IoT Based Health Monitoring System using Raspberry Pi

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Abstract— **Health has become one of the global challenges for humanity. Cardiac diseases, Lung failures and heart related diseases are increasing at a rapid rate. Monitoring health of elderly people at home or patients at hospitals is necessary but it requires constant observation of Practitioners and Doctors. Information Technology (IT) and its growing applications are performing major role in making human life easier. Internet of Things (IoT) is transforming healthcare and the role of IT in healthcare. IoT consists of physical devices, such as sensors and monitoring devices for patients (glucose, blood pressure, heart rate & activity monitoring, etc) to connect to the internet and transforms information from the physical world into the digital world. The proposed system, with the help of IoT's such features, will help to keep the necessary details and reports of a patient organized and available to all actors in the system. IoT devices like low power sensors will be used to collect data from patients and it will be displayed using LCD and stored on any personal computer and also on the cloud so that any actor in the system can refer to it.**

***Keywords*— Internet of Things (IoT), Remote health, System on a chip (SoC), MQTT (Message Queuing Telemetry Transport) protocol**

I. INTRODUCTION

Internet of things, as the name suggests, is a 'network of things' or in more particular context 'network of devices' (having some intelligence) that are connected together to achieve some excellence in the performance of the entire system. Devices in the network have unique identities so that it is easy to use them and to manage the entire network. Gartner's definition of IoT is - "The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment."

Objects in IoT refers to any type of object, it can be a smart device with more artificial intelligence which can communicate with other objects very efficiently or it can be a dumb object which does not have any communication capabilities. Objects with communication capabilities become communicating nodes. Hence IoT is not only the concept of hardware or software, it also considers the interaction between the objects. IoT networks have the huge amount of data.

IoT Layers:

Internet of things can be viewed into five different layers [1]. Each of these are having their own responsibilities and functionalities.

1. *Perception Layer:*

This layer consists of the sensing devices to collect data through, includes RFID, Zigbee and all kinds of sensors. This layer has the responsibility of gathering the data and transferring it to upper layers.

2. *Network Layer:*

This layer takes over the responsibilities of provision of better communication and secure data transfer. It uses advanced technologies and standards for wireless communication. Hence main function is transfer of data between lower and upper layers.

3. *Middleware Layer:*

It is responsible to store the collected data safe in some pre-defined databases. It also has responsibility like service management.

4. *Application Layer:*

It functions to provide all types of services with respect to the corresponding field.

5. *Business Layer:*

The topmost layer, can be thought of as an analysis layer. It is responsible for the detailed analysis. It guides for the future actions.

II. STATE OF THE ART

A Traditional way of health monitoring includes continuous diagnosis processes and observations which have flaws like wrong diagnosis, missed prescription, inability to access patient's history due to data loss, missing initial follow-ups etc human errors. These errors can be removed by using a total device dependent observation and monitoring system. Such systems can be developed using Internet of things concept. IoT has devices which have intelligence and can collect data intelligently, they can process this data and send it to the network. These functions can be used in healthcare field to

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collect patient's data on local and also send it to remote machines. The data collected can be processed and sent to other nodes. Abilities of IoT networks can be used to monitor the health of a patient by periodically analyzing the data collected. Hence Healthcare application of IoT involves three major functions:

a) Tracking an object or patient
b) Identification and authentication
c) Sensing and Data collection

Data collection here refers to the collection of health parameters like temperature, Blood Pressure, Heartbeat rate, ECG parameters etc

III. PROPOSED SYSTEM

The proposed system aims to Monitor Health of elderly people using IoT devices and store the collected data on the IoT server

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A. Objective of the Work

- To Provide technological support to make healthcare systems easier and faster
- To Collect accurate physical parameters of a patient
- To Provide availability of necessary data on the internet
- To Provide faster assessment and treatment

B. Proposed System Approach

An The work flow of the proposed system consists of four stages- Data acquisition, Data Processing, Data Storage and Data Transmission.

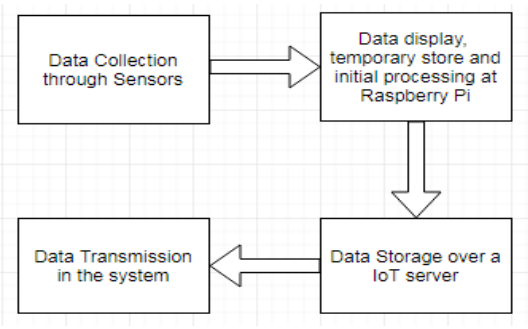

Fig 1: Work-flow of the proposed system

As per the workflow first task in the system is to collect data from patients through the sensors. Data here refers to the health parameters of temperature and heartbeat-rate. The sensors used in such systems are low power sensors. They collect data from patient on timely basis. With this frequently obtained data the health condition of particular patient is observed and required prescriptions are recommended. This collected data is shown on a LCD display connected to the raspberry pi board, if required that data is processed and then forwarded to IoT server for storage from where it is accessible to desired clients in the system. Hence this system works on the basic client-server principle of computer networking. Data collected on the IoT server is stored for the reference of all peers in the system and transmitted to these peers as and when required.

C. Proposed System Architecture

Basic Blocks:

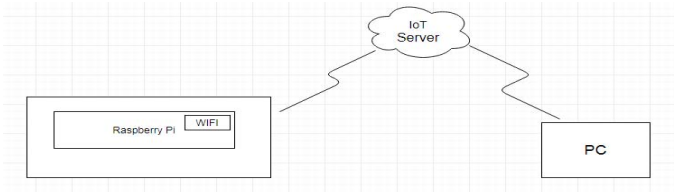

Fig 2: Basic Blocks of the system

The proposed system basically consists of three main blocks as shown in figure 3. One block consists of the raspberry pi 3 model b in which wireless connectivity is provided within the kit itself and does not need external wifi module. The data is collected at this side and is sent to IoT server. IoT server is the data storage of overall system. That data is accessible at the doctor's side so they can access this information of patients and provide necessary prescription.

System Architecture:

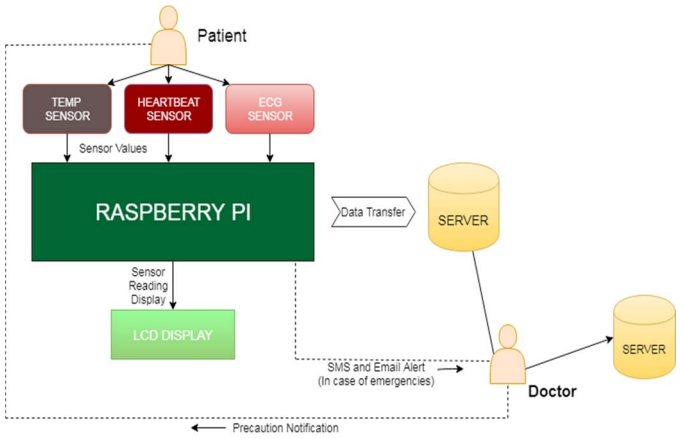

Fig 3. Proposed System Architecture

As shown in the proposed system architecture, the data from patient is collected at the raspberry pi with the help of sensors. The data collected will be stored onto the IoT server as per patient-ids and then forwarded to Doctor for analysis. The Doctor will analyze this data and will give assessment accordingly and hence monitoring of health is done. The protocol used for data transfer and communication is HTTP. Generally used protocols with IoT based systems are CoAP , MQTT and HTTP. CoAP is used where network performance is the main target to achieve while HTTP and MQTT are chosen for sensor based

applications and according to the application's requirement.

D. Implementation:

Devices used:

1. *Raspberry pi*

The Raspberry Pi is a credit-card sized small and cheap computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. [7]
Several generations of Raspberry Pis have been released. All models feature a Broadcom system on a chip (SoC) with an integrated ARM compatible central processing unit (CPU) and on-chip graphics processing unit (GPU). Raspberry Pi 3 Model B was released in February 2016 and has on-board WiFi, Bluetooth and USB boot capabilities. By 2017, it became the newest mainline Raspberry Pi. On 28 February 2017, the Raspberry Pi Zero W was launched.[8]
The proposed system uses Raspberry pi 3 model B. Data is collected from the sensors which are connected to this raspberry pi board. Sensors used are temperature sensor, heartbeat sensor and ECG sensor which are described in the succeeding sections. The data from these sensors is displayed on the LCD display and is sent to the IoT server. And it is accessible to desired ones. Patients' data is collected from these sensors and it is provided to doctors and health professionals. The analysis should be given back to patients from the data provided.

2. *Temperature sensor:*

Temperature sensors are of different types. The proposed system uses the LM35 temperature sensor. It is an analog sensor but provides correct readings as desired by the application.

3. *Pulse-Rate Sensor:*

Pulse rate sensor is used for checking the pulse-rate. The pulse rate up to 88-90 is considerable beyond that range it is not acceptable and considered as a danger so an alert will be generated for such cases. The sensor used is an analog sensor and needs an Analog to Digital converter as raspberry pi does not take analog inputs.

4. *ECG Sensor*:

Electrocardiogram sensor is used for ECG monitoring. ECG provides more information about the heart-beat rate and all other disease indications. Hence monitoring the help will be more useful with the help of this sensor. The threshold value set for this sensor is 200 ms (PR interval) if found value beyond than that alarm is generated.

Circuit connections of the System:

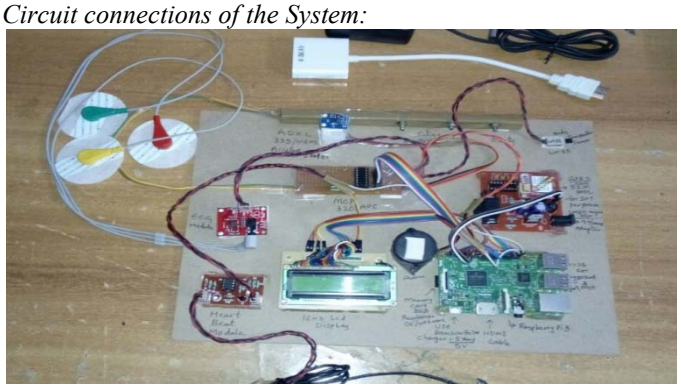

Fig 4: Circuit of the system

User Login for data access:

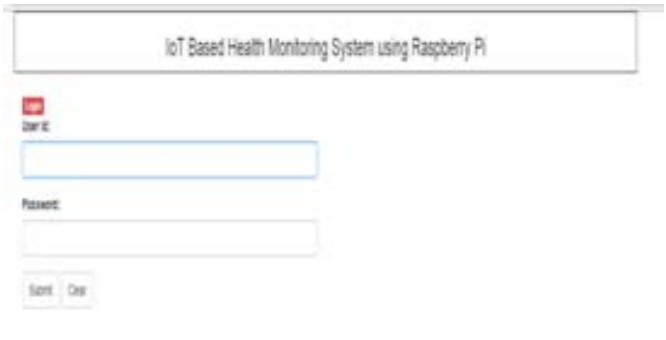

Fig 5: Login Page

Database on the server:

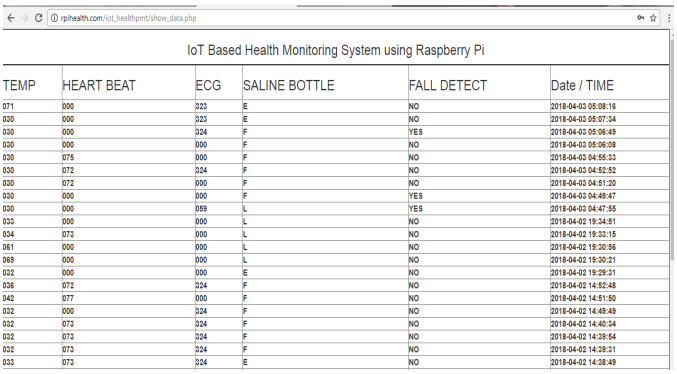

Fig 6: Data Storage on the IoT sever

E. Results:

Alert Notifications:

This system sends sms and email alerts to the targeted users (Doctors/ Health professionals)of the system if

particular sensor value is beyond the decided range, threshold value so that user will be aware of the health and can take care accordingly.

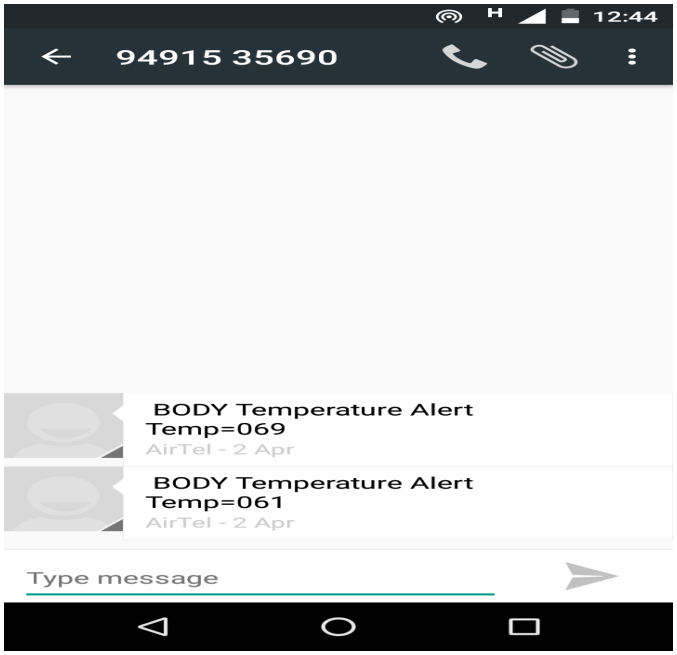

Fig 7: Sms Alert

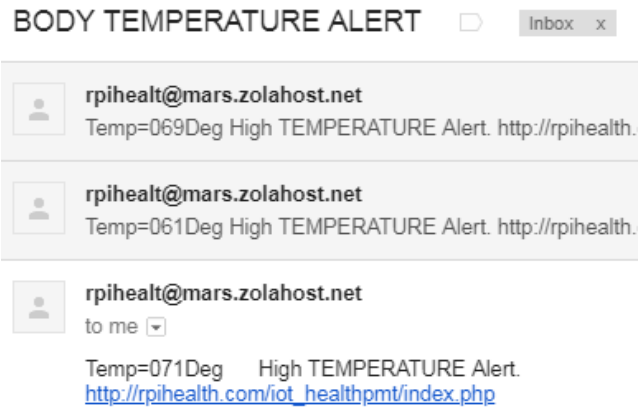

Fig 8: Email Alert

Decision Making of Health condition(on Doctor's side):

No. of sms/email alerts	Health Status of a Patient
Alerts<=3	Unhealthy
Alerts>3	Critical

Table 1: Health Status Predictions

Sending Precaution Notification from Doctor to Patient:

In case of emergencies that is in case of sensor values crossing the threshold values doctor gets the alert sms and from that he/she will be able to know about the health status of the patient and can take further decisions. If found urgent he/she sends precaution notification and instructions about the diet to the patient.

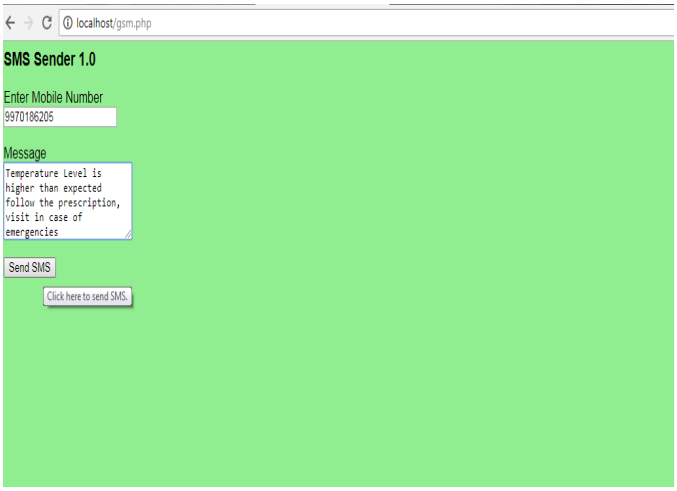

Fig 9: Precaution notification via sms

IV. CONCLUSION

A health monitoring system based on concept of internet of things with implementation of it on raspberry pi is proposed. It follows the basic MQTT protocol of IoT and it is an application of remote health monitoring. It helps for better diagnosis of the patients with chronic diseases. This system helps to monitor health of elderly people who cannot visit the hospitals on regular basis. Hence Primary health checkups are also made easy. Patients' history is saved on the server hence it benefits the follow-ups. As it uses information technology for the assessment human errors are removed hence gives better performance.

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