IoT-based Smart System for Continuous Patient Health Monitoring

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ABSTRACT
Health monitoring is a huge, severe issue in today's environment. Patients have major health problems as a result of a lack of patient health monitoring. There are many IoT smart gadgets available nowadays that can monitor patients' critical health conditions via the internet. Health professionals are also using smart devices to monitor their patients. With hundreds of new healthcare technology start- ups, IoT is rapidly transforming the healthcare industry. The IoT-based patient health monitoring equipment is utilized in both hospitals and homes. Manual techniques are not the best alternative for monitoring the patient's physiological characteristics. This equipment is highly beneficial for doctorsto diagnose a patient who has suffered for a long time. They can easily be able to access the respective patient's data from the cloud to their personal computer, cell phone, etc., In this work, objective is to develop with NODE MCU (ESP8266) based device, Interfaced with the physiological data acquisition sensors [DS18B20 (Temperature Sensor), MAX30100 (Pulse Sensor) And Heart Rate Sensor]. With the help of this board, the data can easily transmit to the cloud server and fetch it.

Keywords
IoT, sensor, Health, heart rate, monitoring, modules

1. INTRODUCTION
Nowadays the Internet has become one of the important parts of daily life. It has changed how people such as live, work, play, and learn. In the busy world, the Internet serves many purposes such as education, finance, Business, Industries, Entertainment Social Networking, etc. In the medical field, an IoT (Internet of Things) patient monitoring system revolutionizes the healthcare is delivered and monitored. This cutting-edge technology combines the power of connected smart devices, sensors, and data analytics toprovide real-time monitoring of patients' health conditions. A healthcare monitoring system is necessary to constantly monitor the patient's physiological parameters. The main advantage of this system is that the results can be viewed at any time and at any place. The doctors can be notified by using mobile phone messages if a patient's health is abnormal. In this system, a heart rate sensor, temperature sensor, and spo2 sensors are used. The IoT is connected with objects to the Internet and used to control those objects or remote monitoring. By seamlessly integrating various medical devices, such as wearables, smart implants, and home monitoring systems, the IoT patient monitoring systemenables healthcare professionals to remotely track vital signs, detect anomalies, and intervene promptly when necessary. This innovative system not only enhances patient safety and improves healthcare outcomes but also empowers individuals to actively participate in managing their own health. With the ability to gather and analyze vast amounts of data, the IoT patient monitoring system opens new possibilities for personalized and preventive care, creating a transformative impact on the healthcare industry as a whole.

2. LITERATURE REVIEW
The project introduces a wearable, portable, low-power consumption, real-time bio-real-time signal monitoringsystem. This initiative provides an advanced step for the remote healthcare sector. The number of people who need health care is increasing every year and standard bio-signals monitoring systems require that patients be present within hospitals [1]. This system uses Temperature and heartbeat sensors for tracking patients' health. Both the sensors are connected to the Arduino-uno. To track the patient's health,the microcontroller is, in turn, interfaced to an LCD display and Wi-Fi connection to send the data to the web server (wireless sensing node) [2]. The recent development of, the Internet of Things (IoT) makes all objects interconnected andit has been recognized as the next technical revolution. Some of the applications of the Internet of Things are smart parking, smart homes, smart cities, smart environments, industrial places, agriculture fields, and health monitoring processes. One such application is in healthcare to monitor the patient's health status. The Internet of Things makes medical equipmentmore efficient by allowing real-time monitoring of patient health, in which sensors acquire data of patients and reduce human error [3]. This article describes surveys on advances in IoT-based healthcare methods and reviews the state-of-the-art technologies in detail. Moreover, this review classifies an existing IoT-based healthcare network and represents asummary of all prospective networks. IoT healthcare protocolsare analyzed in this context and provide a broad discussion on it. It also initiates a comprehensive survey on IoT healthcare applications and services [4]. The main contribution of this research paper is to highlight IoT-based healthcare monitoring systems in detail so that future researchers, academicians, and scientists can easily find a roadmap to understand the current healthcare monitoring systems and can easily provide solutions and enhancements for such critical applications. This research paper provides a general idea of IoT-based healthcaremonitoring systems in a systematic way, along with their benefits and significance, and a literature review [5]. Health monitoring systems are one of the most notable applications ofIoT. Many types of designs and patterns have already been implemented to monitor a patient's health condition through IoT. In this paper, a review of IoT-based smart health monitoring systems is presented [6]. system

is necessary to constantly monitor the patient's vital signs. The paper describes the monitoring of heart pulse sensor data on the cloud using nodemcu. In, which the data is directly transmitted to the cloud [7]. This article describes surveys on advances in IoT-based healthcare methods and reviews the state-of-the-art technologies in detail. Moreover, this review classifies an existing IoT-based healthcare network and represents a summary of all prospective networks. IoT healthcare protocols are analyzed in this context and provide a broad discussion on it. It also initiates a comprehensive survey on IoT healthcare applications and services[8]. Adafruit IO's health monitoring system and the internet have made it possible for everyone to track their health. Inadequate security often leaves patient data vulnerable to an unidentified danger, making a propercollection of essential medical data critical to therapy. It is suggested in this study that different kinds of sensors be utilized to gather data regarding health-related and environmental characteristics and sent to the cloud as part ofan e-Health monitoring and Adafruit IOT monitoring system that is built on the Internet of Things [9]. The significant part of the preferred output is to construct a better environment thatis affordable even for a common person who is in need of this medical assistance at a low expenditure and minimum knowledge in the field of programming as per the requisites ofthe victim situation. Also in this project, the usage of sensorsis also very easy when compared with the real hospital machinery. This project, will discuss the follow-up of pulse rate, blood pressure, body temperature, and saline levels of thevictim[10].

3. MATERIALS AND METHODOLOGY

3.1 MATERIALS: ESP8266(WIFI-MODULE)

The ESP8266 is an inexpensive and easy-to-use device that offers internet connectivity for projects. The module is able to function as both an Access point (able to create a hotspot) and as a station (able to connect to Wi-Fi), allowing for easy retrieval and uploading of data to enable the Internet of Things. It is also capable of retrieving information from the web, making it simple to obtain project data and enhance its intelligence. The ESP8266 is a commonly used Wi-Fi module that is widely deployed in IoT (Internet of Things) projects. It is a module with integrated Wi-Fi capabilities that is inexpensive and consumes very little power. The ESP8266 module enables microcontrollers and other devices to connect to Wi-Fi networks and access the internet wirelessly. It can function as a client or an access point while supporting the TCP/IP protocol stack. The module comes with a variety of functions and can be programmed with different development platforms, making it a perfect option for incorporating wireless connectivity in IoT projects.

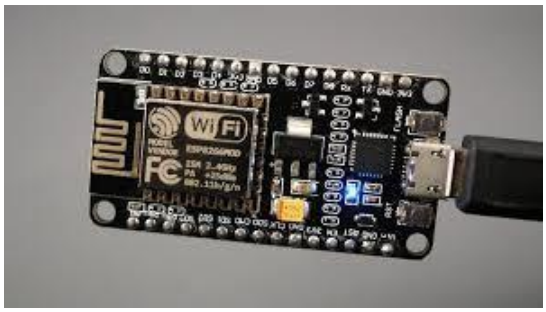

Fig 3.1:ESP8266

3.2 HEART RATE SENSOR:

Heart rate sensors are utilized to monitor heartbeats. Heart rate sensors are created to provide a digital readout of heartbeats when a finger is placed on them. As soon as the heartbeat detector is activated, the LED light blinks in sync with each heartbeat. A heart rate sensor is a device or technology that measures and monitors a person's heart rate in real time. It is created to monitor and track the frequency of a person's heart beats each minute, giving important details about their heart health and overall wellness. Different types of heart rate sensors are available, including chest straps, wristbands, and sensors built into wearable devices like fitness trackers and smart watches.These sensors typically use different methods to capture heart rate data, including optical sensors that measure changes in blood flow and electrical sensors that detect the electrical signals generated by the heart.

By continuously monitoring heart rate, individuals can gain insights into their exercise intensity, track their recovery during workouts, and assess their heart health during rest or physical activity. Heart rate sensors have become an integral part of fitness tracking, sports performance monitoring, and healthcare applications, enabling users to optimize their training, improve their fitness levels, and detect any abnormal heart rhythms or potential health issues.

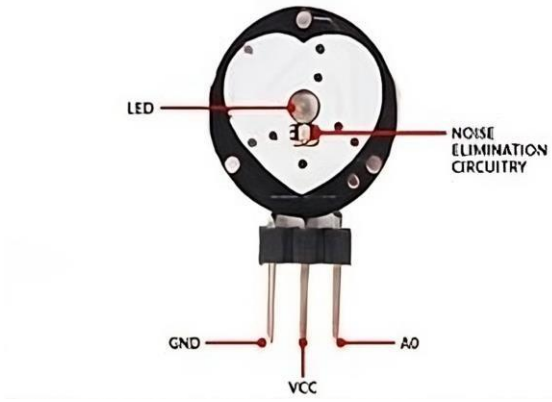

Fig 3.2: Heart rate sensor

3.3 MAX30100(PULSE OXIMETER SENSOR)

A Spo2 Sensor, also known as a Pulse Oximeter Sensor, is utilized for measuring the oxygen levels in red blood cells. Typically small clip-like gadgets that can be attached to various body parts like fingers, toes, and earlobes are knownas SpO2 sensors, or pulse oximeter sensors, and are employed in measuring blood oxygen saturation levels. It usually attaches to a person's fingertip, earlobe, or other body areas. The sensor emits light waves that penetrate the skin and blood vessels, analyzing light absorption to measure oxygen saturation. The SpO2 sensor gives a numerical SpO2 reading and can also track heart rate. It is frequently utilized in healthcare environments such as hospitals, clinics, and home monitoring to evaluate respiratory and circulatory well-being.

Fig 3.3 MAX30100(PULSE OXIMETER SENSOR

3.4 DS18B20 TEMPERATURE SENSOR

Maxim Integrated produces the DS18B20, a digitaltemperature sensor. The sensor gives precise temperature measurements from -55°C to +125°C. It has a digital output that works with the 1-Wire interface, enabling multiple sensors to be linked with just one data line. It provides precise temperature measurement with an accuracy of ±0.5°C and enables customization of resolution settings. The DS18B20 is display technology commonly used in electronic devices. It uses liquid crystal cells to create images or text by manipulating light. LCD displays are thin, lightweight, and consume less power compared to other display technologies. They are widely used in devices such as televisions, computer monitors, smartphones, and digital watches. LCDs provide high-resolution visuals and are capable of displaying various colors and graphics, making them a popular choice for visual information representation.

Fig 3.5: 16*2 LCD DISPLAY

3.6 THING SPEAK:

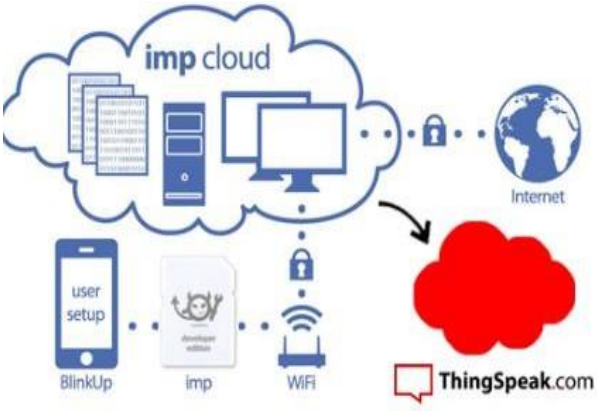

Fig 3.6: Thing Speak

Thing Speak, created by Math Works, is an Internet of Things platform. Users can gather, assess, and display data from IoT devices or sensors instantaneously. It provides a webinterface and restful API for easy data logging and retrieval. Thing Speak supports integration with various IoT hardware platforms. Users can create custom dashboards, and charts, and perform data analysis for effective IoT data management.

commonly utilized in a variety of industries due to its dependable performance and user-friendly features.

Fig 3.4: DS18B20 (TEMPERATURE SENSOR)

3.5 16*2 LCD DISPLAY:

A16*2 LCD is used to display the different characters and symbols. It can display 16 characters per line and there are2 such lines. In this LCD each character is displayed in a 5*7 pixel matrix. An LCD (Liquid Crystal Display) is a flat panel

4. METHODOLOGY

4.1 Hardware Setup:

- a. Setup the required components: ESP8266 microcontroller, MAX30100 sensor, DS18B20 temperature sensor, Pulse Sensor, jumper wires, breadboard, power supply, and a computer.

  b. Connect the ESP8266, MAX30100, DS18B20, and Pulse Sensor to the breadboard.

  c. Establish the necessary connections between the components, ensuring proper wiring and connections.

- Software setup Install the Arduino IDE software and figure out the necessary code, install the necessary Libraries.

- Calibration of the sensors:

The calibration process improves the system's performanceand functionality. It helps to reduce system errors. A calibrated sensor produces accurate readings and can be used as a benchmark for comparison. Many sensors are now incorporated onto a single chip as embedded technology advances and sensor sizes shrink. Undetected failures in a single sensor might cause the entire system to degrade. To ensure that automated systems work accurately, the sensor must be calibrated. Each sensor is calibrated by frequent usage in order to get accurate readings

- Data acquisition:

This project involved developing a real-time data acquisition

(DAQ) system for healthcare purposes. The technology can show localized data for pulse rate (BPM) and oxygen level (SpO2). The setup consists of acontroller, a sensor, and IDE software for processing the GUI. Data from each sensor is obtained using specificalgorithms. By using it, one will obtain the essential valuesof heart rate, temperature, and Spo2 (Blood oxygen saturation).

- Connecting to IoT:

Setting up Wi-Fi Connectivity to the ESP using Arduino IDE, In the programming code it specified a particular local network to which the ESP will connect to the internet. And found a communication gateway such asHTTP.

- Thing Speak cloud integration:

This open IoT platform allows any device with Internet

access to transmit data to the cloud. It enables your live data and reveals it with visual tools through setting up various actions and notifications. ThinkSpeak immensely helps developers by collecting sensor data and converting it into useful information. The Thing Speak server is available for free and provides support for thedevelopment of small, nonprofit projects.It created an account in the Thing Speak cloud server and added a separate channel for patient monitoring system. With the help of the specific API (Application programming Interface key), ESP is configured with this unique key to access the cloud server.

- Cloud Visualization:

Cloud visualization is a feature of IoT healthcare monitoring systems that allows clinicians to remotely monitor and analyze patients' health data. Once the program is loaded onto the ESP, the data begins transmitting to the server within seconds, making it easy for us to visualize.

A. BLOCK DIAGRAM

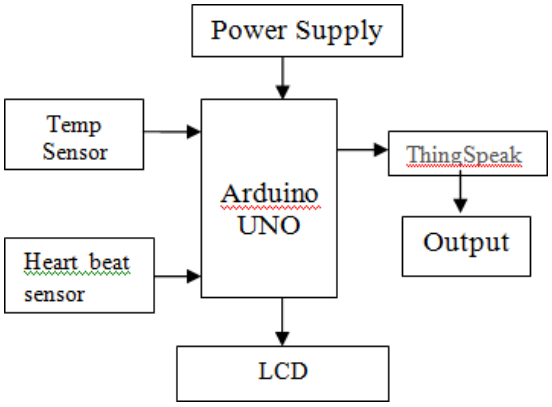

Fig 4.1: A. Block diagram

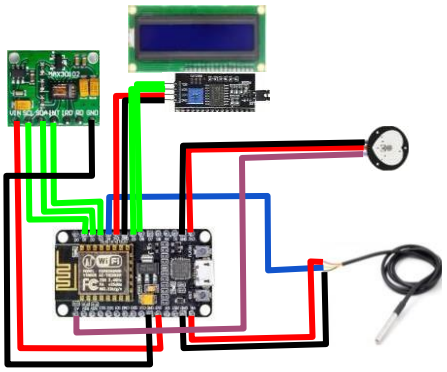

Fig 4.2: Circuit diagram

Fig 4.3: Working Model

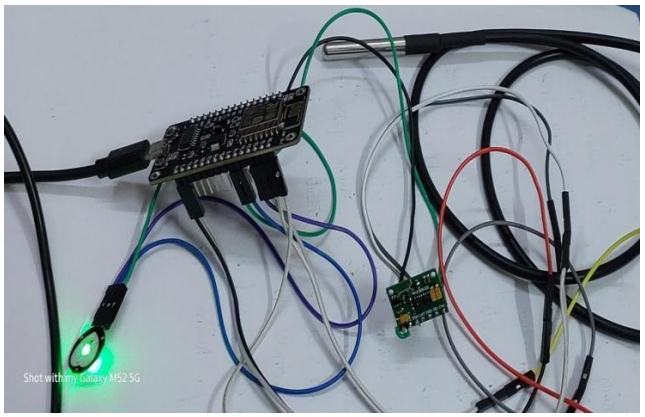

Fig 4.4: Working Model

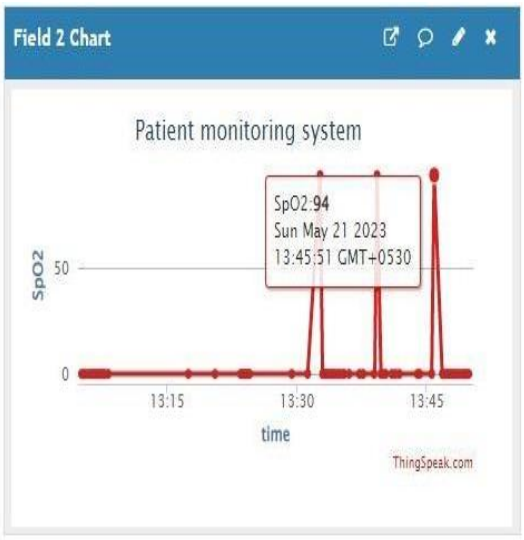

Fig: 4.5 Output(Serial monitor)

5. RESULT AND DISCUSSION

From this project first, it performs the heart rate, Spo2, and Temperature monitoring by using a Heart Rate Sensor, Pulse Oximeter Sensor(Max30100), And Temperature Sensor(Ds18b20) And got output from the SERIAL MONITOR. Next, the patient monitoring system obtained data on Heart rate, temperature, and spo2 from the Thing Speak cloud server by connecting to the Cloud server.

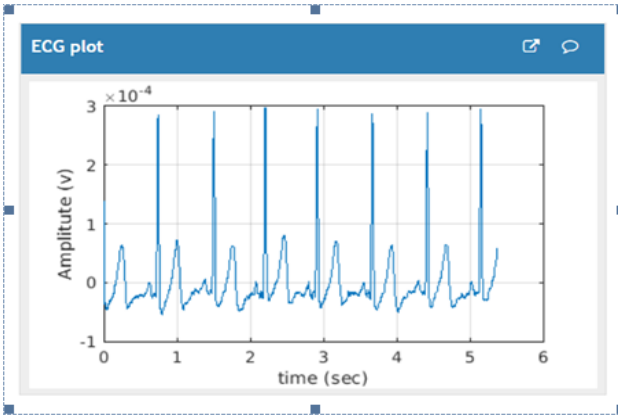

Figure 5.1. Graph on ECG sensor output

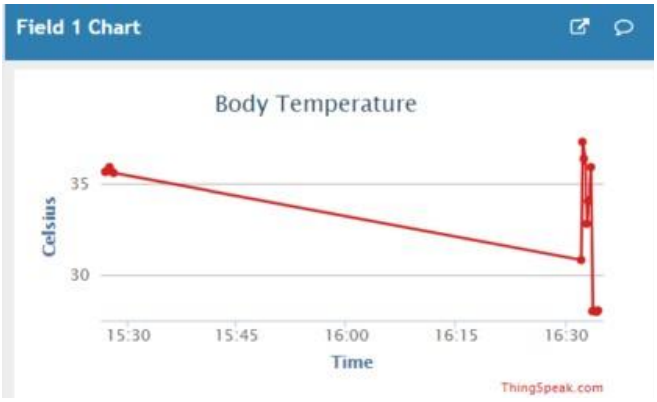

Figure 5.2 Graph on Temperature sensor output

Figure 5.3. Graph on Heart rate sensor output

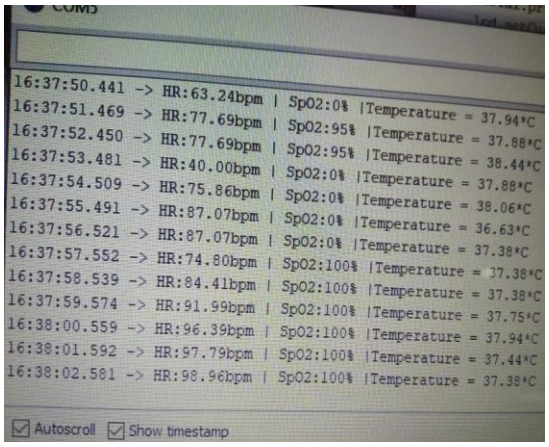

Fig 5.4.A. Temperature monitoring

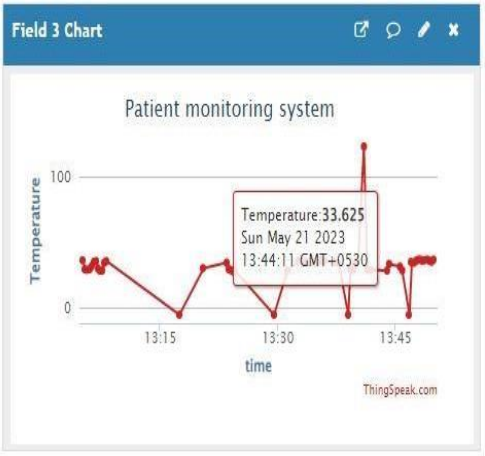

Fig 5.4.B Temperature monitoring

Designing and developing an IoT patient monitoring system, which includes monitoring a patient's heart rate, spo2, and temperature, is a fascinating yet complex challenge in the field of patient health monitoring usingIoT technology. The usual ingredients for the project include a Heart rate sensor, a Temperature sensor (DS18B20), a Pulse Oximeter Sensor (MAX30100), anESP8266 (WIFI MODULE), and an LCD display. Measuring the oxygen saturation in red blood cells using a Pulse Oximeter sensor (MAX30100) is a key challenge in this project.

6. CONCLUSIONS

Throughout in this work, objectives were successfully developed and implemented a robust infrastructure that seamlessly connects various medical devices, sensors, and

wearable technologies to a central monitoring hub. This integration enabled healthcare providers to always monitorvital signs like heart rate, temperature, and oxygen levels,without the necessity of being present at all times. The IoT patient monitoring system has demonstrated numerous benefits. Initially, it has greatly enhanced patient results by allowing timely identification of possible health problems and quick intervention. By consistently monitoring, healthcare providers can detect any irregularities or sudden shifts in vital signs promptly, leading to a quicker response, thus lowering the chances of complications or emergencies. Additionally, the system has improved patient convenience and comfort through the use of remote monitoring and consultations. Patients have the option to access healthcare services at home, which eliminates the requirement for regular hospital trips and decreases healthcare expenses. This is particularly beneficial for people with long-term health conditions or those residing in isolated regions with restricted medical resources. Moreover, the project has created opportunities for improved decision-making based on data in the healthcare sector. The patient monitoring system for IoT gathers large quantities of patient data that can be examined to detect patterns, trends,and connections. This important data can help in creating customized treatment plans, preventive actions, and predictive models, which can ultimately enhance patient care and resource distribution. In conclusion, the IoT patientmonitoring system project effectively utilized IoT technology to improve healthcare services. It has shown its capacity to enhance patient results, boost convenience, and facilitate data- informed decision-making. Advancing in this field, additional research and development show great potential for the future of healthcare, with the IoT patient monitoring system acting asa key factor for continued innovation in remote healthcare services

7. FUTURE ENHANCEMENT

The future outlook for IoT patient monitoring systems shows great potential to transform healthcare delivery and enhance patient results. These systems utilize the capabilities of the Internet of Things (IoT) to link different medical devices, sensors, and wearable technologies for monitoring patients' vital signs and health parameters in real-time. An important element of what lies ahead is the smooth incorporation of IoT patient monitoring systems into current healthcare infrastructure.

With the ongoing advancements in IoT technology, we can anticipate increased compatibility between these systems and electronic health records (EHRs) as well as other healthcare management platforms. This integration will make it easier for healthcare providers to share and analyze data, helping them make timely decisions on patient care. Additionally, remote and personalized healthcare are being seen as potential advances in future IoT patient monitoring systems.

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