signal analysis. Cardiac auscultation sensing unit and Bluetooth protocol for monitoring cardiovascular health and moderate data transmission rate respectively. To extract the heart sound signal features as well as eliminate interference signals Hilbert-Huang transform is used. A cardiac auscultation protocol named Wireless Cardiac Auscultation Monitoring System that can access data remotely, facilitate seamless connectivity between users and clinical physiology for clinical decision support. This protocol is simple to configure and implement with the application of the Internet of Things.

Preprocessing, Segmentation and Clustering techniques are performed for significant health monitoring information interpretation. Data can be accessed remotely, facilitate seamless connectivity between users and clinical physiology to provide data analysis. But accurate results are not obtained so algorithm for finding accurate readings is to be done.

Weiping Zhang, Mohit Kumar, Junfeng Yu, Jingzhi Yang [22], This system uses CC2430 microcontroller, human information sensor, microelectronic and modern wireless communication technology. Online debugging of system is combined with hardware and software. Sensor node collects three physiological signals including body temperature, pulse and ECG. All the collected data is transmitted to the information management system of the computer which can be later checked by doctors and medical staff. The network node is reliable and data is accurate meeting the requirement necessary.

Taiyang Wu, Jean-Michel Redoute, Mehmet Yuce [23], In this paper, a T-Shirt which is small, flexible and wearable with real-time electrocardiograph (ECG) monitoring system is integrated. Ad8232 is used to collect data of patient's ECG and is transmitted using Bluetooth Low Energy (BLE) for displaying. A PC graphical user interface (GUI) is designed for indoor real time visualization whereas mobile application is designed for outdoor real-time visualization. Power consumption is 5.2mW and has 240mAh rechargeable batteries which can operate for more than 110 hours continuously. Solar energy can also be used for the charging of batteries.

This can be further be improved by using dry electrodes, which may cause discomfort on skin. A cloud database is to be developed to store data for the long run.

3. FINDINGS OF LITERTURE SURVEY

After going through all the papers, we can conclude saying that now a day's technologies are being used in all fields and using it in the medical field can help saving a lot of lives. Some papers are published on the improvement of the sensors where new models are used and, in some projects, the new or the next version of the communication devices is used. The previous papers are all related to the medical industry.

4. PROPOSED SYSTEM

The method used in this is that the patients can keep track of their health condition on the regular basis. So that whenever there are any issues, they can contact their doctors as soon as possible. Even the doctors can get the reports from the MongoDB database by giving the patient's ID which is stored when the patient has come for check-up. These are done when the patient ID is entered the EMR triggers and the readings are updated in the web socket. Pulse Sensor and ECG are connected to the Raspberry pi through ADS1115. The analog readings from sensors such as pulse and ECG are converted to digital samples before consumed by the collector application running on Raspberry Pi. The advantages of this model for reading of Pulse sensor and ECG are

1. As the diagnosis of a patient's disease mainly relies on a number of tests and their results including vital signs recorded at the time of OPD consultation, any errors in recording the vital signs manually would result in wrong diagnosis. So, our IoT based cloud platform provides measurement of vital signs such as pulse and ECG readings to be recorded automatically in the patient EMR system at the time of patient consultations and this method allows

healthcare providers to minimize the errors caused due to manual recording of vital signs.

2. Our IoT based cloud platform allows healthcare providers to become mobile seamlessly and help them in conducting mass screening where lots of patients come for check-ups for ex: NGO camps.

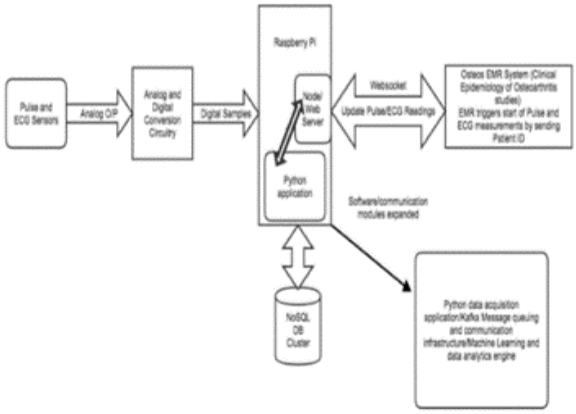

Fig 1: High level architecture for vital signs integration.

Above figure1, shows the high-level architecture of the different entities involved in the overall flow of sensor data to NoSQL cloud-based database where patient record is being stored. Pulse sensor and ECG are used for checking the heartbeat of the person. The connections shown in the figure are done using jumping wires, where ECG is connected to channel 2 as pulse sensor is connected to channel 1. Here ADC used is the 16-bit which is ultra-small and has low-power. The consumption of power is less.

5. SECURITY COMPLIANCE

This digital platform conforms to the safety and security regulations defined by the standard bodies such as CDASH and EHR standards. The implementation of this platform considers all the security measures to preserve the patient personal details and the front-end web based Integrated EMR system binds with premium SSL certificate and all the front-end Web UI requests to the backend will be carried over Secured HTTP connection. The platform also makes use of encryption feature provided by the NoSQL database out of the box. So, with all these security features incorporated in the digital platform along with backup and high availability features of cloud database server, it's ensured that the critical sections of the patient personal data and any other platform data critical to end users are preserved safely all the time.

6. CONCLUSION AND FUTURE WORK

There are many ways of communication between patients and doctors, and by this method they can not only communicate but can simultaneously track if the patient's health can be kept. The stored data can be accessed easily by doctors and nurses only by entering the patient's ID. By using this method, the errors that occur while manually entering the data can be reduced. The readings are only been accessed by the medical staff and the patient only if ID are known. The personal information of the patient is kept in high security using all the necessary steps needed. Patients having heart issues will have great help of this device.

This project can be further improved by adding more parameters like blood pressure, blood sugar, temperature and many more. Even GPS can be used where data can be directly sent to patient's ID and mail it to doctor so continuous checking of webserver can be reduced. The platform can easily be extended and/or integrated for conducting online consultations remotely using tele-health platforms.

The patient vital signs data collected on our platform over a period of time could be used for ML and AI based prediction models for early detection specific diseases. Later all the required data are displayed on the mobile screen.

REFERENCES

1. Ashton, K, That 'internet of things' thing, RFID journal, 2009, 22(7), 97-114.

2. Gubbi, J., Buyya, R., Marusic, S., Palaniswami, M, Internet of Things (IoT): A vision architectural elements, and future directions, Future generation computer systems, 2013, 29(7), 1645-1660.

3. Felipe Fernandez, George C. Pallis, "Opportunities and challenges of the Internet of Things for healthcare: Systems engineering perspective", International Conference on Wireless Mobile Communication and Healthcare, pp 263-266.

4. L. C. Jersak, A. C. da Costa, D. A. Callegari, "A Systematic Review on Mobile Health Care", Tech. Report 073, Faculdade de Informática PUCRS – Brazil, May 2013.

5. E.-M. Fong and W.-Y. Chung, "Mobile Cloud-Computing-Based Healthcare Service by Noncontact ECG Monitoring", Sensors, 13(12), Dec. 2013, pp. 16451-16473.

6. Deshpande, Uttam U., and Milan A. Kulkarni. "Iot based real time ecg monitoring system using cypress wiced."

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 6.2 (2017).

7. Deshpande, Uttam U., and V. R. Kulkarni. "Wireless ECG monitoring system with remote data logging using PSoC and CyFi." International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 2.6 (2013): 2770-2778.

8. Sola Usha Rani, Antony Ignations, Bhava Vyasa Hari, Balavishnu V J, IoT patient health monitoring system, Indian Journal of Health Research and Development, 2017, 1330-1334.

9. Mehmet Tastan, IoT based Wearable Smart Health Monitoring System, Celal Bayar University Journal of Science, 2018, 343-350.

10. Syed Misbahuddin, Junaid Ahmed Zubairi, Abdul Rahman Alahdul, Muhammad Arshad Malik, IoT- based Ambulatory Vital Signs Data Transfer System, Hindawi Journal of Computer Networks and Comunications, 2018, 8 pages.

11. Duarte Dias, Joao Paulo Silva Cunha, Wearable Health Devices-Vital Sign Monitoring Systems and Technologies, MDPI Journal, 2018, 18(8):2414.

12. K.Satwik, N.V.K.Ramesh, SK.Reshma, Estimation and Monitoring of Vital Signs in the Human Body by using Smart Device, International Journal of Innovative Technology and Exploring Enginerring, 2019, 1035-1038.

13. Faisal Jamil, Shabir Ahmad, Naeem Iqbal, Do-Hyeun Kim, towards a Remote Monitoring of Patient Vital Signs Based on IoT-Based Blockchain Integrity Management Platforms in Smart Hospitals, MDPI Journal, 2020, 20, 2195.

14. Mehak Chhabra, Manik Kalsi, "Real time ECG monitoring system based on Internet of Things (IoT), IJSRP journal, 2017, 547-550.

15. Zhe Yang, Qihao Zhou, Lei Lei, Kan Zheng, "An IoT-cloud Based Wearable ECG Monitoring System for Smart Healthcare", Journal of Medical System 40(12):286, 2016.

16. Jorge Gomez, Byron Ovideo, Emilio Zhuma, "Patient Monitoring System Based on Internet of Things", Procedia Computer Science 83(2016), 90-97.

17.Jeevan Kharel, Haftu T Reda, Soo Y Shin, "An architecture for smart health monitoring system based on Fog Computing", Journal of Communication, 2017, 12(4), 228-233.

18. Revathi Sundarasekar, M Thanjaivadivel, Gunasekaran Managaran, Priyan Malarvaizhi Kumar, R Varatharajan, Naveen Chilamkurti, Ching-Hsien Hsu, "Internet of Things with Maximal Overlap Discrete Wavelet Transform for Remote Health Monitoring of Abnormal ECG signals", 2018, 228(1-13).

19. Jemal H. Abawajy, Mohammad Mehedi, "Federated Internet of Things and Cloud Computing Pervasive Patient Health Monitoring System", IEEE communications Magazine, 2017, 48-53.

20. Zhendong Ai, Zihan Wang, Wei Cui, "Low-Power Wireless Wearable ECG Monitoring Chestbelt Based on Ferroelectric Microprocessor", Chinese Control Conference, 2019, 6434-6439.

21. Haron Ren, Hailong Jin, Chen Chen, Hemant Ghayvat, Wei Chen, "A Novel Cardiac Ausculation Monitoring System Based on Wireless Sensing for Healthcare", IEEE Journal, 2018, 1-11.

22. Weiping Zhang, Mohit Kumar, Junfeng Yu, Jingzhi Yang, "Medical long-distance monitoring system based on internet of things", EURASIP Journal, 2018, 1-8.

23. Taiyang Wu, Jean-Michel Redoute, Mehmet Yuce, "A Wearable, Low-Power, Real-Time ECG Monitor for Smart T-Shirt and IoT Healthcare Applications", Springer Nature Switzerland, 2019,165-173.