

Machine Learning algorithms for Disease Prediction using IoT Environment.

Samir S. Yadav, Shivajirao M. Jadhav

Abstract: *In the most advanced healthcare application environment, the use of IoT technologies brings convenience to medical professionals and patients, since they have applied to health areas. In IoT, Body sensor network (BSN) technology plays a vital role in the healthcare system where lightweight wireless and low-powered sensor nodes used for monitoring the patients. In this paper, we propose a healthcare system using IoT and BSN technology. This system includes various sensors like pulse rate sensor, temperature sensor, and blood pressure sensor. These sensors sense the parameters and send the data to the controller. According to the conditions, the buzzer will on as temperature exceeds the given range. It carries the sensed data to the LCD to display on it. At the same time, data send to doctors using the internet, so that they can give quick and proper solution in real-time. Many patients suffer because of not getting the timely and appropriate solution and help for their problem. Proposed system hence offers the real-time solution and help in case of emergency. This system is convenient; therefore, a person can carry it with them. Thus continuous health checking is possible. The system also predicts the disease for a particular patient base on current reading using various supervised learning algorithms.*

Keywords: *Machine Learning, Internet of Things (IoT), Body Sensor Network (BSN), Fuzzy Random Forest (FRF)*

I. INTRODUCTION

Various works are going on how to monitors the human's health by using fewer components which will make it comfortable and easy in medical services. Health issues are getting increased nowadays [1]. Due to busy lifestyle scheduled, visiting medical consultant or hospital at regular basis becomes time-consuming. For this problem, the medical industry invents many wearable devices, but they all are not easy to understand and use. A portable health monitoring system is proposed to overcome this sophisticated wearable devices problem. Here, the main goal is to provide a wireless, low cost and user handy system which allows the subject's to measure their clinical findings, such as body temperature, and heart rate to provide the doctors with the ability to control the subject's disease easily and quickly remotely. The proposed portable health monitoring system uses sensors embedded with wearable devices for measure and monitors the user's health with the help of sensors.

Moreover, also collect the data, and collected data is sent, in case of emergency, it will communicate with the relevant authorities, caretakers, or doctors. Sensors measure the temperature of the body and pulse rate. Regular health

checkup is possible using this system on a real-time basis. Sensors measure the parameters data in analog form and send all measured data in digital form to relevant authorities or doctor for the regular monitoring of health with the help of internet. For the proposed system, we are going to use IoT (Internet of Things), which help to build a real-time device. It is easy to monitor and store data digitally as data is sent on the ThingSpeak cloud, which is an open-source cloud. It is used accessible by the user having an account on the thingspeak so that it is necessary to create an account on it [8].

Nowadays, healthcare is one of the major problems around the world. Continuous health checking is the issue being addressed in today's rushed life. To give real-time solution interfacing of blood pressure, pulse, temperature sensors are done to communicate with doctors and caretakers. In this paper, we measure the subject's vital signs such as Electrocardiograms (ECG), subject's temperature, pulse, heart rate, etc. with the help of different available sensors. This sensor collected information, i.e., biometric data is transmitted to raspberry pi, and then it is delivered to the cloud.

II. LITERATURE SURVEY.

Arsalan Mosenia et al. [2] proposed a Wearable Medical Sensor (WMS) based system design, which consists of various services and applications. The system focused on their design goals and challenges. In this paper, they first provided a history of WMSs and how it is grown in the market. After they discussed the application of WMS and its scope. Next, the architecture of a conventional WMS-based system is described. Finally, the comparison between the previous research and WMS based systems are shown by using the different parts of the WMSs.

Prakash goud Patil et.al.[3] proposed a Health Care System based on fuzzy logic and Wireless Sensor Network (WSN). The WSN sensor gives interface in healthcare systems. Also, WSN with advance Micro-Electro-Mechanical Systems (MEMS) technology, build a Body Sensor Network (BSN) that continuously observes the unusual variations in the health of subjects. This system proposed an application for measuring clinical data of the subjects. This system proposed a design for measuring clinical data of the subjects. With the help of temperature and pulse sensor, and also a microcontroller, Base Station devices are built, which is controlled by remote system. WSN continuously checks the temperature and pulse of subjects at the clinic or inaccessible place.

Revised Manuscript Received on October 20, 2019.

* Correspondence Author

Samir S. Yadav*, Research Scholar and Assistant Professor, Information Technology Department, Dr. Babasaheb Ambedkar Technological University, Lonere, India. Email: ssyadav@dbatu.ac.in

Dr. Shivajirao M. Jadhav, Professor and Head, Information Technology Department, Dr. Babasaheb Ambedkar Technological University, Lonere, India. Email: smjadhav@dbatu.ac.in



This WSN system is developed to continuously obtain and transfer the vital bio-signs to the patient's or the doctor's mobile phone. In an emergency, warning messages, i.e., Short Message Services (SMS) will send to the doctors and relatives of the subjects or patients. Also, they can get a remote prescription from the doctors with the help of this system. This data collected from patients will be stored to the database cloud, which then transferred to the fuzzy logic controller to improve the accuracy. A Fuzzy logic controller (FLC) is used due to the crisp data collected from the sensor; the FLC is one of the components in their healthcare monitoring system. The sensor data acts as an input to the FLC system, which then converts this data to the fuzzy lexical variable data as output. This output data is then sent to the doctors or patients. The primary goal of this system is to address the patient's health information to the patients and doctors simultaneously. In this paper, the mobile health monitoring and use of wearable Wireless Body Sensor Network are demonstrated. If there is urgency or there is any disparity in the body of patient, the concerned bio-parametric data is sent to a doctor or relative or the emergency unit. After receiving the information from the patient, the doctor can control the patient via remote. The primary goal of the system is to provide a quick facility to the hospital. This paper proved that WSN is useful in healthcare applications in large extent. Ekta Madhyan Mahesh et. Al. [4] proposed BSN and Zigbee Technology-based Unique Health Care Monitoring System. This system monitors patients remotely using their clinical parameter data obtained from sensors. In this paper different clinical parameters of patients such as ECG(Electrocardiogram), heart rate, spirometer(lung functioning) and temperature signals are measured and monitored with the help of standard IEEE 802.15.4 Zigbee protocol. The information collected from the patient via radio frequency that data displayed on the displaying module such as mobile devices or desktops. Moreover, collected data is transferred via GPRS or WI-FI to a database. This data contains clinical information which can be controlled on the small devices and can be given to the doctors at any time when they needed. The proposed system can monitor the various parameters of the patient's body, such as Blood Pressure (BP), Electrocardiogram (ECG), Electroencephalogram (EEG), respiratory, (spirometer) glucose, Temperature. Then this data is given to the Zigbee, and then it sent to another Zigbee in the line. After getting the data, it displays on the display device such as mobile phone of family or doctor or emergency unit. In this paper, an intelligent healthcare and monitoring system using BSN and local sensor network is proposed. The BSN and IEEE 802.15.4 Zigbee based wireless bio-signal acquisition system-on-chip(WBSA-soc) application is used to get the patient's real parameter such as heart rate, temperature, and ECG. This WBSA-soc system developed on the real-time measurement of those parameters.

Arvind Bal Subramanian [5] proposed a personalized Healthcare system for Discovering Multidimensional Motifs (MDM) in Physiological Signals. Nowadays, the patient can be monitored with the help of a sensor that is worn on the patient body. These sensors can be monitored personalized diagnosis and the therapy of the patient. Suppose that the patient is having any abnormal changes in the body then these

wear sensor to sense and collect the information and transfer and informs any emergency to the family or doctor. In this paper, the Multidimensional Motif (MDM) discovery method is proposed. This MDM is used for capturing the patient's physiological parameter. In the previously proposed system, the MDM has the Capability of simultaneous processing and multiple dimensions. The author proposed a practical and real-time strategy for MDM discovery in the body sensor. There MDM monitoring the performance of the patient during the therapy. This proposed system enables the recording of patient performance and quick update and retrieve the data that are collected from the different sensors. The medical care and doctor can be alert and give proper medication to the patient. The context-aware method is used for investigating the patient movement in an unsupervised or in a semi-supervised manner for finding patterns. MBM O algorithms are used by the authors in this paper. The given system proposed by the author has scalability that manages the online investigation and monitors the patient in healthcare system.

Yena Kim et al. [6] proposed a Health Telemonitoring system using a Coexistence of Zigbee-based WBAN and wifi. The telemonitoring concept can be used via Wireless Body Area Network (WBAN) that provide the home-based mobile health care monitoring system is given in this paper. A WBAN (Wireless Body Area Network) sensor is a brilliant system. In this system, the physiological parameter, i.e., EEG, EKG, and BP of patients, are collected. Then this data is monitored by using this healthcare application. These sensors collect the physiological parameter from the patient body and sent to the coordinator, which is a small mobile device. After that, the coordinator sent this data through the wireless network after which can be sent to the doctor or clinic.

Benny P.L. Lo et al. [7] proposed a health monitoring system using progress in embedded computing technologies and wireless sensor network (WSN). The continuous monitor and analysis of the patient's body parameters are also done in this system. Moreover, recently proposed Body Sensor Network (BSN) sensing the patient's physiological part. The vital aim of the proposed system is to check and quick investigation of the patient's illness. Cardiovascular is a disease that causes death in the UK. In each year, 38% of all deaths are occurred due to Cardiovascular disease. 29% of the heart attack patients died before reaching the hospital. This heart attack can happen without any suggestion. Nowadays, mostly Electrocardiogram (ECG) Holter monitoring systems are used to capture disorder in the human body. The ECG signals information recorded up to 24 hours by Holter monitors are retrieved and analyzed by the doctors.

The doctors detect any abnormal change in the ECG signal and inform the patients. The system developed in this paper is also compared with the recently developed WSN based health monitoring systems for cardiac patients.

III. RESEARCH METHODOLOGY

The proposed system has partitioned into two different parts, training and testing.

A. Training

- Collect data from the online repository like synthetic data as well as real-time patient data.

- Apply data mining approaches like data pre-processing, data cleaning, data acquisition, outlier detection, and data conversion.
- Once complete these phases, data is saved into the database called as background knowledge, which is used at the time of testing.

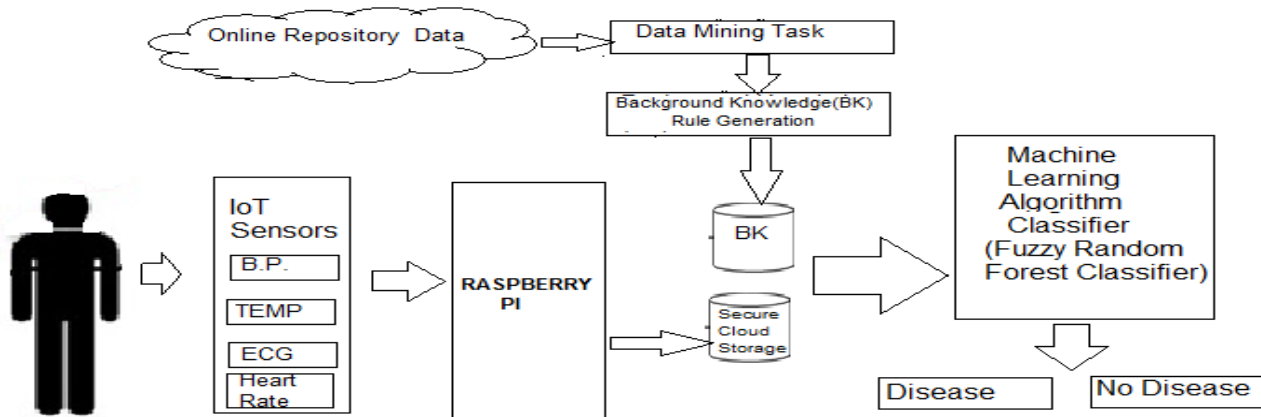


Figure 1: System Architecture

B. Testing

- Initially, IoT based environment is created by using minimum 6 sensors as wearable devices.
- Then these sensors are connected to Raspberry Pi, where data will be collected using a batch processing approach from these sensors.
- All collected data then stored into a global database using a connection-oriented architecture.
- In testing, we read all training and testing dataparallely.
- To predict the possible result apply Fuzzy classifier using a decision-making approach.
- At the final stage provide accuracy analysis using True positive (TP) and false negative (TN) statements of system.

Initially, the system collects all the healthy raw data using different sensors, with the help of Raspberry Pi. Then the whole generated data from the sensor is processed using data mining techniques, like data cleaning, data acquisition, outlier detection. Then this data is stored into the Mysql cloud DB .i.e. secure cloud storage. In the next part, the system is developed using GUI based application. This application is developed by using java application and python webpage. By using this application, user can see the data interpretation regarding his/her health. In the final part, the system will recommend possibilities like disease or no disease. The architecture of the proposed health monitoring system is as shown in Figure 1. Initially, one end of the IoT sensors are attached to the patient's body, and the other end is connected to the Raspberry pi. After this connection, data will be acquired and stored into the secured cloud storage using the Raspberry pi B+. This data i.e., biometric data, can be seen by using LCD if these data values exceeded the normal range, the alarm triggers.

GSM is used to send these values to the cloud server. The most recent values are displayed on the webpages.

The doctor can access these patients current and previous information using login credential provided to him/her and suggest medicines online. Similarly, patients can also see only his previous records. The system design is again distributed into two parts:

Hardware and software components.

C. Hardware components

1) **Temperature sensor (LM35):** The temperature of the patients is measured by using this sensor. The LM35 series are accuracy integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Centigrade temperature. It measures temperature more accurately than thermostats. It does not undergo oxidation. It does not require an output voltage to be amplified.

2) **ECG sensor:** ECG electrode sticks to the chest to pick up ECG signals. Then wires are connected to AD8232. This sensor is used to measure the rhythm of the heart. Also, this sensor is coast-effective. AD8232 op-amp is used to remove noise from ECG signals. It helps to capture PQ and PR signals quickly and clearly.

3) **Heart Rate sensor:** This sensor is used to obtain digital output from the heartbeat. It requires to place a figure on it to get the production in Beats per Minute (BPM) rate

4) **Raspberry Pi:** The Raspberry Pi B+ is a cost-effective and are of little cost, small-sized computer system that connects to LCD or TV, and uses a standard keyboard and mouse. The Raspberry Pi Model B+ has dual-core ARM11 processor with 512MB SDRAM and powers through Micro USB socket of 5V. Sensors are connected to the Raspberry Pi Model B+. Raspberry Pi sends the information to servers through the GSM module.

5) GSM module: Subscriber Identity Module(SIM) is required to activate communication with the network. The GSM sends health information to the webpage. Patients can leave the hospital with the help of GSM. But still, he needs to stay in some known places to guarantee the capacity to reach him in emergency cases. Even with this solution, the patient can't travel freely and be far from his residence.

6) Max232: To convert CMOS/TTL logic level to RS 232 logic level, the MAX232 IC is used. For communication, the direct link between these two logical levels is severe. So, MAX232 provides an intermediate link between them. Low Supply Current 8 mA.

D. Software Components

In this part we have used machine learning algorithm for the prediction of diseases. In the next section we have described how the data collected from the IoT sensor is used to analyze using various algorithms.

IV. PROPOSED ALGORITHMS

Algorithm 1 : Probabilistic Fuzzy Random Forest(FRF)

Input : TrainFeature set {} which having values of numeric or string of train DB, TrainFeature set {} which having values of numeric or string of train DB, Threshold T, List L.

Output: classified all instances with weight.

Step 1 : Read all features from Test set using below

$$\text{TestFeature} = \sum_{j=1}^n (T[j])$$

Step 2: Read all features from Trainset using below

$$\text{TrainFeature} = \sum_{k=1}^m (T[k])$$

Step 3: Read all features from Trainset using below

Step 4 : Generate weight of both feature set

$$W = (\text{TrainFeature}, \text{TestFeature})$$

Step 5 : Verify Threshold

$$\text{SelectedInstance} = \text{result} = W > T ? 1 : 0;$$

Add each selected instance into L, when n = null

Step 6 : Return L.

Algorithm 2 : Classification using Linear Regression

Input: User input file data record which contains {I to n attributes}, segment of average score from train database.

Output: Projected value

Step 1: Read R {I to n} from current record.

Step 2: Map with train features with each sample.

Step 3 : calculate average score of train DB with same evidences

$$\text{AvgTScore} = \sum_{k=0}^n (Sc)$$

Step 4 : PreScore = (CScore + AvgTScore)

Step 5: ReturnPreScore

Algorithm 3: Q- Learning Algorithm

Input: inp[1...n] all input parameters which is generated by sensors, Threshold group TMin[1...n] and TMax[1...n] for all sensor.

Output : Trigger executed on appliances, Buzzer execution and GPS message.

Step 1 : Read all records from database (R into DB)

Step 2 : Parts [] ← Split(R)

Step 3 : CVal = $\sum_{k=0}^n$ Parts[k]

Step 4 : check (Cval with Respective threshold of TMin[1...n] and TMax[1...n])

If(true) execute trigger on respective output appliances.

Else Continue;

Step 5 : T ← get current state with timestamp

Step 6 : if(T.time > Defined Time)

Active GPS for messaging or on buzzer

Else continue.

Step 7 : end for

Step 8: return DB

V. DATASET DESCRIPTIONS

The dataset used for this project is a real-time health care data. The data has been collected from different IoT environment like ECG sensor, temperate sensor, and pulse rate sensor. Once data has generated by sensors, it will send to the microcontroller, and then this same data will be sent to the cloud server. This data system is also used for runtime prediction. The below attributes we have taken from different sensors.

Table 1: Attributes Information

Parameter id	Attribute Name
1	Systolic BP
2	Diastolic BP
3	Heart rate
4	Pulse rate
5	QT
6	temperature
7	Pulse pressure

VI. RESULT AND DISCUSSIONS

In the experiment, we carried different experimental analysis, Fig 2 shows the result of the average performance of 400 patient's data, and measure the accuracy using different classification algorithms like Probabilistic Fuzzy Random Forest, Linear regression and Q-learning algorithm.

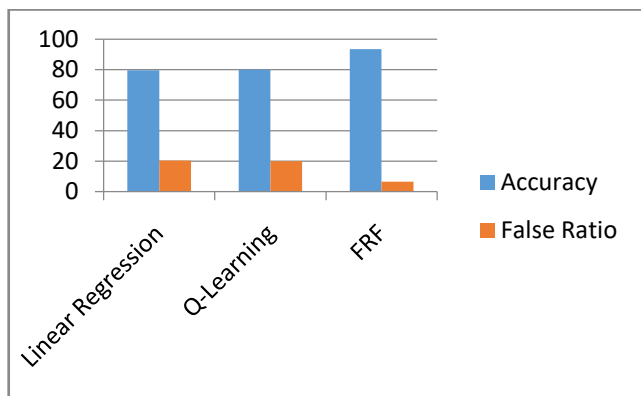


Figure 2: System performance with different algorithms

The proposed framework has conveyed with java and mobile base android platform. Beneath figure demonstrates that the recognition component builds information loss for the ECG sensor. Here No of users are shown on X-axis , and the average packet loss from ECG device is shown on the Y-axis. From figure 2 we can say that probabilistic Fuzzy random classifier gives 93.57% accuracy with different patient's real-time data.

VII. CONCLUSION

The system provides real-time health monitoring and also the prediction of disease over the internet. It can work base on real-time as well as synthetic training data. Prediction accuracy of FRF algorithm is better than other learning approaches. The system also can provide the alert when any criticalness 24×7 . The proposed machine learning algorithm provides the best accuracy than other machine learning approaches with minimum time complexity. Future studies consist of implementation of such a system with parallel processing with high dimensional data using Hadoop or cloud environment.

REFERENCES

1. Harshavardhan B. Patil. Wireless biomedical parameter monitoring system. Journal of Engineering Research and Applications, pages 46-48, April-2015.
2. Mosenia A, Sur-Kolay S, Raghunathan A, Jha N. Wearable Medical Sensor-based System Design IEEE Transactions on MultiScale Computing Systems. 2017 May 20.
3. Patil P, Mohsin S. Fuzzy logic based health care system using wireless body area network. International Journal of Computer Applications. 2013 Jan 1;80(12).
4. Madhyan E, Kadam 2014 M. A Unique Health Care Monitoring System Using Sensors and ZigBee Technology. International Journal of Advanced Research in Computer Science and Software Engineering. 2014 Jun;4(6).
5. D. Balasubramanian A, Wang J, Prabhakaran B. Discovering multidimensional motifs in physiological signals for personalized healthcare. IEEE Journal of Selected Topics in Signal Processing. 2016 Aug;10(5):832-41.
6. Kim Y, Lee S, Lee S. Coexistence of ZigBee-based WBAN and WiFi for health tele monitoring systems. IEEE journal of biomedical and health informatics. 2016 Jan;20(1):222-30.
7. Sandeep Kakde et. Al. Implementation of health-care monitoring system using raspberry pi. IEEE ICCSP 2015 conference, Vol.2,1083-1086, 2015.
8. Lo BP, Thiemjarus S, King R, Yang GZ. Body sensor network—a wireless sensor platform for pervasive healthcare monitoring.

AUTHORS PROFILE



Samir S. Yadav received the B.E.in computer engineering, in 2011 from Pune University, and M.tech in computer engineering from Dr. Babasaheb Ambedkar Technological University, Lonere in 2014. He is currently a Research Scholar and assistant professor at Dr. Babasaheb Ambedkar Technological University, Lonere from 2015. His research interest includes Machine learning , soft computing , IOT and health analysis using clinical findings.



Shivajirao M. Jadhav received BE in computer engineering from Nanded, Maharashtra. And received Masters in computer engineering from VJTI, Mumbai. He has received Ph.D. degree from Dr. Babasaheb Ambedkar Technological University, Lonere in 2015. He is currently working as Professor and Head in Department of Information Technology at Dr. Babasaheb Ambedkar Technological University, Lonere. He has published several articles in refereed journals and renewed international conferences. His research interests include soft computing, Machine learning and healthcare system.