

INTELLIGENT HEALTH MONITORING SYSTEM

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Abstract — The use of mobile phones and smart devices has increased significantly in the modern world. The main objective of the present work is to design and develop an "IoT based Integrated Health Monitoring System" to monitor vital parameters of patients like body temperature, oxygen level and pulse rate with the help of pulse oximeter sensor and IR based thermal scanner. To read and process sensory information an Arduino supported Wi-Fi enabled NodeMCU controller has been used. Thus, IoT based patient monitoring system effectively monitor patients' health status and save life on time.

Keywords— IoT, Health monitoring, Heart Beat rate, Body Temperature, Sensors, Arduino.

I. INTRODUCTION

Today there is a significant increase in the number of people with chronic disease, the cause can be variety of factors such as eating factors, alcohol consumption and physical activity. The symptoms as well as the treatment of chronic diseases can vary significantly [1].

Early detection and diagnosis of potentially fatal conditions such as heart attack require constant observation of patients' health screening after transfer from hospital to home. Researches have found that 30% of the patients with a coronary heart disease were rehabilitated at least once every 90 days with study rates ranging from 25 to 54% within 3–6 months. In response to these kinds of needs, health monitoring systems are being suggested as an inexpensive solution. Such a system comprises of physiological details that stores, processes and communicates through a local device such as smart phones, personal computers etc. Such systems should make certain of strict safety, security, reliability, and long-term real-time operation requirements [2].

The progression of the advancement of the technology has constantly intrigued us. Moreover, we additionally found that there are very few critical examines on computerization technology for

Hospital's need for an IoT based Patient Monitoring System. IoT is a network where all the physical objects are connected to the internet via different sensors, devices etc. IoT is an intelligent technique which can reduce the human effort and interaction [3]. IoT has made its presence felt in the modern world by giving us many new innovations such as smart parking, smart home, smart cities etc. The use of IoT in the healthcare management can be very utilitarian [4.] Along these, we began to search the published paper and advancements around us. In the modern era, medical science is evolving day by day. On this creating technique people advancing more noteworthy reinforce logical frill, for example, brilliant belt which find persistent breath and additionally electro dermal movement (EDA) sensors to successively show for physiology indications of seizures during the evening. Patient monitoring system is easily accessible, painless and smooth for the patient. Objectives of the present work are as follows:

- a. It will be a very handy tool as it shows all the data collection and information by using just only the internet. Therefore, it reduces the workload and stress of the patient's relatives working outsidess.
- b. By connecting to IoT health care system, doctors can improve the diagnosis accuracy as they receive all the required data of the patient. In a word, we can say that it allows monitoring patient continuously and remotely.
- c. By using this system, we can get approximate result based on patient health. Moreover, it will be less error, collect data in less time and more accuracy than any human performances.
- d. When a patient receives home-based medical care in real time, there is no need for an unnecessary doctor or nurse to visit. In particular, this project helps to reduce the cost of hospital stay and re-admission
- e. e.Through IoT, doctors and relatives can do their individual job without any hesitation as they can

observe the patient's health condition from any- where. In addition to that, the system would send notifications whenever a specific health parameter goes beyond or below the specified limit. Moreover, by getting SMS alert doctors and relatives can take necessary steps. Lastly, we can say that it saves lives in case of emergency.

II. LITERATURE SURVEY

In [5], a comprehensive review on usage of IoT in healthcare system has been discussed. In this paper, they have addressed several methods and things that are used in IoT in healthcare systems, challenges of IoT in healthcare.

In [6], author has presented "An IOT Based Health care monitoring system". Regular observation is required in hospitals where the patients are under medical care for a longer period of time. Although the patient is not in a critical situation, the doctors still need confirmation on their health parameters. Now a day, the expenses for hospitalization are high and expensive. So the health policies in various countries have shifted its focus from providing reactive, acute care to provide care outside the hospital. Hence author designs and build the sensing data that conditions the system to display accurate body parameters of the patients. The aim of this paper is to supervise the heart rate, blood pressure, temperature and ECG continuously through respective sensors. The recorded data is sent to the device and if the value exceeds, the alert message will be sent to the doctor

In [7], an interference aware scheduling of sensors in an IoT enabled healthcare monitoring system for a real-time smart health monitoring system has been prioritized. There are a number of sensors linked with a local data processing unit with a shared channel that has a fixed bandwidth. There are many sensors which have a wide variety of channel access requirements.

In [8], an IoT-aware architecture for smart healthcare systems is put forward. Implementing an IoT-aware smart architecture for automated monitoring and tracing of patient's personal, and medical data within hospitals and nursing facilities.

In [9], an IoT-based on intelligent regeneration has been launched. In this study, an ontology based automating a smart regeneration system using IoT technology is introduced.

In [10], a wireless system for remote monitoring of oxygen saturation and heart rate has been proposed and described. In this analysis, making use of the pulse oximeters, the level of oxygen in the blood and also the heart rate of the patient is determined. Then, this measured data is transferred to a central monitoring station via a WSN. The patient will be frequently monitored and the central monitoring station receives the patient's information like oxygen saturation level and heart rate through the WSN.

In [11], a secured IoT-based healthcare system with body sensor networks has been proposed. It operates through BSN architecture to achieve system efficiency and robustness of transmission within public IoT-based communication networks.

In [12], building an IoT-aware healthcare monitoring system is introduced. A prototype is presented for the implementation of an IoT-aware healthcare monitoring system, which will reduce the cost of healthcare and will increase the need of specialized care. It alerts about the patient's health condition in real-time, if any problem is experienced, and if the patient needs any medical attention or hospitalization.

In [13], because of the advancement in VLSI technology, the size of the sensors have been reduced which has led to the development of wearable solutions. Due to consistent internet connectivity, the devices are becoming more efficient and powerful. IoT based health monitoring devices monitor the sick individual 24/7. At any crucial situation, the devices bring about necessary signals by inspecting statistical data.

In [14], The use of Internet of Things (IoT) and its e-Health applications within the Tele-medicine health system leads to seamless flow of knowledge between doctors and patients, thereby making the cost of healthcare more efficient effective and improving the standard of patients' treatment. The 2 fundamental aspects in monitoring people in danger are: 1) Prevention 2) Effective and early intervention during medical emergency

In [15], In remote mobile health monitoring system, the patient health parameters are recorded by a sensible phone by eliminating a further hardware and transmit data through an internet interface.

III. METHODOLOGY

IoT based patient health monitoring system is a generic term given to any medical equipment that has internet capability and can measure one or more health data of a patient who is connected to the device such as heartbeat, body temperature, saturation percentage of oxygen (SPO2) etc. The equipment can record, transmit and alert if there is any abrupt change in the patient's health.

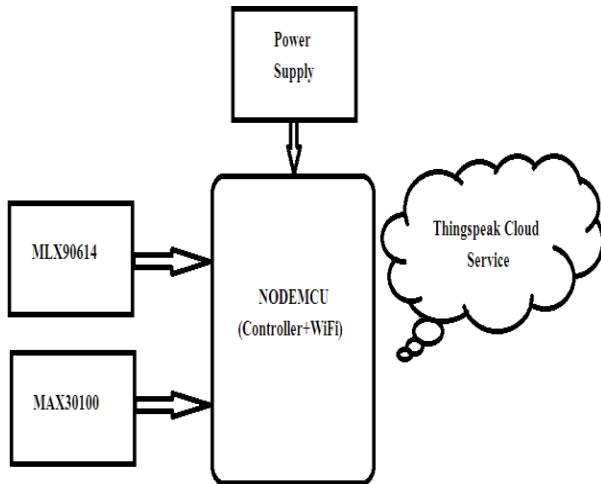


Fig. 1 Block Diagram of Proposed System

The circuit diagram of proposed system is shown below in fig. 2. In this circuit diagram a multi- channel I2C module TCA9548 has been used because nodeMCU has only one I2C communication channel at pin number D1 and D2. Pin D1 of nodeMCU is SCL (serial clock) and pin D2 is SDA (SDA) of I2C communication protocol.

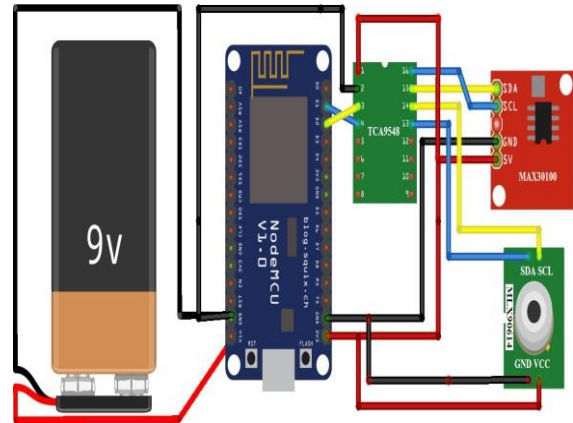


Fig. 2 Circuit Diagram

The motive of this project is to provide an integrated health monitoring system which monitors multiple health parameters like body temperature, oxygen percentage, heart rate and blood pressure on single platform. A microcontroller accesses different sensors; IR thermal temperature meter MLX90614 and Pulse oximeter sensor using MAX30100 then uploads information to IoT server with the help of Wi-Fi module ESP8266 and also displays parameters on sever in graphical form.

MAX30100 is an integrated pulse oximeter and heart-rate monitor sensor solution. It's an optical sensor that derives its readings from emitting two wavelengths of light from two LEDs – a red and an infrared one – then measuring the absorbance of pulsing blood through a photo detector. This particular LED color combination is optimized for reading the data through the tip of one's finger.

SPO2 can be calculated with help of ratio of absorbance. The ratio of the absorbance due to red led to that of infrared led can be formulated as:

$$R = \frac{\frac{V_{max}(Red)V_{min}(Red)}{V_{min}(Red)}}{V_{min}(Infrared) - V_{max}(Infrared)}}{V_{min}(Infrared)} \quad (1)$$

, and oxygen saturation of blood can be formulated as:

$$SpO2 = \frac{HbO2}{HbO2 + Hb} \quad (2)$$

IV. COMPONENTS

A. Temperature Sensor

The MLX90614 infrared thermometer is a contactless temperature sensor module for Arduino compatible device. An infrared thermometer works to measure the object temperature by the infrared radiation in the form of an electromagnetic wave through the light emitted on the object [16].

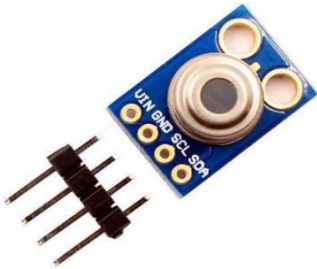


Fig.3 MLX90614

B. Pulse Oximeter and Heart Rate Sensor

Based on the principle of oxygen saturation measurement, this paper introduces a blood oxygen saturation detection system design scheme based on the integrated chip MAX30100, which can simplify the circuit design, reduce system footprint, reduce the designing time and system power consumption [17].



Fig. 4 MAX30100

C. Multiplexer

The TCA9548A device has eight bidirectional translating switches that can be controlled through the I2C bus. The SCL/SDA upstream pair fans out to eight downstream pairs, or channels.



Fig. 5 TCA9548A

D. Controller and Wi-Fi Module

NodeMCU is an open-source, lua-based firm-ware and development board, specifically designed for the internet of things (IoT)-based applications. It includes a built-in the software running the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware module based on ESP-12 [18].

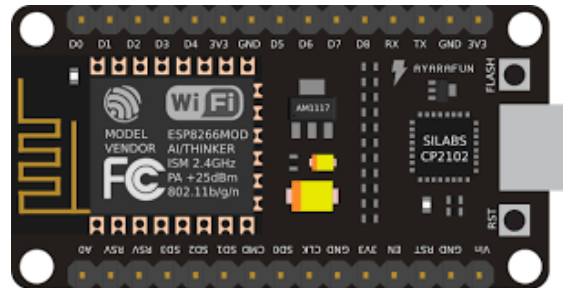


Fig. 6 NodeMCU

E. IoT Platform

- Use the Thingspeak platform to send data to the cloud from any Internet-enabled device.
- You can then configure actions and alerts based on your real-time data and unlock the value of your data through visual tools.
- Use the Think speak offers a platform for developers that enable them to easily capture sensors data and turn it into useful information [19].

V. RESULT AND DISCUSSION

An IoT server is created on Thingspeak cloud powered by Mathswork. And its API key is written Arduino program and user name, password of hotspot is also written to code so that Wi-Fi device nodemcu which is basically Arduino based Wi-Fi device can connect and upload data to Thingspeak server. Thingspeak channel is created as shown in fig. 7.

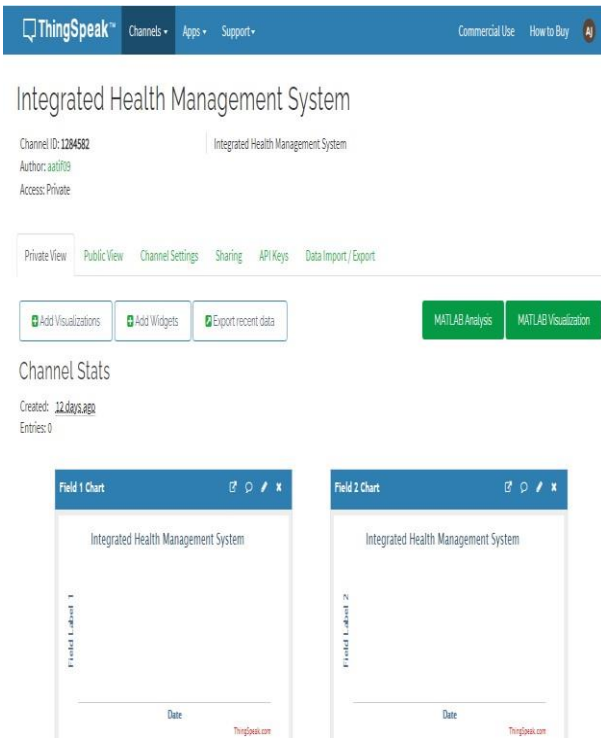


Fig. 7 Thingspeak Project Channel

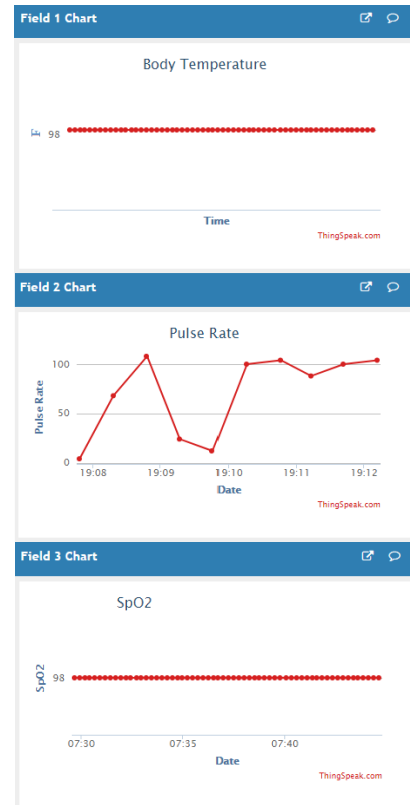


Fig. 8 Data Receive on Thingspeak Cloud

Hardware collects data from various sensors and upload it on cloud server Thingspeak. Some capture data is presented on server are shown below in fig. 8, which represent the graphical view of received data and this data can be further process and used for prediction of patient's health. So this is useful for the patients not able to walk out for doctor advise and those who need daily care.

Data capture on regular interval is shown in table 4.1 below

Table 4.1 Hardware Data on Server

S. No.	Temperature (K)	SPO2 (%)	Heart Beat (BPM)
1	98.7	98	100
2	98.6	98	90
3	98.7	99	79
4	98.7	98	80
5	98.6	98	100
6	98.8	98	78

VI. CONCLUSION AND FUTURE SCOPE

In general IoT based health care platform which connects with smart sensors attach with human body for health monitoring for daily checkup. In project work we discussed about IoT based integrated patient health monitoring system. The system technologies being used by smart phones or gadgets in present time where we also mentioned about advantages, challenges and opportunities. Due to the importance of observing medical patient, continuous remote monitoring is necessary. Our project work is giving the opportunity to monitor patient continuously by using the web and apps service along with live monitor and mobile message service. This paper also compared the early aged medical system between present time health monitoring. The present time represents the time reducing, reduce health care cost especially for rural area people.

The subsequent development of the project is extremely crucial in order to make the system more advanced and useful. In the designed system the improvement or amplification would be linking more sensors to internet which assess various other health parameters and would be advantageous for patient monitoring i.e. linking all the sensors to internet for swift and effortless access. Establishing a Wi-Fi mesh type network to increase in the communication range [20]

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