A Secure IoT-Based Modern Healthcare System Using Body Sensor Network: An Overview

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***Abstract*: In the modern health care environment, the usage of IoT technologies brings convenience of physicians and patients, since they are applied to various medical areas. The body sensor network (BSN) technology is one of the core technologies of IoT developments in healthcare system, where a patient can be monitored using a collection of tiny-powered and lightweight wireless sensor nodes. However, the development of this new technology in healthcare applications without considering security makes patient privacy vulnerable. In this paper, at first, we highlight the major security requirements in BSN-based modern healthcare system. Subsequently, we propose a secure IoT-based healthcare system using BSN, called BSN-Care, which can efficiently accomplish those requirements. The body sensor network (BSN) technology is one of the most imperative technologies used in IoT-based modern healthcare system. It is basically a collection of low-power and lightweight wireless sensor nodes that are used to monitor the human body functions and surrounding environment. Since BSN nodes are used to collect sensitive (life-critical) information and may operate in hostile environments, accordingly, they require strict security mechanisms to prevent malicious interaction with the system. The system also predicts the disease for particular patient base on current reading using Fuzzy Random Forest (FRF) algorithm.**

Index terms: Internet of Things (IoT), Body Sensor Network (BSN), Advanced Encryption Standard (AES). FRF, Machine Learning

I. INTRODUCTION

Health is a dynamic process which needs to be continuously monitored. Health sectors have been facing various hospital admission problems due to higher rate of patient admission to hospital. To this aim, a system is proposed for human health care. The system provides regular monitoring of patients metabolic parameters and disease detection using the parametric values obtained. Due to increase in number of sudden deaths caused by chronic heart failure or high blood pressure, it is necessary to provide continuous health monitoring service at home. The prime goal was to develop a reliable patient monitoring system so that the healthcare professionals can monitor the patients, who are either hospitalized or executing their normal daily life activities. Recently, the patient monitoring systems is one of the major advancements because of its improved technology [2]. In our system we are measuring patient's parameters (ECG, temperature, heart rate, pulse, etc) different available sensors. This sensor collected data i.e. biometric information is given to raspberry pi and then it is transferred to server.

II. LITERATURE SURVEY

From above literature view we can conclude that sensors are important to capture different type data such as ECG, body temperature and blood pressure on dataset different machine leaning algorithm are used for classification and prediction disease as well as basic parameters like body temperature is monitored and is transferred on webpage to make it locally visible for users. We first provide a brief history of WMSs and discuss how their market is growing. We then discuss the scope of applications of WMS-based systems. Next, we describe the architecture of a typical WMS-based system and the components that constitute such a system, and their limitations. Thereafter, we suggest a list of desirable design goals that WMS-based systems should satisfy. Finally, we discuss various research directions related to WMSs and how previous research studies have attempted to address the limitations of the components used in WMS-based systems and satisfy the desirable design goals.[1] System designed for measuring health parameters of patient body in which it consists of temperature and pulse sensor, this sensor is connected to Base Station through a microcontroller and that device have the ability to be control and monitored by remote computer. Wireless Sensor Network system continuously monitoring the pulse and temperature of patients at remote or in hospital. This paper demonstrates the use of wearable Wireless Body Sensor Network and ambulatory health monitoring. If there is any change in the patient body that physiological parameter information is transferred through sensor, if there is any emergency then these message is transferred to doctor or relative or emergence unit. After receiving the information from patient doctor can controlled the patient via remote.[2].Monitor the different aspect of the human body such as Blood Pressure, Electrocardiogram (ECG), Electroenchaplogram (EEG), Temperature, glucose, respiratory (spirometer). The proposed system in which it gathered the information from patient through different aspect of body function and these information is transmitted to zigbee and from that zigbee it sends data from one zigbee to another zigbee, after receiving the information it display on the display module such as mobile of doctor or family or emergence unit. We can also say that intelligent healthcare and monitoring system that include body sensor network (BSN) and local sensor network has been presented. The wireless bio-signal acquisition System–on–Chip for BSN application is applied to capture the real human body temperature, heart rate and ECG signal monitor[3].Suppose that the patient having any abnormal changes in the body then these wear sensor sense and collect the information and transfer and informs the any emergency to the family or doctor. This proposed

system enables the recording of patient performance and speedy update and retrieve the data that are collect from the sensor. The wearable sensor widely used that can be that can be continuous monitored the patient performance at the time of therapy from the accurate analysis from the sensor.[4]The concept can be used concept can be used via Wireless Body Area Network (WBAN) that provide the home based mobile health monitoring. A wireless Body Area network (WBAN) in which having small sensor, this medical sensor is very intelligent that is collect the physiological parameter i.e. EKG (electrocardiogram), EEG (electroencephalography and the last one blood pressure can be monitored in this healthcare application. These sensors are wearable on the patient body that sensor collects the patient body that sensor collect the physiological parameter from patient and send to the coordinator is small mobile devices after that the coordinator sends this data through wireless network this can be send to the doctor clinic.[5]With the help of new technology of Raspberry Pi, health care system can be monitored. In this type of technology same area network is shared by multiple users which helps in monitoring. Wireless communication is done through Wi-Fi which provides flexibility and extendibility.

III. AIMS AND OBJECTIVES

- Wearable IoT devices have more demand in the market, due to the availability of Internet for a decent price and well accessibility. Following are some important objectives of healthcare monitoring system.
- To get the information about human health in real time via IoT wearable device.
- Analysis and Prediction of chronic disorders in primary stage through the data mining techniques which gives the methodology useful for decision making.
- Preprocessing of data acquisitioned about human (if necessary).
- To bring IoT-based healthcare monitoring solutions, anywhere, anytime.
- We implement a semi supervised approach for learning as well as disease prediction.
- Use of Fuzzy classification approach for prediction.
- Implement a system on mobile as well as web base platform.
- Implement an AES for data security.

IV. PROBLEM STATEMENT

The proposed research work is to design and implement a system that can provide the patient health by monitoring any disease recommendation by using fuzzy classification approach. We collect data from patient by using the wearable devices using IoT framework.

V. SYSTEM ARCHITECTURE

Basically proposed system has divided into two different phases, training and testing.

Training

- Collect data from internet like synthetic data as well as real time patient audit data.
- Apply data mining approaches like data preprocessing, data cleaning, data acquisition, outlier detection and data conversion.
- Once complete these phases data has save into the database called as background knowledge, which is used at the time of time testing.

Testing

- First system creates the IoT-based healthcare system environment where we used minimum 6 sensors as wearable devices.
- Then we have connected all sensors to Raspberry Pi, and collect data from sensor suing batch processing approach.
- All collected has store into global database using connection oriented architecture.
- In testing we read all testing as well as training data simultaneously.
- Apply Fuzzy classifier and predict the possible using decision making system
- Finally provide the analysis accuracy with True positive and false negative of system.

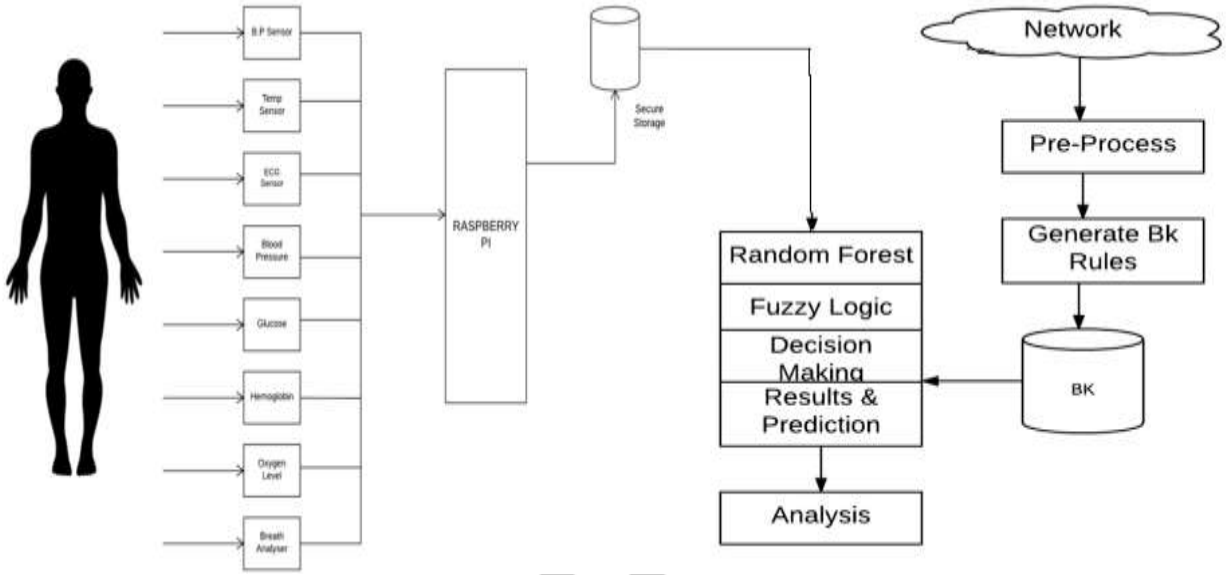

Figure 1: Proposed system architecture

First system collects all the health raw data using different sensors, with the help of Raspberry PI. Then whole generated data from sensor it is collect by Raspberry pi, and process all data mining task on such data like data cleaning, data acquisition, outlier detection and store into Mysql cloud DB. In third section system introduce the GUI with the help of android base application as well as python webpage, where user can see the whole data interpretation as well. In the fourth phase system also recommend some possibilities like possible disease, survival time of patient etc.

VI. IMPLEMENTATION METHODOLOGY

The interconnection between different components is explained using the architecture of system. Architecture diagram is shown in figure 1. The patients connect the sensors to their body and the other end of the sensors is connected to Raspberry Pi. The data acquired by sensors is stored in the Raspberry pi B+. The data values (i.e. Biometric data) are shown on LCD display and at the same time if the values exceed the normal range, the alarm triggers. The values stored are sent to server with the help of GSM. All the values are stored on the server and the most recent value is displayed on webpage. The doctor along with their login credentials can login and see the patient data. Doctors can see all previous records of a patient and suggest medicines and changes in prescription. Also patients are given unique user id and password to view their records. The design of the system is divided into two parts:

VII. Hardware components and software components.

A. Hardware components

1) Temperature sensor (LM35): It is a sensor used to measure temperature. The LM35 series are precision integrated circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It measures temperature more accurately than thermostats. It is sealed and does not undergo oxidation. It does not require output voltage to be amplified.

2) **ECG sensor:** ECG electrode sticks to chest to pickup ECG signals. Then wires are connected to AD8232. This sensor is a cost-effective board used to measure the electrical activity of the heart. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal from the PR and QT Intervals easily.

3) Heart Rate sensor: The sensor gives the digital output of heat beat when a finger is placed on it. When the sensor starts, the LED flashes in unison with beat. The output generated is in Beats per Minute (BPM) rate.

4) Raspberry Pi:The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, nd 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 GSM module.

Figure. 2 Raspberry Pi

5) GSM module: It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. The use of GSM to send health information to webpage. This gives patient the ability to leave the hospital but still he has to stay in some known places to ensure the ability to reach him in emergency cases. Even with this solution the patient can't move freely and be far from his home.

6) Max232: The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of microcontrollers with PC. This makes it difficult to establish a direct link between them to communicate with each other. The intermediate link is provided through MAX232. Low Supply Current 8 mA.

VIII. MATHEMATICAL MODEL

Many users can obtain one result or multiple results.

Set Theory:

S={s, e, X, Y}

Where,

s = Start of the program.

- **Log in user.**
- Get the data from sensors or Hardware (Temperature sensor, Pulse sensor and BP sensor).

e = End of the program.

- Display the captured data on the screen (monitor).
- Log out the user.

X = Input of the program. Input should be sensors data.

Y = Output of the program. Finally we display the captured data on the screen (monitor).

X, Y, U

Let U be the Set of System.

U= {Client, I, S, H, A, D, R}

Where Client, I, S, H, A, D, R are the elements of the set.

Client=User

I=Input data (sensors data).

S=Sensor.

H=Hardware.

A=Application (Web).

D= Display captured data.

R=Result or output.

Space Complexity:

The space complexity depends on Presentation and visualization of discovered patterns. More the storage of data more is the space complexity.

Time Complexity:

Check No. of patterns available in the database= n

If (n>1) then retrieving of information can be time consuming.

So the time complexity of this algorithm is O.

Above mathematical model is NP-Complete =Failures and Success conditions.

Failures:

Huge database can lead to more time consumption to get the information.

Success:

Search the required information from available in Datasets or Database. User gets result very fast according to their needs.

IX. ALGORITHMS

Preprocessing Algorithm

Input: disease name and Url and DB size

Output: dataset DB with disease wise

Step 1: initialize the disease list as D[].

Step 2: Provide disease D[i] with URL to server admin

Step 3: for each D[i] create one chunk for raw data.

Step 4: Convert XML to text

Step 5: read each concept from text Db and build a taxonomy for DB

Step 6: end for.

Step 7: return DB

Fuzzy Classifier

Input : Training Dataset DB, testing instance T(i), threshold T,

Output : Each training node with score (0.0 to 0.99)

Step 1: for (each instance from T upto NULL)

Step 2: for (each instance from DB up to NULL)

Step 3: Forest construction is an iterative process. Here we have to find similarity of two Nodes a=(a1…..an) and b(b1…bn) where a(n) and b(n) are the components of the nodes (features of the train node, or values for each features of the node) and the is the dimension of the node:

Weight = CalcSim(a,b)

Step 4: Save each tree node with disease into the databases.

end for

end for

Fuzzy classifier with Decision Tree Mathematical Model

Input : database DB with each node having weight w, possible range for threshold T.

Output : Each instance with tree and disease probability

Step 1: Select max(w) instance from database

Step 2: Select each max instance

Step 3: map w to each conditional verifier from given threshold.

Step 4: set action label L to each node.

Step 5: Generate tree with label L

Step 6: Display tree.

$$\vec{a} \cdot \vec{b} = \sum_{i=1}^{n} a_i b_i = a_1 b_1 + a_2 b_2 + \cdots + a_n b_n$$

X. RESULS AND DISCUSSION

The proposed framework has conveyed with various java and in addition Mobile base android platform. Beneath figure demonstrates that the recognize component really builds infor-mation loss for the ECG sensor (it could be helpful for bring down information rate sensors), while pressure emphatically expands the quantity of ECG gadgets that can be all the while utilized for a given packet loss rate. Here x axis show the no. of users and Y shows the average packet loss from ECG devices.

XI. CONCLUSION AND FUTURE WORK

System provides real time health monitoring as well as disease prediction over the internet. It can work base on synthetic as well as real time training data. Accuracy of prediction is good than other learning approaches. System also having a capability to provide the alert when any criticalness 24*7. For Future studies to implement a such systems with parallel processing with high dimensional data using hadoop or cloud environment.

XII. ACKNOWLEDGMENT

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