Fingerprint Integrated E-Health Monitoring System Using IoT

N.Keerthana[1], K.Lokeshwaran[2], P.S.Kavinkumar[3], T.Kaviyan[4], M.Manimaran[5]and S.Elango[6]

[1,2,3,4,5,6]Department of Electronics and Communication Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode-638 401, Tamil Nadu, India
keerthanan.ec18@bitsathy.ac.in

Abstract: Health has the foremost importance in our daily life. For the past few decades, people are getting infected with an increased number of diseases due to improper health care. Health care is prominent for every being to lead a successful life. Health monitoring concepts are acquainted with developed and developing countries. Health monitoring using IoT helps people by providing smart, reliable health care services. This framework monitors the patient's body temperature, heartbeat rate, and blood oxygen level with different sensors. Transmission of information from a body sensor is stored in the cloud using Node MCU and converts data into readable signals with proper security measures. This information's are sent as a message to the doctor and guardian of the patient. This system is beneficial for elderly and bedridden patients to monitor their health condition properly.

Keywords: Internet of Things (IoT), Sensor System, Cloud, E-Health Monitoring.

1 Introduction

Health is said to be the state of physical, mental and social well-being. But recently, we are facing many health issues due to improper health care, inadequate services. Nowadays, medical sensors play an essential role in an E-Health monitoring system and promote innovative research and invention. People use a thermometer to check the home temperature and take some precautions before consulting the doctor [1]. E-Health monitoring using IoT helps us find the patient's health condition in the house and informs the doctor through message for better medical care at the earliest. In the existing model, Arduino was used along with a Wi-Fi module to store the data in the cloud, and a GSM module is

used to send message to the authorized person[8]. In the proposed model, the Infrared temperature sensor, MAX30102- Pulse oximeter and pulse rate sensor are used to measure the body temperature, blood oxygen level and heartbeat rate, respectively, with the help of LCD. The data are stored in the cloud via NodeMCU (ESP8266 Wi-Fi SOC), and the details are sent as a message to the doctor and guardian of the patient to ensure the earliest medical care [2].

Internet of Things is a platform that connects everything embedded with sensors and software. The term 'things' in IoT represents everything we are accessing in our day to day life [3,4]. It is working on many platforms. It is a technology which is increasing at present, and a lot of innovations are developed. In future, it will become a common platform where all things can connect. IoT has many features where the standard features are connectivity, analyzing, integrating, and artificial intelligence. In this work, the IoT concept is used to store the data in the cloud, examine with the base knowledge and send an alert message to the authorized persons. IoT applications include Machine to machine communication, Machine to infrastructure communication and Telehealth (i.e.) patient data monitoring, analyzing and predicting the disease at the earliest [5,6].

In this work, the cheap and absolute system is proposed using ESP8266 and fingerprint sensor to ensure security. The objective of the work is to get real-time medical information of the patient via IoT. To ensure all sensors work concurrently and give the message to the authorized persons. As an outcome, Doctors can quickly diagnose and treat the disease or disorder in the preliminary stage by using advanced technologies. A physician can provide medical assistance for the minor illness based on the data received from the health monitoring system messages anywhere [7,9].

The rest of the works as follows, related work in section 2, tell the health monitoring system's recent development. Section 3 discusses the proposed methodology, followed by the hardware description. Working and Implementation of the proposed model is discussed in Section 4 and 5, respectively. The conclusion is given in section 6.

2 Related Work

Many works have been done in the field of health monitoring with the help of the IoT system. Here some works in the field of E-health are discussed. The patient monitoring system monitors the basic health parameters like temperature, pulse rate, blood pressure, and ECG. For this temperature, heartbeat, ECG sensors are used withSST89E516RD2, which acts as a microcontroller, and a Wi-Fi module is used for data transmission. GSM is used to send the alert note [1]. In [2], implemented the health monitoring system that monitors the patient's temperature and pulse rate with an Arduino Microcontroller's help. These data are stored in the cloud for future purpose. These details are displayed on LCD.

The patient monitoring system using IoT with the help of temperature, BP,

heartbeat and vibration sensors to monitor the temperature, blood pressure, pulse rate, and body movements of the patient, respectively, is designed [3]. In this, the health details are sent to the doctor with the help of the GSM module. In [6], the authors have developed a telehealth application that monitors the health condition and provides chronic diseases' workout recommendations. In [7] intended a smart healthcare monitoring system sed in the hospitals to monitor the patients' health parameters like heartbeat rate. This setup is done to monitor the patient's health condition and environmental conditions like room temperature, co and co2 level in the ambient.

3 Proposed Methodology

Designing of Health monitoring system is a challenging task for every researchers, engineers, and student. A Health monitoring system is
Portable and widely used in areas like homes, hospitals, sports etc. They are designed based on the needs of the user. The model is created using Node MCU (ESP8266), which is used primarily for IoT based projects because it is open-source software that includes firmware that runs on ESP8266 Wi-Fi Soc. The biomedical sensors are integrated with the microcontroller to give accurate and reliable data for monitoring health care, as shown in Figure 1. The health parameters like temperature, blood oxygen level and pulse rate are monitored by the Infrared Temperature sensor and Pulse oximeter sensor. The sensor data are transmitted to the cloud via NodeMCU, where they are processed, analyzed, and compared with the data provided earlier. Once the data is verified, the alert message will be sent to the doctor and the patient's guardian. Patient's data will be used by stored in the cloud, and doctors can provide medical assistance based on the previous reports. The data of the patients are protected with the help of the fingerprint-based security system. This helps to avoid mismatching and loss of data. It also allows doctors to observe the patient with well-maintained data and provide proper medication at any time.

.

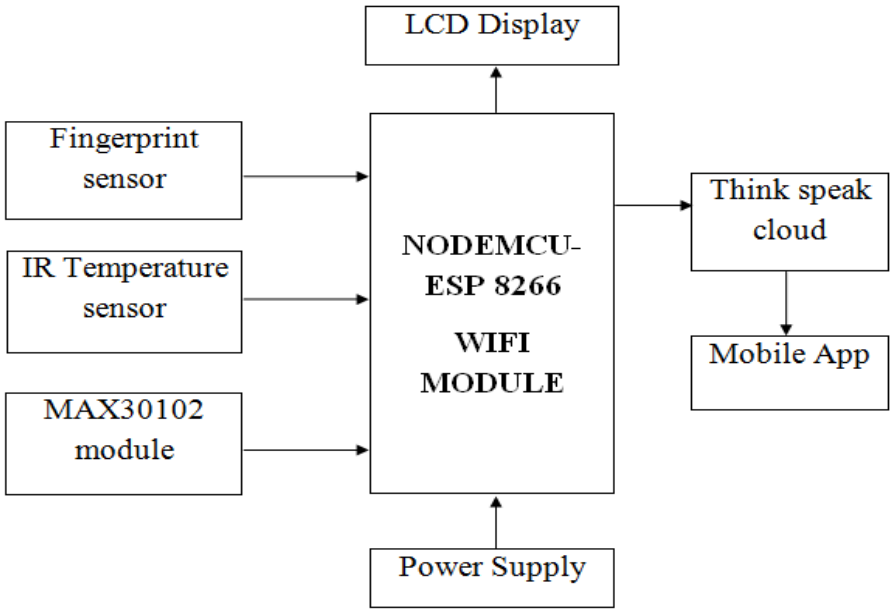


Fig. 1. Block Diagram of the proposed model

Proposed Hardware Model Description

NODE MCU:

In the proposed model, the biomedical sensors are connected to the NodeMCU ESP8266, a microcontroller that includes a Wi-Fi module. It makes it ease of transferring and storing the data to the cloud without external hardware assistances. Then the data are processed in the cloud, and the alert messages are sent to the mobile. NodeMCU is an open-source, bank card sized microcontroller (Ten silica 32-bit RISC CPU Xtensa LX106) mainly used for IoT based applications. It includes Lua based firmware, runs on ESP8266 Wi-Fi SOC and hardware is based on ESP -12 modules with an operating voltage of 3.3v.

FINGERPRINT SENSOR:

R305 is an optical biometric fingerprint sensor module that is small in size with low power consumption and excellent performance. The Features of the Fingerprint module are as follows, and it holds the capacity to store 980 fingerprints. It has a lifetime of 100 million times, and its matching method is based on the ratio of 1:1 and 1:N.

INFRARED TEMPERATURE SENSOR:

The infrared temperature sensor senses electromagnetic waves from 700nm to 14000nm. IR thermometer uses a Lens to focus light from one object to a THERMOPHILE detector, which absorbs IR radiation and turns into heat. The more IR energy, the thermopile gets hotter. An infrared thermometer is used to measure human forehead temperature.

PULSE OXIMETER SENSOR:

MAX30102 is a module that includes both a heartbeat sensor and a pulse oximeter sensor. An oximeter sensor is used to measure the blood oxygen level in the body. A person's heartbeat is measured through a Heart rate sensor based on the time-series responses of IR and red LEDs. MAX30102 operates on a single 1.8vpower supply and a separate 3.3v power supply for LED'S present inside.

LCD:

Liquid Crystal Display (LCD) is the displaying device that is used in many circuits. It is flat and contains liquid crystal cells that do not emit light directly; instead, it uses a backlight to display the panel's image.

4 Working of the Proposed Model

Figure 2 shows how to extort the patient's medical data from different sensors that continuously monitor the patient's health condition. Then the data are stored in the cloud and analyzed with the knowledge base. Later the message is sent to the authorized persons.

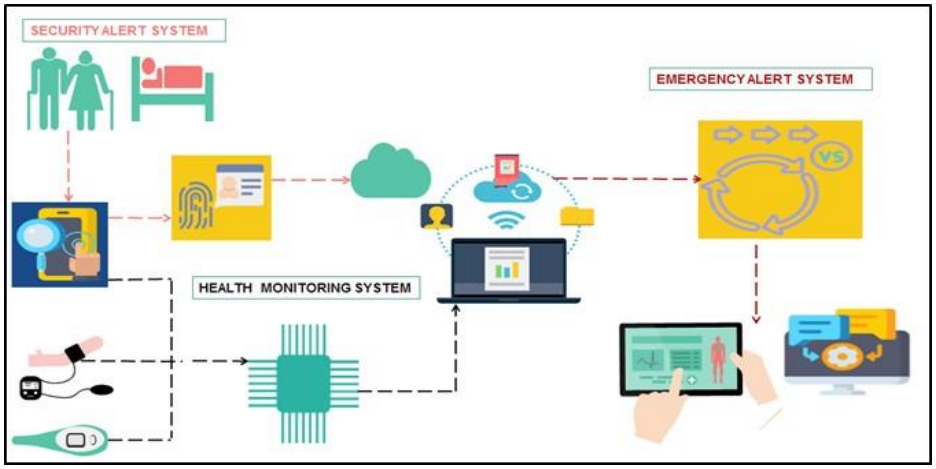


Fig. 2. Proposed Model

Working of the system

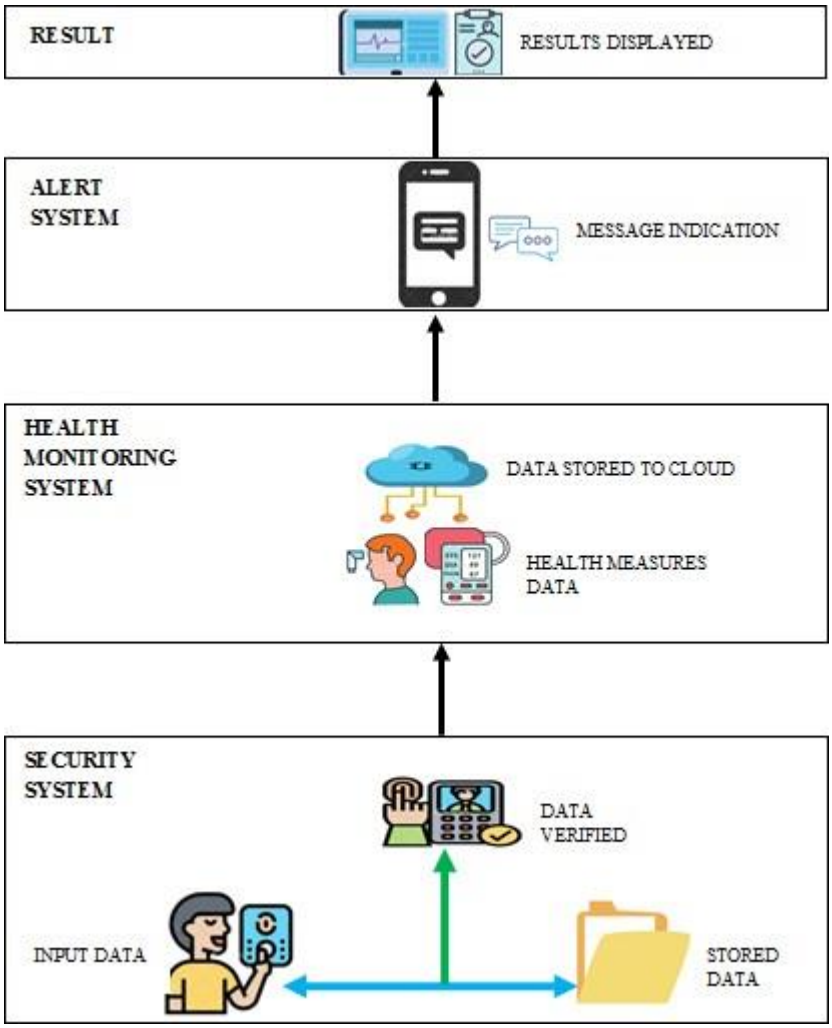


Fig. 3. System-Level Stages of the proposed model

The proposed idea comprises the three stages shown in figure 3, which explains the model's complete working.

- Security alert system
- Health monitoring system
- Emergency alert system

4.1 Security alert system

In this system, every patient is given a unique id and biometrics; medical details are added to the cloud at registration. Once the patient keeps his biometric, his /her details will be shown, and the cloud will allocate the space for data storage.

4.2 Health monitoring system

In this system, various health parameters like temperature, blood oxygen level and heartbeat rate are monitored using biomedical sensors like Infrared temperature sensor, MAX30102 Pulse oximetry and pulse rate sensor. The data is sent to the cloud with the help of the microcontroller. These data are stored in the memory allocated.

4.3 Emergency alert system

In this system, the patient's data is compared with the knowledge base, which is already provided, shown in Table 1. If the data are normal, it sends the message "NORMAL" to the authorized person. If the values are mismatched, it will send a notification "ABNORMAL" to the authorized person and seek a medical emergency. This will also help the doctors predict the disorder in the preliminary stage and quickly diagnose them with advanced technologies like data mining.

Table 1. Threshold values

COMPONENTS	NORMAL RANGE
Infrared Temperature Sensor	36.5 – 37.5°C / 97.7 – 99.5°F
Blood oxygen level	95 – 100 %
Pulse rate sensor	60 – 100 beats / minute

5 Implementation

In this project, the fingerprint sensor is used to get the patient details with the unique id for maintenance and security. Once the fingerprint of a person is verified and matched with the cloud's data, the IR temperature sensor placed above the fin-

gerprint module detects the person's temperature. The health monitoring system monitored the heartbeat rate, the patient's blood oxygen level with sensors' help and placed on the patient's body. This sensor sends the data to the cloud using NodeMCU which act as a controller cum Wi-Fi module. The data are stored and processed with the knowledge base and sends an intimation message to the authorized person, as shown in figure 3. As the name "E-Health Monitoring system using IoT" implies that health is monitored automatically with biomedical sensors, IoT and microcontroller. The result of the proposed system shown in figure 7 and 8 will significantly help the doctors and patients observe keenly. This will help the patients take care of their health correctly with less expense to hospitals. Doctors can quickly identify and maintain the patient's records to monitor their health condition and give them better medical assistance in all situations. The proposed system is modest, easy to understand, and constructs the doctors and patients' bond for a better life.

The system's working explained in figure 4, and the corresponding sample test case in table 2 helps us understand the proposed model's functioning. After the verification of fingerprint for security, the cloud allocates the storage memory and monitors the patients' health parameters. These data are sent to the cloud and analyzed with the base data, and then an alert message is sent. If all the values, i.e. temperature, blood oxygen level and pulse rate, match the base data, then the message will be 'All the values are Normal'. If the values are mismatched, then the alert message will be 'All the values are Abnormal'. In some cases, if any one of the three values is mismatched, then the alert will be 'Abnormal value of the particular parameter'. This system provides the plot of the health parameters in a detailed manner shown in figure 5.Test sample of a single patient is given in table 3 shows the detailed view on actual value and the observed value of the patient health parameter with a plot in figure 6.

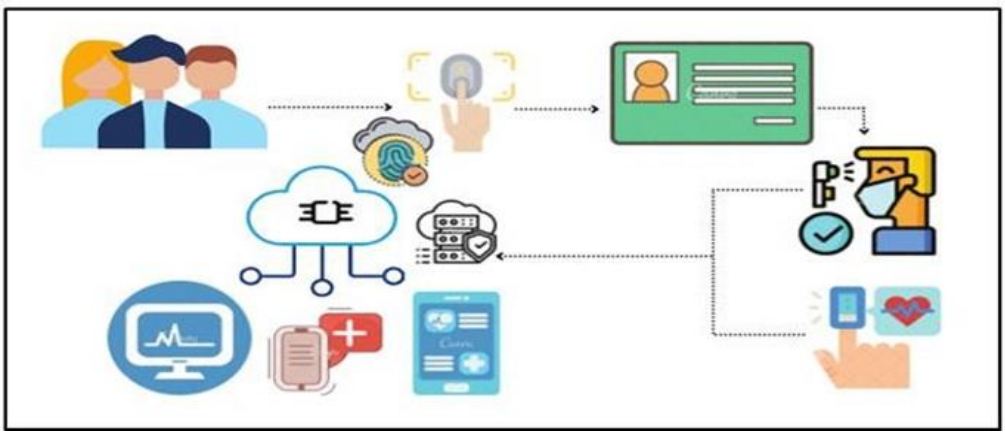


Fig. 4. Implementation of the system

Table 2. Test samples

Patent	Temperature (°F)	Blood Oxygen Level (%)	Pulse Rate (Beats/Minute)	Message
1.	98	96	70	All values are Normal
2.	100	98	80	Abnormal value of Temperature
3.	99	90	70	Abnormal value of Blood oxygen level
4.	99.9	80	50	All values are Abnormal
5.	99.1	99	65	All values are Normal
6.	101	96	85	Abnormal value of Temperature

Table 3. A test sample of a single patient

Health Parameters	Actual value	Obtained value
Temperature	97.7-99.5	101
Blood Oxygen	90-100	85
Pulse Rate	60-100	80

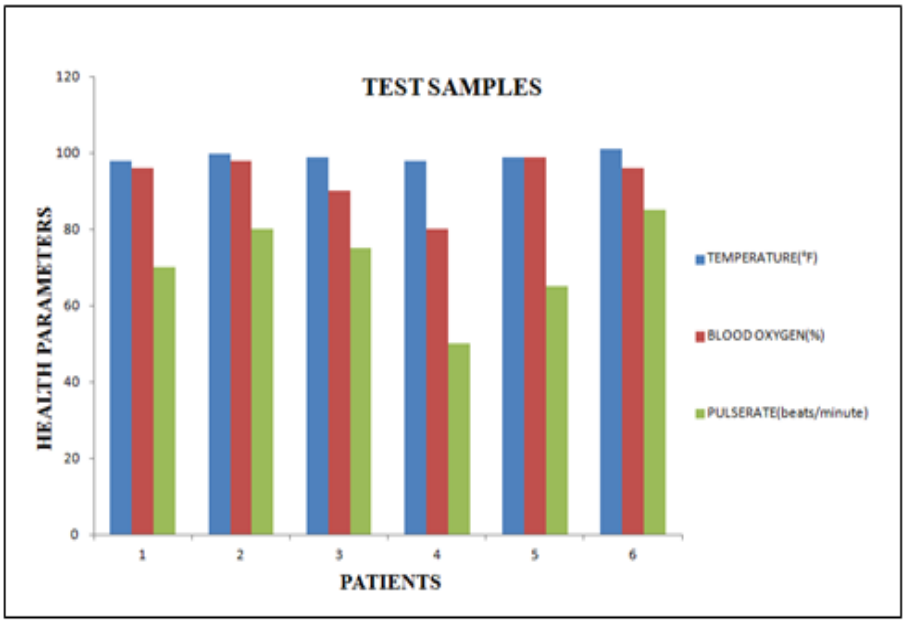
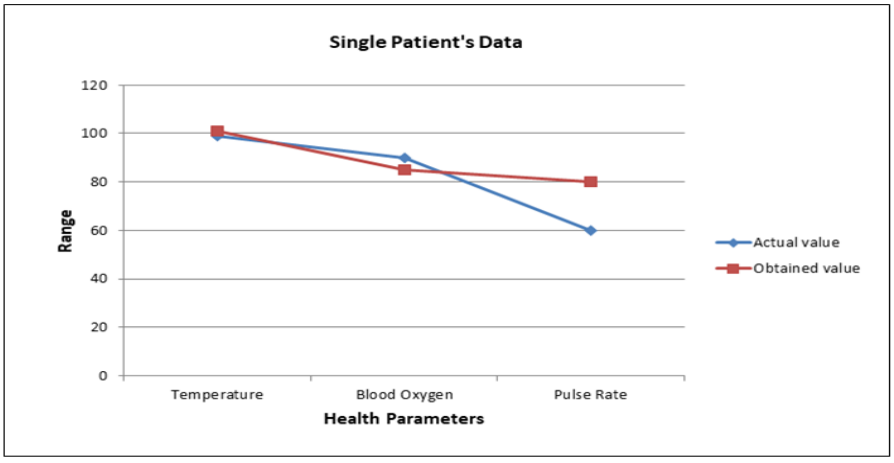


Fig. 5. Test samples plot



\

Fig. 6. Sample plot of Single patient

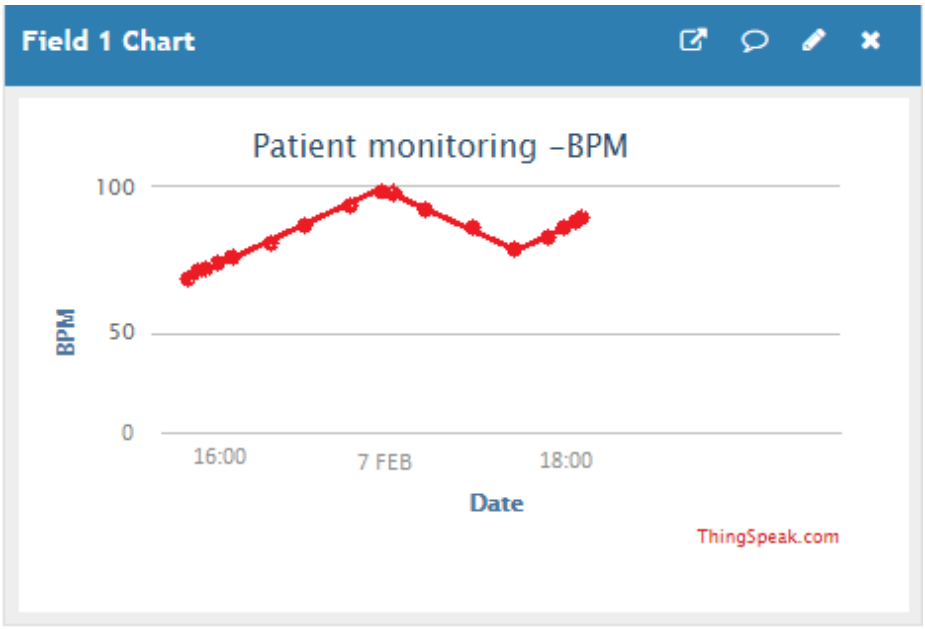


Fig. 7. Sample result of the proposed model (BPM)

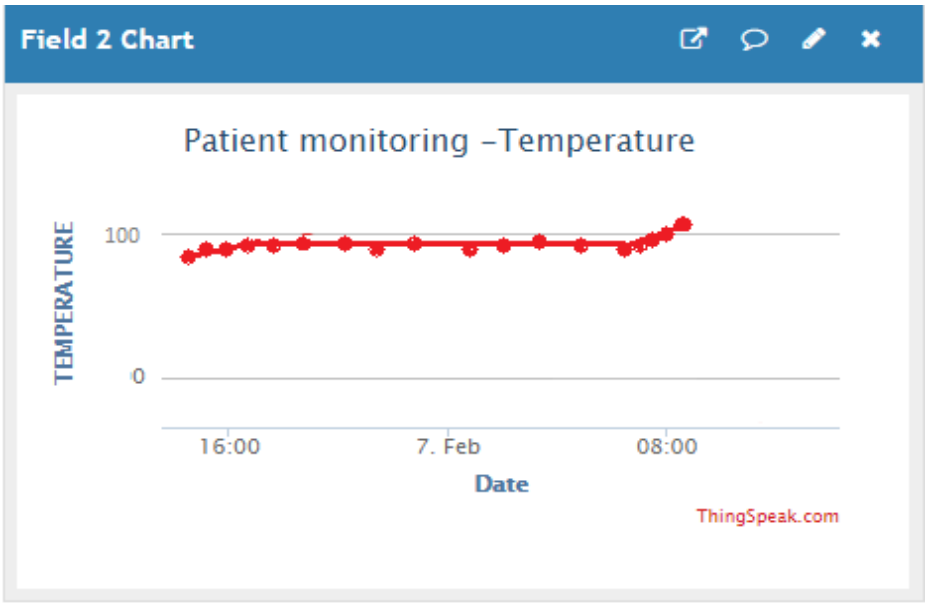


Fig. 8. Sample result of the proposed model (Temperature)

6 Conclusion

The proposed model fulfils the needs of the people based on their requirements like cost-efficient, reliable, user-friendly, security etc. This E-Health monitoring system using IoT helps take care of older people, bedridden patients who require medical assistance every day. This system will help rural people monitor their condition and help the doctors find the disorder with the regular observation of the patient with data maintenance and analysis of the health condition. The proposed solution can be set up in hospitals to monitor the patients in more massive amounts to provide better medical care. The emergency alert system present in the model helps users monitor their health condition with an alert message.

6.1 Future work

Artificial intelligence technology can be integrated with our proposed system to improve the work of the system. Data mining will help to explore the medical details of many patients. This will work on patterns and allows doctors to analyze the patient's reports and give them the proper medical assistance at an appropriate time.

References

1.Surekha N, Yamuna N, Akhil Kumar J, Naveen Kumar KG, Rajesh Kumar Kaushal, Patient monitoring system using IOT, International Journal of Innovative Research in Advanced Engineering (IJIRAE), Vol.5, 5, pp. 176-182, 2018.
2.Shivleela Patil, Sanjay Pardeshi, Health Monitoring System Using IOT, International Research Journal of Engineering and Technology (IRJET), Vol. 5, 4, pp. 1678-1682, 2018.
3. Shubhan Banka, Isha Madan, S.S. Saranya, Smart Health Monitoring Using IOT, International Journal of Applied Engineering Research, Vol. 13, 15, pp. 11984 - 11989, 2018.
4. M. Neyja, S. Mumtaz, K. M. S. Huq, S. A. Busari, J. Rodriguez and Z. Zhou, "An IoT-Based E-Health Monitoring System Using ECG Signal," GLOBECOM 2017 - IEEE Global Communications Conference, Singapore, 2017, pp. 1-6. DOI: 10.1109/GLOCOM.2017.8255023.
5. B. Godi, S. Viswanadham, A. S. Muttipati, O. P. Samantray and S. R. Gadiraju, "E-Healthcare Monitoring System using IoT with Machine Learning Approaches," 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA), India, 2020, pp. 1-5, DOI: 10.1109/ICCSEA49143.2020.9132937.
6. Orge Gomez, Byron Oviedo, Emilio Zhuma, Patient Monitoring System Based on Internet of Things, Procedia Computer Science, Vol. 83, 2016, Pages 90-97, ISSN 1877-0509.

7.Md.Milon Islam, Ashikur Rahaman, Md.Rashedul Islam, Development of Smart Healthcare Monitoring System in IoT Environment, Springer Nature Singapore Pte Ltd,26 May 2020.
8.Prajoona Valsalan, Tariq Ahmed Barham Baomar, Ali Hussain Omar Baabood, IoT Based Health Monitoring System, Journal of Critical Review, ISSN-2394-5125, Vol 7, Issue 4,2020.
9.M.Sathya, S.Madhan, K.Jayanthi, IoT based Health Monitoring System and Challenges, International Journal of Engineering and Technology, Vol. 7 (1.7), 175-178, 2018.
.