Abstract: Nowadays IoT is playing an important role in health care systems, which is not only helpful for monitoring the health parameters but also helpful for communicating, storing and displaying the monitored data. The main aim of the project is to design and implement effective health care patient monitoring system. The proposed system monitors the health parameters like Temperature, BP and Pulse rate etc. and then transmits the parameters wirelessly through wifi module technology. The transmitted data is displayed on the PC .This data gets updated into database continuously. From the database with the help of android application fetches all the updated data and displays it on doctor side personal mobile. This tells the doctor the current status of the patient in real time. If any parameter of a particular patient goes beyond a pre-assigned threshold value, then an automatic notification will send on doctors mobile using android mobile application. The system basically consists of hardware like sensors, microcontroller (ATmega16), LCD display, wifi module(ESP8266), MQTT protocol for sending data on cloud, android app etc.

1. INTRODUCTION

Internet of things (IoT) dependent patient monitoring is a network implemented to operate different medical sensors connected to the human body. Implementing it in medical application gives flexibility of operation. They reduce user discomfort and enhance mobility. Applications in this category include monitoring of the biological parameters, tracking and monitoring of the patients inside hospital. Applications in this category include monitoring of the biological parameters, tracking and monitoring of the patients inside hospital. Proposed system is a special purpose network designed to operate various medical sensors connected to the human body. They measure body’s basic functions which can be helpful for monitoring general health of a person. The aim of the healthcare application is to provide better healthcare to all the people anywhere and at any time and purpose of the system is to prevent delays in the arrival of patient’s medical information to the healthcare providers, especially in accident and emergency cases.

Basically the flow of system is based on medical sensors that measure patient’s physical parameters with the help of wireless sensor networks (WSNs). These sensors transfer data from patient’s bodies over the wireless network to the cloud environment. Cloud environment gives suitable and on-demand network access for number of computing resources such as networks, systems, applications, and services. The proposed system consists of following component:

Sensing node: Each sensor node is connected with a microcontroller and a power source. The sensors will require limited source of energy. The sensing nodes will sense physical data then the monitor all conditions and performing small processing operations it will transmit data to other sensing nodes in network.

Transmission technology: Transmit data over network through Wi-Fi module with the help of Message Queuing Telemetry Transfer (MQTT) protocol.

2. SYSTEM DESCRIPTION

2.1 System Block diagram

The block diagram of patient monitoring system is shown in figure. Here three IoT biomedical sensors named as temperature sensors, blood pressure sensors and pulse rate sensors are connected to AVR controller. They will sense medical parameters with respect to the three sensor then with the help of MQTT (Message Que Telemetric Transfer) publish-subscribe protocol the information of the patient is sent on cloud through wi-fi module and using

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Fig. 1 Block diagram of patient monitoring system

2.2 Methodology of Implementation

In proposed system, three applications have implemented. These are as follows:

a. Data collection
b. Data on cloud
c. Decision making process

a. Data collection

Patient’s physical parameters are measured using medical sensors that are connected to a microcontroller. It is responsible for collecting data from the sensors and transferring it over router, to the cloud environment.
The sensors transmit real time data in the cloud continuously based on the set conditions which are in their configuration program.

![Block diagram of data collection](image1)

The DS18B20 digital thermometer gives 9-bit to 12-bit Celsius temperature measurements. The DS18B20 communicates over a 1-Wire bus requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can take power directly from the data line; it does not require external power supply.

![Block diagram of data collection](image2)

**Table 1** Classification of temperature

| Hyperthermia | Normal | Fever | Hyperthermia |
|--------------|--------|-------|--------------|
| <35.0°C      | 36.5-37.5°C | >37.5°C or 38.3°C | >40.0°C or 41.0°C |
| (95.0°F)     | (97.7-99.5°F) | (99.5°F or 100.9°F) | (104.0°F or 105.8°F) |

Pulse Sensor is plug-and-play heart-rate sensor for controller. The sensor clips onto a fingertip and plugs right into microcontroller. The power supply voltage: 3.3V ~ 5V

![Block diagram of data collection](image3)

**Table 2** Pulse rate range

|                         | 1-12 month | 1-2 years | 3-6 years | 7-12 years | Adolescence |
|-------------------------|------------|-----------|-----------|------------|-------------|
| 120bpm                  | 110bpm     | 100bpm    | 95bpm     | 80bpm      |

Blood pressure is the pressure of the blood in the arteries as it is pumped around the body by the heart. When your heart contracts and pushes blood through the arteries to the rest of your body force creates pressure on the arteries. Blood pressure recorded as two numbers—the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats).

![Block diagram of data collection](image4)

**Table 3** Blood pressure range

| AGE       | GENDER | MIN/ MAX(mmHg) |
|-----------|--------|-----------------|
| <18       | Male   | 80/120          |
| 18 to 20  | Male   | 82/125          |
| 21 to 40  | Male   | 85/135          |
| 40 and above | Female | 85/130         |
| <20       | Female | 80/123          |
| 21 to 40  | Female | 82/133          |
| 40 and above | Female | 85/133         |

b. Data on cloud

Here MQTT protocol suit is used. It is a publish subscribe type. MQTT broker will act as mediator between publisher and subscriber. The publisher will send or transfer the information regardless specific receiver. Receivers are categorized and receive information according to topic.

![Block diagram of data collection](image5)

The MQTT messages are delivered asynchronously ("push") through publish subscribe architecture. The protocol works with the help of exchanging a series of MQTT control packets where each one has a specific purpose and every bit in the packet is used to reduce the data transmitted over the network. Client and server communicate over different control packets. Steps to connect MQTT server are as follows:

Step 1: Download an application named “MQTT dashboard” on android Phone.

Step 2: Open application and Go to settings.

a. In First text box enter Client ID
b. In Second text box enter URL of MQTT server/client that is iot.eclipse.org
c. Third Text box is for Port, type 1883
d. Left username and password blank.
e. Press Create.
Step 3: Now you have to create a TOPIC in Phone
Step 4: To subscribe to the topic on Phone, you have to type the topic name in phone, which is “patient1”.
In such manner connection with MQTT server is completed. For sending the data on cloud along with MQTT protocol we have used wi-fi module ESP8266.

![ESP8266](https://www.ijert.org)

The ESP8266 is low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections.

Basic flow chart:

![Flow Chart](https://www.ijert.org)

- d. Decision making process
  Here sensor will sense the data that is human body’s medical parameters such as temperature, pulse rate and blood pressure. If the data is normal then it is saved in database and it will send decision to doctors follow up. Now if the is not normal then it will check medical condition the result is send for doctors approval for further treatment.

3. DECISION APPROVAL
After the system makes the decisions, it will be sent to medical staffs for the patient’s healthcare for approval. There are different ways to notify medical staff including SMS & email. They can use a web browser from any device to review and update decisions as needed. medical staff can decide if the current decision which are created from the system are right for the patient’s condition or they need to change and update the them.

4. EXPERIMENTS
This section describes results for patient monitoring system using IoT and then experiments which we have performed for performance calculation of implemented system.

4.1 Results
Following figure shows that the results on LCD and android app. In the result following parameters are shown: Temperature, motion and position of animal.

I. LCD output

![LCD output](https://www.ijert.org)

II. Temperature output

| Patient ID | Temperature in °C (thermometer connected to hardware measured value) | Temperature in °C (directly measured value (expected value)) | Status of the patient with respect to standard temperature range |
|------------|------------------------------------------------------------------|----------------------------------------------------------|---------------------------------------------------------------|
| Patient1   | 34.35                                                            | 34.00                                                   | Normal                                                        |
| Patient2   | 34.50                                                            | 34.50                                                   | Normal                                                        |
| Patient3   | 33.50                                                            | 33.50                                                   | Normal                                                        |
| Patient4   | 33.75                                                            | 33.75                                                   | Normal                                                        |
| Patient5   | 34.10                                                            | 34.10                                                   | Normal                                                        |
| Patient6   | 34.90                                                            | 34.90                                                   | Normal                                                        |
| Patient7   | 34.55                                                            | 34.55                                                   | Normal                                                        |
| Patient8   | 35.12                                                            | 35.12                                                   | Normal                                                        |
| Patient9   | 34.42                                                            | 34.42                                                   | Normal                                                        |
| Patient10  | 35.13                                                            | 35.13                                                   | Normal                                                        |
| Patient11  | 36.43                                                            | 36.66                                                   | Normal                                                        |
| Patient12  | 38.45                                                            | 38.45                                                   | Normal                                                        |
| Patient13  | 36.88                                                            | 36.88                                                   | Normal                                                        |
| Patient14  | 36.88                                                            | 36.88                                                   | Normal                                                        |
| Patient15  | 37.35                                                            | 37.22                                                   | Normal                                                        |

III. Pulse rate output

| Patient ID | Age | Measured value | Measured value | Status of the pulse rate with respect to standard pulse rate range |
|------------|-----|----------------|----------------|---------------------------------------------------------------|
| Patient1   | 55  | 60             | 60             | Normal                                                        |
| Patient2   | 70  | 60             | 60             | Normal                                                        |
| Patient3   | 55  | 70             | 70             | Normal                                                        |
| Patient4   | 50  | 70             | 70             | Normal                                                        |
| Patient5   | 42  | 60             | 60             | Normal                                                        |
| Patient6   | 40  | 60             | 60             | Normal                                                        |
| Patient7   | 35  | 60             | 60             | Normal                                                        |
| Patient8   | 31  | 70             | 70             | Normal                                                        |
| Patient9   | 32  | 70             | 70             | Normal                                                        |
| Patient10  | 30  | 70             | 70             | Normal                                                        |
| Patient11  | 40  | 70             | 70             | Normal                                                        |
| Patient12  | 40  | 70             | 70             | Normal                                                        |
| Patient13  | 35  | 70             | 70             | Normal                                                        |
| Patient14  | 35  | 70             | 70             | Normal                                                        |
| Patient15  | 35  | 70             | 70             | Normal                                                        |
IV  Blood pressure output

| Patient ID | Blood pressure output | Blood pressure in as per expected | Status |
|------------|-----------------------|----------------------------------|--------|
| Patient1   | 120/90                | 120/90                           | Normal |
| Patient2   | 130/80                | 130/80                           | Abnormal |
| Patient3   | 140/90                | 140/90                           | Abnormal |
| Patient4   | 150/100               | 150/100                          | Normal |
| Patient5   | 160/110               | 160/110                          | Normal |
| Patient6   | 170/120               | 170/120                          | Normal |
| Patient7   | 180/130               | 180/130                          | Normal |

Above Table 4-6 shows humans basic body parameters that are the temperature, pulse rate and blood pressure parameter with different conditions.

V.  Android app output

Fig.7  (a) and (7) shows the output on android app. It shows the temperature, pulse rate and blood pressure.

II.  Performance parameter

1)  Percentage error measure:

To calculate the performance of the system, we have to use a percentage error measure. It is the difference between a measured value and an expected value. The formula for percentage error is as follows:

\[
\% \text{ error} = \frac{(\text{approximate value} - \text{exact value})}{\text{exact value}} \times 100\% \quad (1)
\]

From above three table values % error of temperature sensor calculated as:

- For reading no.1
  \[\% \text{ error for Temperature Sensor} = \frac{(\text{measured value} - \text{expected value})}{\text{expected value}} \times 100\%\]
  \[= \frac{(35.25 - 34.98)}{34.98} \times 100\% \approx 0.27 \times 100\% \approx 27\%\]

- For reading no.2
  \[\% \text{ error for Temperature Sensor} = \frac{(\text{measured value} - \text{expected value})}{\text{expected value}} \times 100\%\]
  \[= \frac{(34.50 - 34.21)}{34.21} \times 100\% \approx 0.29 \times 100\% \approx 29\%\]

Similarly we can calculate % error of Pulse rate sensor and Blood pressure sensor

2)  Accuracy:

Accuracy measures the ability of designed system to detect the true value or expected value with respect to the given condition. The formula for calculating accuracy is as follows:

\[\% \text{ Accuracy} = \frac{100\% \text{accurate system} - \% \text{error measure}}{2}\]

From above three table values % Accuracy of temperature sensor calculated as:

- For reading no.1
  \[\% \text{ Accuracy} = \frac{100\% \text{accurate system} - \% \text{error measure}}{2}\]
  \[= \frac{100\% - 27\%}{2} \approx 73\%\]

- For reading no.2
  \[\% \text{ Accuracy} = \frac{100\% \text{accurate system} - \% \text{error measure}}{2}\]
  \[= \frac{100\% - 29\%}{2} \approx 71\%\]

5.  CONCLUSION

In this paper we proposed a framework for patient monitoring using Internet of Things which used to transmit the data which is sensed from biomedical sensor to the server by using wi-fi module. It is completely integrated so that it is possible to measure human body’s basic parameter anytime from anywhere. It has real time capability. The accuracy of system is affected by some factors such as time delay, network around the mobile, GPS receiver having accuracy is 93.33% and sensitivity of system is 93.33%.

Circuitry is having less complexity and Modules used are smaller in size and also lightweight and portable.
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