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IoT based Smart Remote Health Monitoring System

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***Abstract*— An IOT based healthcare system can ensure better well-being of patients and condition of life especially in remote areas where there is no healthcare system. In this paper, the vital signs of health like body temperature and pulse rate are measured using the sensors like LM35 and MAX30100, the measured data is send over to the IOT cloud to get recorded history of the patient. We tried to proposed a model which is non-invasive in nature and can monitor the patient in remote area through sensor connected networks. The principle aim of this model is to provide healthcare facilities in rural areas.**

Keywords—Internet of Things, Remote Health Monitoring, I2C protocol, Telemedicine.

I. INTRODUCTION

Internet of Things (IoT) can be defined as when "Things start to think". Here things in IoT can be any physical object or entity which has unique identifiers (UIDs). It is a system of interconnected devices (with UIDs) have the ability to sense, accumulate and transfer data over a network with less or without human intervention and can be utilize remotely. In healthcare sector IoT plays an important role as it is reliable, flexible and affordable system, it offers an optimizing technology to acquire the leading healthcare services and can meliorate the current medical services[4].

There are many vital signs for measurement of health parameter, out of which measurement of body temperature is used to determine that person is having fever or not. As the body temperature varies with the variation in the temperature of environment i.e., in dawn the temperature happened to be lowest while highest in the afternoon. 37 ℃ or 98.7 ℉ is considered as the normal body temperature of a person. As we know the about the temperature variation, both the variation of environment and body need to measured. Similarly, the pulse rate of a person plays an important role in the cardiovascular process. Pulse rate expressed in beats per minute (BPM) measured by beats of heart in per minute. About 72bpm – 100bpm is taken as normal, if it either exceed or decrease then prevention is needed. BPM depends on how a person is working i.e., if a person is exercising then the heart rate increases. The fitness of a person is decided by the rate at which pulse rate comes to normal point.

With India being the second most populous country in the world, medically challenged people increasing steadily rural population are affected most because of the lack of medical practitioners. India has a vast healthcare system and this system is divided into two sectors: public and private but there are many differences in the level of healthcare of rural and urban area resources, as well as also in the public and private healthcare facilities. With rapid increase in population, is getting very challenging for health division of India to provide a proper and well-ordered healthcare for the rural area and remote population. Even 75% of the healthcare infrastructure are in urban areas where only 27% of the population is living. The remaining 73% of the country's population is lacking proper primary healthcare facilities.

Telemedicine is the solution for remote population where availability of a health professional is scarce. Telemedicine is the distribution of medical services. It helps in providing the services without presence of health professionals in-person. As we know that in India the distribution of doctors and nurses are lopsided, so telemedicine is the solution. For remote areas population where money is also the factor to concern telemedicine can help in reducing the diagnosis cost.

A well-equipped health monitoring system is most publicly applicable to professionalize the health maintenance in necessitous population of the country. E-healthcare is an appropriate way to provide medical care to the remote area patients with cheap and easily overcome the problem of unavailability of doctors in isolated areas. By measuring the patient's body temperature and pulse rate, the recorded data is saved on the cloud for real time visualization and also patient detail is send to patient himself. This system also minimizes the gap between the patient in rural area and the doctor.

II. LITERATURE STUDY

In present scenario, many wireless body sensor networks have been introduced, that continuous keep track of an individual health condition. The first WBSN which the researchers made uses the atmega-8 microcontroller with various sensors integrated to it [1]. A Galileo board [2] is an integrated sensor based IOT device that provide medical platform for review of electrocardiogram (ECG) signals and based on that algorithm used to monitored heart function. By Woo et al. [10] pay attention on the essential issue of fault tolerant health data services. To do so, authors present a fault tolerant algorithm and the proposed architecture provide a gateway that can be linked to form a connected network for fault tolerance. Furthermore, the copy of the previous gateway is stored in the gateway for backup. Nonintrusive sensor based small wearable device [15] will enable enormous data to be collected automatically. This will help in reducing the expenses and also the frequent visit to the health professional or medical center. By Swaroop et al. [3] focused on the design of real time health monitoring system which can back-up the patient's health record and also focused on various mode of transmission of data using mobile application, messaging service and internet.

Implementing medical care system for remote population should provide continuous data analysis and can be easily accessible for anyone with little knowledge. For remote health monitoring a diagnosis system is needed instead of wearable device, wearable devices cannot be afforded by rural area people.

III. Proposed Model

The working of the system is classified in two parts i.e., Hardware and Software. Hardware part consist of sensors, processing unit and communication unit (Wi-Fi module) and the software part belong to the language used and communicating protocol used.



Fig. 1. Roadmap of the system

The roadmap of the system consists, 1) Collection of data, 2) Data Acquisition, 3) Processing of data, 4) Storage of data, 5) Data transmission [7].

Here in the first stage the collection of data, sensor collect the data from the patient for the further monitoring. In the data acquisition stage, the collected data is in analog form so that data need to be combined and converted into digital form. In short data acquisition perform integration and conversion of data.

The next stage is processing of data, here the sensor collects huge amount of data in order to make sense to that data, data processing is needed. The main purpose of this stage is to provide meaningful data by converting the raw data. In storage of data stage, the transmission of data to cloud is done through Wi-Fi module using MQTT protocol. The processed data is stored over the cloud and in the last stage the transmission of data is performed.

A. Component Used in Hardware Implementation

For realizing health diagnosis system there is a need of required module to get the patient physiological data. This system generally uses temperature sensor LM-35, pulse sensor, Arduino UNO board, node-MCU. Here description of the used hardware is mentioned.

i. *Temperature Sensor-LM35* - It can preserve accuracy of +/-0.4°C at room temperature while +/-0.8°C from 0°C to 100°C. The accuracy of thermistor is not comparable to the LM35, as its precision is high.



Fig.4. Temperature senor (LM35)

It offers an advantage over other temperature sensor that it can directly converts measured (in Kelvin) data either into Fahrenheit or Celsius [18].

Its operating temperature range from -55°C to 150 °C. Its operating voltage is range from 4V-20V.

ii. *MAX30100* – It is used to measure heart rate and oxygenated blood level of a patient, measures heart rate in BPM (beats per minute). It uses two LEDs, one is emitting red light and other is near infrared light. It works in the voltage of 1.8V to 3V. it is designed to give digital output of heart beat when finger is placed on it [17].



Fig. 3. Pulse sensor

iii. *Arduino UNO* – It is core hardware of the health monitoring system. It gathers the data from the different sensors, it is mainly used for controlling and processing. It does not require external ADC and require less power to operate. It offers the advantage of 14 digital input/output pins (out of which 6 pins used as PWM output) and 6 analog pins. A software serial library is used for serial communication on any digital pin of the Arduino [5].



Fig. 4. Arduino UNO

iv. *Node-MCU* – It comes with ESP8266 Wi-Fi SOC development board/kit [6]. It has single analog pin and 8 digital pins. It is mainly used for communication or sending data over cloud.



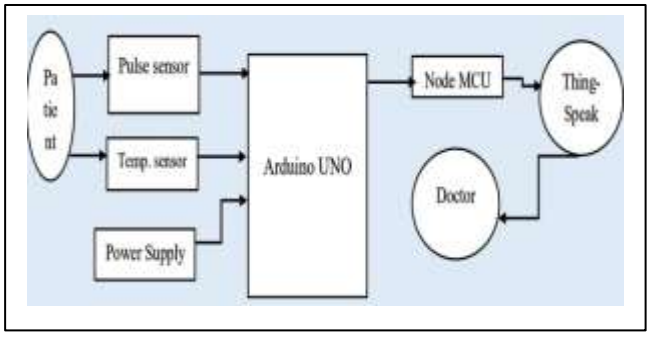
Fig. 5. NodeMCU

B. Proposed model architecture

In this proposed system patient anatomical measurements can be done by various sensors like temperature sensor and pulse sensor. Firstly, the patient physiological data is gathered by the sensors. The collected data are then controlled and processed by the microcontroller to get the measured body temperature and pulse rate. The patient health parameter can be shown on serial monitor screen. With the help of nodemcu the data can also be forwarded to

the IOT cloud, from where remotely center doctor can easily access the patient health parameter.

Fig. 6. Proposed model architecture



C. Hardware Implementation

In this section we tried to make a portable health monitoring system that can monitor patient's physiological parameter. The proposed system mainly targets the remote population of the country. In this proposed model the patient health parameters are measured using several sensors. Arduino Uno is used as the main microcontroller, further ESP8266 development kit (NodeMCU) is used for sending the meaningful data over the cloud. Both the microcontroller and NodeMCU are connected serially using UART communication protocol as shown in fig.7.

The sensors are interfaced to Arduino to monitor the patient. The sensors and Arduino can use either SPI or I2C protocol for communication depending on the sensor used.

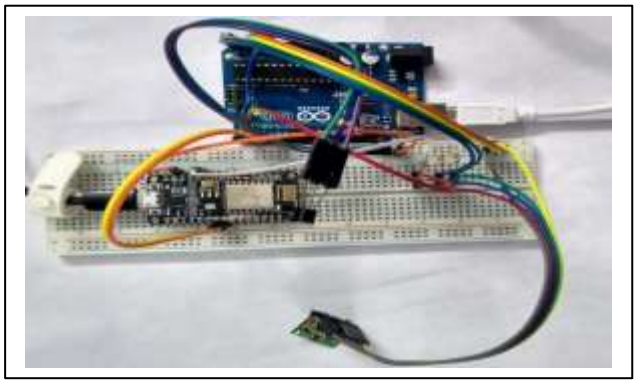


Fig. 7. Hardware implementation

D. Result

Fig 8. Screenshot of measured data



Fig. 8. Pulse sensor data on cloud



Fig. 9. Temperature sensor data on cloud

Using I2C protocol between Arduino and sensors helps in reducing the wiring, as it requires only two pins with these two pins it can connect up to 128 slaves. It works in master-slave mode and it also helps in providing multi-master system. It is best suited for short distance communication.

CONCLUSION

In this paper, we have analyzed the smart remote health monitoring system using IOT. It will help in providing better diagnosis for the rural area population. The principle of this paper is to create a common interface between remote area and healthcare practitioner. It will also help in reducing the gap between the patient and doctor. This system has many benefits like cost-effective, reliable, portable and easy handling which can be easily deployed in rural area.

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