IoT Enabled Health Monitoring System

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ABSTRACT

Monitoring patient health condition using IoT system deals with collection, interoperation of patient data which is collected from the sensors associated with the system deployed in the hospitals through IoT technology. The collected sensor information will help the doctor in the situations like emergency for the quick treatment and keeping the patient in better health condition. To implement proposed system the hardware required are set of sensors and Raspberry Pi 3 Model B+ with well equipped communication module to communicate with a doctor through IoT technology. The Python software is embedded into the Raspberry Pi model. The proposed health monitoring system will help doctors for quick diagnosis after knowing the patient health conditions anywhere in the world. In the proposed system, sensors will collect the medical information about the patient in the form of heart rate, movement information in case of bed ridden situation, pulse rate, present temperature, humidity condition and air quality conditions of the patient room. The sensor's captured information is sent to the cloud storage through an IoT technology and stored as health data server. Both doctor and patient have access to this server. They can monitor the patient data by sitting anywhere in world with IoT enabled gadgets. Hence, the health parameters of patients are regularly monitored by doctor and patients. The proposed system is sure of suggesting quick and correct medical care for patients at the affordable cost.

Keywords—Internet of Things(IoT), Health Monitoring System, Sensors, Cloud, ThingSpeak etc.

# INTRODUCTION

The IoT is gaining lot of importance in technical, economical and social domains. IoT use sensors, and competent processors with relevant accessories providing very effective means of communication between end users. The communication within the world between two parties is possible using IoT technology which enhances faster way of communication. With the help of IoT technology any application can be invoked anywhere in the world. So, an IoT technology reduces the difficulty level by providing lots of information on the internet. The IoT technology also enables the health conditions monitoring of patient remotely for patient and doctors. This technology provides support for enhancing the cost and quality of patient life and also increases the life span of patients with early medication. In the conventional health care system unsolved and unidentified health problems can be solved by this technology hence increasing healthcare services with digital identity for anybody(authenticated) in the world.. The motivational objectives need to be considered for the proposed work implementation are :

* IoT enabled proposed system helps in real-time monitoring of health care status makes the doctors to decide upon emergency condition of patients. Helps to provide urgent care for critical patients which in turn can save thier life.
* The cost effective and efficient system helps the patients to utilize the resources of the hospitals and save the money.
* The interface of system is very easy for patients and medical professionals.
* The remote health monitoring system is especially useful to monitor patients with chronic diseases. Most chronic diseases are incurable, so it is necessary to monitor the state of the patient while at home, and quickly respond if health indicators worsen.
* The Human Machine Interface is convenient and portable so it is very convenient for doctors to manage patients from the web server, and it is also very easy for patient’s guardians to monitor their family members health remotely.

Health monitoring using IoT is a technology to enable monitoring of patients outside of conventional clinical settings (e.g., in the home), which may increase access care right to the home. In addition, patients and their family members feel comfort knowing that they are being monitored to care and decrease healthcare delivery costs. This can significantly improve an individual's quality of life. It allows patients to maintain independence, prevent complications, and minimize personal costs. This system facilitates these goals by delivering and will be supported if a problem arises.

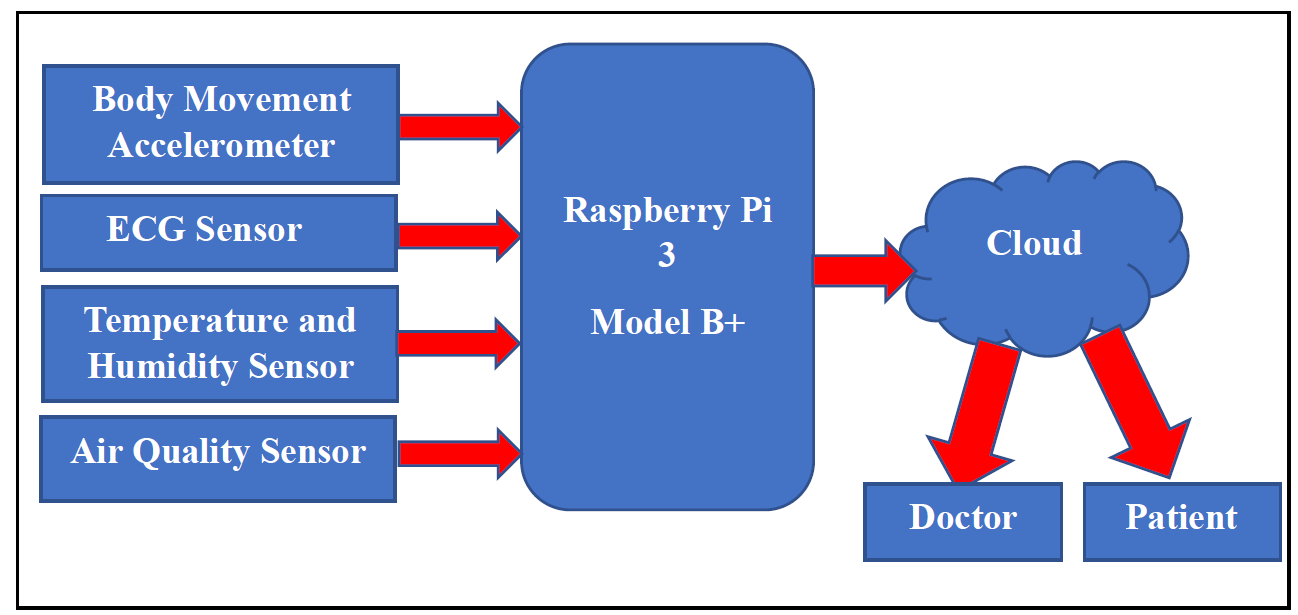
# BACKGROUND

The system which monitors the health conditions of patient consists of several sensors connected to a patient and they communicate the data through the processing unit. In [1], the patient monitoring system consist of Raspberry Pi as a data aggregator as well as a processing device, patient and doctor smart phone/computer are used as a monitoring system. The prototype developed in [2], detects the human motion such as walking, running or position within a closed room. It can classify activities like standing, sleeping, sitting, position. This system also tracks heart rate with the body temperature and humidity to determine the physical condition and abnormality. Md. Milon Islam et al.[3], proposed smart healthcare system to monitor the heart rate, body temperature, and some measures of hospital room’s condition such as room humidity, the level of CO and CO2 gases. This healthcare monitoring system uses Web User Interface for Data Processing. The paper[4], developed a prototype to monitor the health parameters of the patient i.e.; heartbeat and temperature using Raspberry Pi 3. They proposed continuous monitoring of the patient conditions and store the patient's data in the server using the IoT concept. Rameswari.R, Divya.N[5] describes the system which contains various existing and blooming technologies in the healthcare such as ECG, EMG monitoring through android apps, usage different protocols for transferring data such as MQTT, TCP/UDP, OCN authenticated mode, WLAN technologies etc. The paper[6] presents a health care monitoring system. for COVID-19 patients, high blood pressure patients, diabetic patients, etc., To support the health monitoring parameters specially in rural areas, the system will measure a patient’s body temperature, heartbeat, and oxygen saturation (SpO2) levels in the blood and send the data to a mobile application using Bluetooth. The main objective considered here is to increase affordability for regular people. Besides sustainability in the context of finance, patients will have easy access to personal healthcare. The authors presents an IoT-based system that will simplify the utilization of an otherwise complicated medical device at a minimum cost while sitting at home. A 95 percent confidence interval with a 5 percent maximum relative error is applied to all measurements related to determining the patient’s health parameters. The Module[7] implemented using ESP32 processor and two sensors effectively monitors the essential health parameters and information is sent to doctors/ nurses on mobile or computer system. Doctors can see the ECG, EEG waveforms & monitor other parameters of the patient on their computer screen sitting in their room and suggest medicines immediately in emergency. Information also received to cloud through Wi-Fi from the processor. The review paper[8] systematically list out the effectiveness, efficiency, privacy, data protection aspects of various health monitoring schemes. The authors brings out the challenges in the existing systems and provide some suggestions and recommendations for parameters of health monitoring. A smart health monitoring system[9] is developed using IoT technology specially to reach out for rural areas or village people especially in covid-19 situations. This system would help in identifying and early treatment of COVID-19 individual patients. The patient monitoring system[10] is designed using IoT platform, Arduino Mega 2560 and ESP8266 Wi-Fi Module and sensors. The system is able to detect the vital signs of patient using sensors and analyze it as per the patient age and privide alert message through android apps. Doctors will compare the vital information of particular patient with information stored in the cloud for necessary medication. The system[11] is developed to monitor the BP, HB, ECG information on LCD based on finger clip sensor information of the patient. Continuous monitoring is carried using IoT platform if any health parameter variations alert message sent to caretakers. The system[12] is highly used in emergency cases for suggesting medicines for patients using IoT platform. The review in [13] investigated many aspects for healthcare monitoring system including wheelchair monitoring, asthma monitoring, mood monitoring etc using latest technologies. An IoT based wearable health monitoring system[14], which remotely monitors the exact locations and health parameters of individuals of quarantined in real time. The system is built using optoelectronic and electronic components. The study of all the literature leads to formation desired requirements of health monitoring system using latest technologies aiming at:

* Implementation of wired communication is difficult. It is most expensive and takes more time . With help wireless sensor network like IoT makes the system cost effective and have fast installation procedural times with more reliability
* In conventional mechanism, doctor has to visit to patient room and check his medicine details and the patient condition and then suggest further treatment. In the proposed model NO such mechanism exist looking at the patient dashboard screen through IoT doctor immediately suggest suitable medicine
* This system can be deployed in patient and doctor's mobile phones for ease and fast accessing.
* Efficiency of healthcare is enhanced with this proposed system.
* All the sensors can monitor simultaneously and sends the results to the authenticated person. Provide medical assistance according to the data received i.e., heart rate, pulse rate etc.

# METHODOLGY

Continuous online patient and patient’s room condition monitoring is the main idea of the proposed system. The block diagram of health care monitoring system is shown in Fig.1, consist of different hardware and software blocks. The explanation of all the required hardware blocks and embedded software is described in subsequent sub sections. The input sensors sense the change and then information is sent to Raspberry board for evaluation. Then results are continuously updated onto the cloud account. Doctor can see the information available with him on his screen and immediately and suggest the treatment to patient. Both doctor and patient are connected to internet.

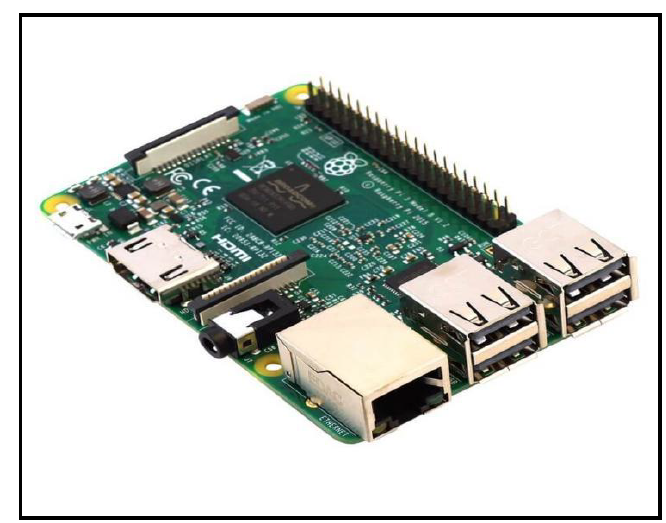


**Fig. 1 Block Diagram of IoT Enabled Health Monitoring System**

## **Hardware Reqiurement of Proposed Syatem.**

* **Raspberry pi 3 Model B+**

The Raspberry Pi is a tiny computer about the size of a deck of cards. It uses what's called a system on a chip, which integrates the CPU and GPU in a single integrated circuit, with the RAM, USB ports, and other components soldered onto the board for an all-in-one package. It doesn't have onboard storage, but it has an SD card slot you can use to house your operating system and files. The Raspberry module used is shown in Fig.2.



**Fig. 2 Raspberry Pi-3B Model**

* **ECG Sensor:**

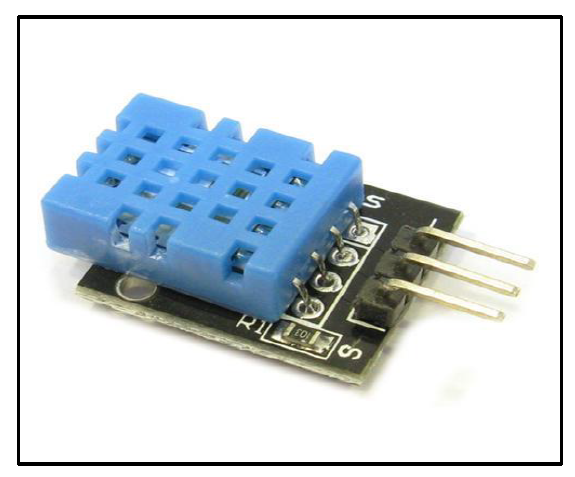
The ECG sensor as shown in Fig.3, record the electrical activity of the heart over a period of time using electrodes placed on the skin. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electrophysiological pattern of depolarizing and repolarizing during each heartbeat.



**Fig.3 ECG Sensor**

* **Temperature and humidity-based sensor:**

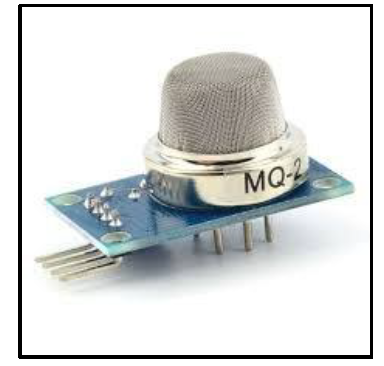
DHT11 module shown in Fig.4 is used for detecting Temperature and respective humidity of the room. It is a low-cost digital sensor. This sensor can be easily interfaced with any micro-controller such as Raspberry Pi to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.



**Fig.4 Temperature and Humidity Sensor**

* **Air Quality Sensor:**

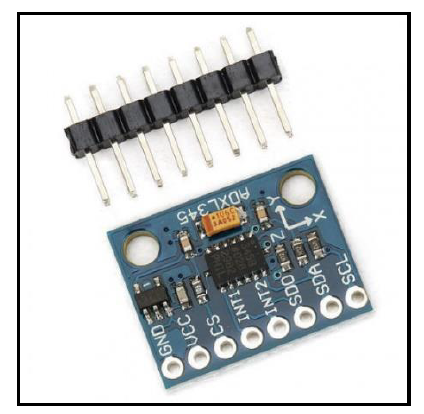
The electronic gas sensor MQ2 is used in the proposed system senses the concentration level of of gases present in the air. Gases such as LPG, Propane, Methane, Hydrogen, Alcohol, Smoke and Carbon monoxide are used to detect from MQ2 sensor. This MQ2 sensor is also called as chemi-resistor. This sensor consist of sensing material whose resistance changes when sensor lead comes in contact with the any of the above sensible gases. This type of sensors are the devices used to detect contaminants in the air. The air quality sensor is shown in Fig.5.



**Fig.5 Air Quality Sensor**

* **Body Movement Accelerometer:**

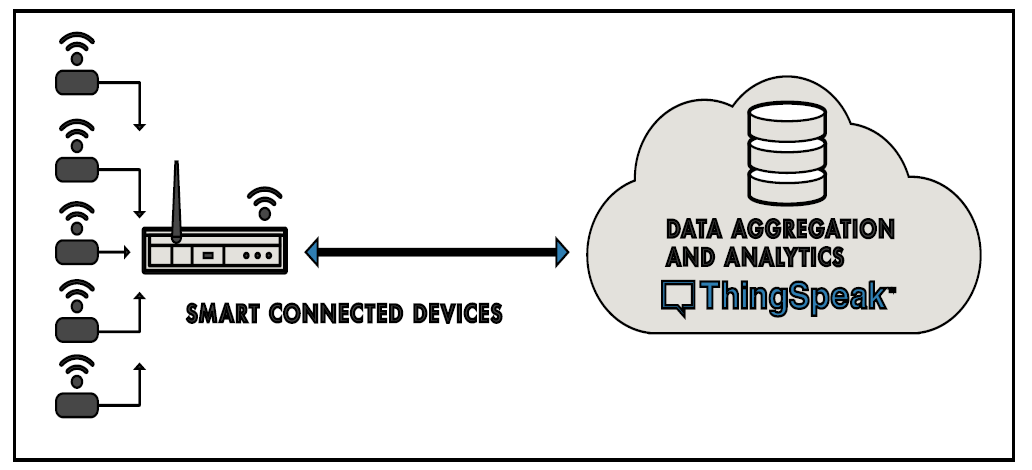
The ADXL 345 module shown in Fig.6 is used for detecting the moving direction. By using this sensor module, human movement can be observed in which direction it moves like Left or Right.



**Fig.6 Body Movement Detection Sensor**

## **Software Requirement**

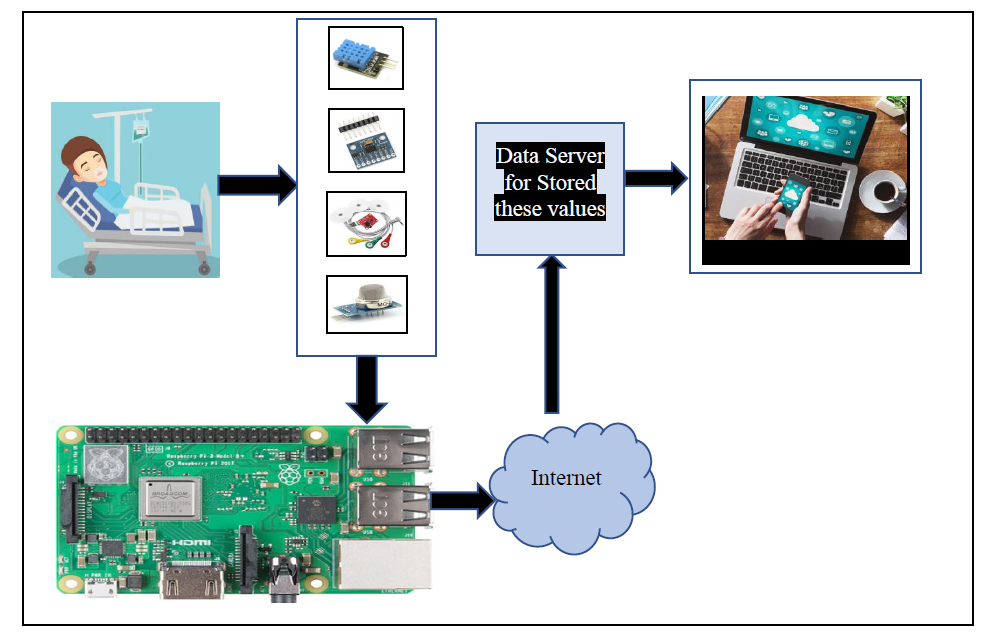
## ThingSpeak is an open-source cloud storage pictorially shown in Fig.7, allows users to communicate with an Internet enabled devices. It facilitates data access, retrieval and logging of data by providing an API to both the devices and social network websites. It is IoT Cloud platform where you can send sensor data to the cloud. You can also analyze and visualize your data with MATLAB or other software, including making your own applications.



**Fig.7 Thing Speak Cloud Connectivity with Smart Devices**

The healthcare monitoring system utilizes the three-stage architectural features, namely

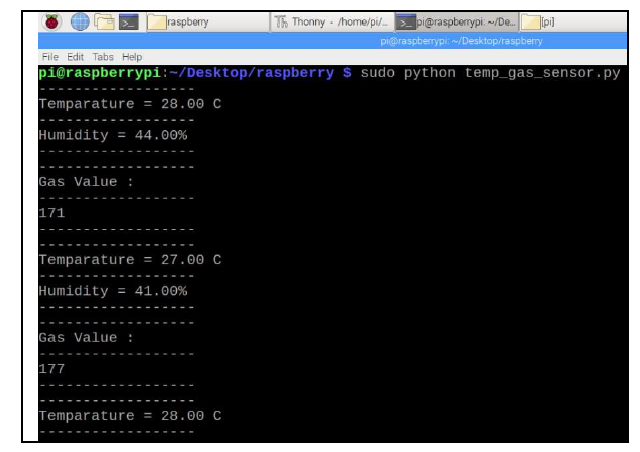
Sensor Module , Data Processing and Module Web User Interface .The sensors are wired which are used to collect data from the patient’s body and the environment by gathering physiological signs. The collected data are then processed in raspberry pi 3 B+ module. The collected data is then stored in cloud through ThingSpeak web application. ThingSpeak is used for the graphical interpretation, and display of collected results. The Doctors and patients can access the details of collected data by logging on to the web application. The prototype of the proposed model is described in Fig.8



**Fig.8 Prototype Model of Proposed work**

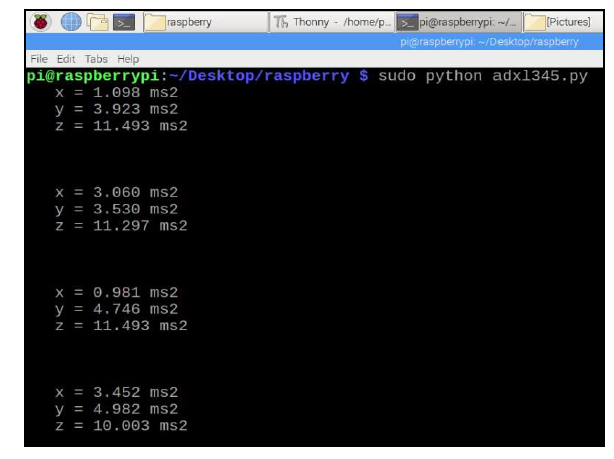
# RESULTS

This system is enhanced to automatically collect the Temperature and Humidity, Body Movement, Air Quality and ECG Sensors. The output of a critical patient and the collected data is then processed in Raspberry pi 3 model B+. The processed data will be sent to cloud via Internet and both the Doctors and Patients relatives are able to access the data by logging on to the web application. The results of Temperature and Humidity monitoring are shown in Fig.9.



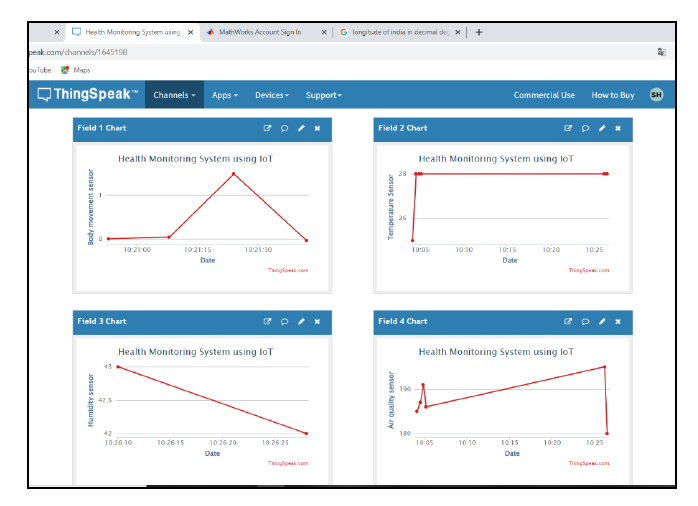
**Fig.9 Readings obtained with interfacing Temperature and Gas Sensors**

Similarly the monitoring of body movements of bed ridden patients positions are also recorded on the screen as shown in Fig.10.



**Fig.10 Readings obtained with interfacing Position Sensor**

The proposed prototype helps the doctors to arrive at quick decisions if the condition of patient is very critical. The results are also continuously sent to the cloud storage via internet. Monitoring system on the ThingSpeak storage are shown in Fig.11.



**Fig.11 Sample Data Storage on Cloud**

Real-time health monitoring systems using IoT can help doctors prioritize patients, and provide urgent care to those who are in the most danger thereby saving lives. More competent patient management can help utilize the resources of the hospital more wisely and save money. It is easy to use the system for patients and medical professionals. The remote health monitoring system is especially useful to monitor patients with chronic diseases. Most chronic diseases are incurable, so it is necessary to monitor the state of the patient while at home, and quickly respond if health indicators worsen. This prototype Human Machine System is convenient and portable so it is very convenient for doctors to manage patients from one app, and it is also very easy for patients to monitor their own health by wearing a lightweight device like a bracelet, watch, ear rings etc.

# CONCLUSION & FUTURE WORK

The system introduced smart healthcare to monitor the basic important signs of patients like heart rate, body movements, and some measures of hospital room’s condition such as room temperature, room humidity and the air quality of room. Authentic medical staff can view and track the data in real-time even though the patients are outside of the hospital. The system is very useful in the case of infectious disease like a novel coronavirus (COVID-19) treatment. The developed system will improve the current healthcare system that may protect lots of lives from death. In the future, IoT health monitoring will provide increased independence and mobility for elderly, sick, and physically or mentally disabled patients and reduce stress for family and doctors who can be alerted and react immediately as soon as issues arise. The proposed system can be enhanced to detect and collect several anomalies for monitoring purpose such as brain signal monitoring, tumour detection etc. The system can be designed further to send alert messages in emergency situation. The situation becomes worst when a patient is suffering from dementia. The wearable devices detect the patient’s condition along with sending information to the caretaker too. The information can either be given through text or email while alerting the doctors too. In medical emergencies, people of any age require immediate help from any source of help. Seeing how beneficial these IoT monitoring devices are- in future, the number of homes will have a sensor network. These networks will monitor each and every activity of a patient with the sensor of sending in alerts in an emergency. IoT monitoring device that keeps track of a patient’s prescribed medicine routine. The technology can be proven best for patients with dementia or Alzheimer’s.

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