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PATIENT HEALTH MONITORING SYSTEM USING IOT

Bhavik Hodar, Akshay Sharma, Shivaprakash munshi Lal, Prof. Mohan Kumar

Department of Electronics and Telecommunication Engineering, Atharva College of Engineering Mumbai, India.

ABSTRACT:

In recent years, there has been a growing demand for healthcare systems that are more efficient, cost-effective, and patient-centric. The integration of Internet of Things (IoT) technology into healthcare has the potential to transform the way healthcare is delivered, particularly in the area of patient monitoring. In this paper, we propose a patient health monitoring system using IoT that allows continuous monitoring of vital signs, such as blood pressure, heart rate, and temperature, and sends alerts to healthcare providers in case of abnormal readings. The system consists of wearable sensors that are connected to a gateway device, which in turn communicates with a cloud-based platform for data analysis and visualization. We describe the design and implementation of the system, including the hardware and software components, and present results from a pilot study conducted with a group of patients with chronic conditions. The results show that the system is reliable, user-friendly, and effective in providing timely alerts to healthcare providers, leading to improved patient outcomes and reduced healthcare costs.

Keywords: Patient Health Monitoring, IoT (Internet of Things), Sensors, Data Collection, Data Transmission, Data Analytics, User Interface, User Experience, Machine Learning, Healthcare, Vital Signs, Wearables, Cloud Computing, Remote Monitoring.

INTRODUCTION.

The increasing prevalence of chronic diseases and an aging population have put a strain on healthcare systems worldwide. In order to address this challenge, there has been a shift towards patient-centric models of care that prioritize prevention, early detection, and self-management. One of the key technologies that is driving this transformation is the Internet of Things (IoT). IoT refers to the network of. physical devices, vehicles, buildings, and other objects that are embedded with sensors, software, and connectivity, allowing them to collect and exchange data.

In healthcare, IoT has the potential to revolutionize the way patient monitoring is done. Traditional monitoring methods involve periodic measurements taken by healthcare providers during clinic visits or hospital stays. However, these methods are often inadequate for detecting early signs of deterioration, and do not provide continuous monitoring outside of the healthcare setting. IoT-enabled monitoring systems, on the other hand, allow for continuous, real-time monitoring of vital signs, and can alert healthcare providers to potential problems before they become serious.

In this paper, we describe the design and implementation of a patient health monitoring system using IoT. The system consists of wearable sensors that are connected to a gateway device, which in turn communicates with a cloud-based platform for data analysis and visualization. The system allows continuous monitoring of vital signs, such as blood pressure, heart rate, and temperature, and sends alerts to healthcare providers in case of abnormal readings. The system is designed to be user-friendly and non-invasive, allowing patients to go about their daily lives without disruption.

Design and Implementation.

The patient health monitoring system consists of four main components: the wearable sensors, the gateway device, the cloud-based platform, and the user interface. The wearable sensors are designed to be comfortable and unobtrusive, and can be worn on the wrist, chest, or other parts of the body. The sensors collect data on vital signs, such as blood pressure, heart rate, and temperature, and transmit the data to the gateway device via Bluetooth or Wi-Fi.

The gateway device is responsible for collecting data from the wearable sensors and sending it to the cloud-based platform for analysis and visualization. The gateway device is also equipped with a cellular modem, allowing it to send alerts to healthcare providers in case of abnormal readings. The cloud-based platform is responsible for storing and analyzing the data, and generating alerts when necessary. The platform also provides a user interface for healthcare providers to access the data and manage alerts.

HARDWARE PARTS.

The block diagram shows the components of the patient health monitoring system, which include the DS18B20 temperature sensor, Max30100 pulse oximeter, and Node MCU ESP8266.The DS18B20 temperature sensor is used to measure the patient's body temperature. It is connected to the Node MCU ESP8266 using a digital interface. The Max30100 pulse oximeter is used to measure the patient's heart rate and oxygen saturation level. It is connected to the Node MCU ESP8266 using an I2C interface.

The Node MCU ESP8266 is used as the microcontroller and Wi-Fi module for the system. It collects data from the DS18B20 temperature sensor and Max30100 pulse oximeter and sends it to a remote server for analysis. It is also responsible for generating alerts in case of any abnormality in the patient's health status.

3.1 bock diagram

Overall, this block diagram shows how the various components of the patient health monitoring system using IoT work together to continuously monitor a patient's vital signs and send data to a remote server for analysis.

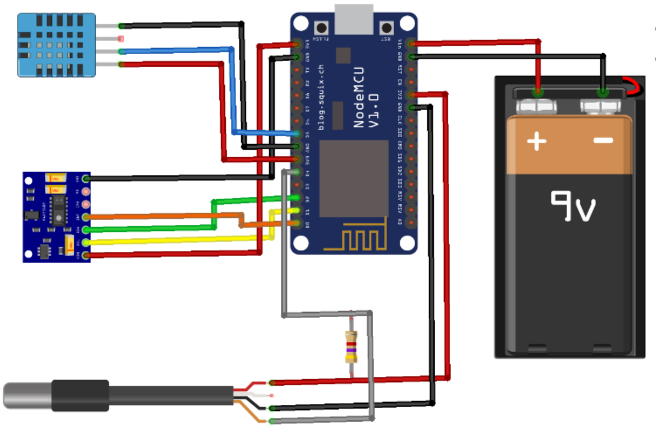

Figure 1: The total block diagram of the hardware.

3.1.1 Components and Connectors.

NodeMCU (ESP8266).

The NodeMCU (Node Micro Controller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

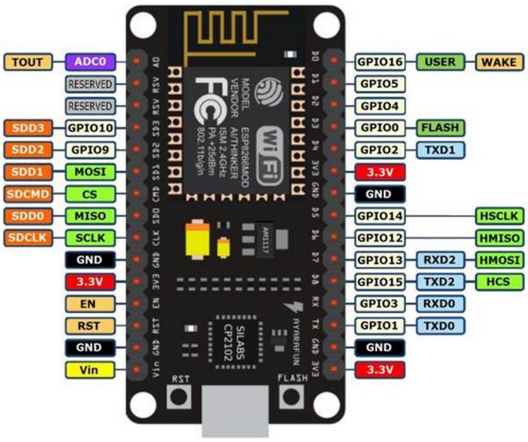

Figure 2: The Diagram of Node MCU (ESP8266).

NodeMCU Specifications.

The NodeMCU is available in various package styles. Common to all the designs is the base ESP8266 core. Designs based on the architecture have maintained the standard 30-pin layout. Some designs use the more common narrow (0.9″) footprint, while others use a wide (1.1″) footprint – an important consideration to be aware.

	Official NodeMCU	NodeMCU Carrier Board	LoLin NodeMCU
Microcontroller	ESP-8266 32-bit	ESP-8266 32-bit	ESP-8266 32-bit
NodeMCU Model	Amica	**Amica**	Clone LoLin
NodeMCU Size	49mm x 26mm	49mm x 26mm	58mm x 32mm
Carrier Board Size	n/a	102mm x 51mm	n/a
Pin Spacing	**0.9" (22.86mm)**	**0.9" (22.86mm)**	1.1" (27.94mm)
Clock Speed	80 MHz	80 MHz	80 MHz
USB **to Serial**	CP2102	**CP2102**	CH340G
USB Connector	Micro USB	Micro USB	Micro USB
Operating Voltage	3.3V	3.3V	3.3V
Input Voltage	4.5V-10V	4.5V-10V	4.5V-10V
Flash Memory/SRAM	4 MB / 64 KB	4 MB / 64 KB	4 MB / 64 KB
Digital I/O Pins	11	11	11
Analog In Pins	1	1	1
ADC Range	0-3.3V	0-3.3V	0-3.3V
UART/SPI/I2C	1 / 1 / 1	1 / 1 / 1	1 / 1 / 1
WiFi Built-In	802.11 b/g/n	802.11 b/g/n	802.11 b/g/n
Temperature Range	-40C - 125C	-40C - 125C	-40C - 125C
Product Link		NodeMCU	NodeMCU

The most common models of the NodeMCU are the Amica (based on the standard narrow pin-spacing) and the LoLin which has the wider pin spacing and larger board. The open-source design of the base ESP8266 enables the market to design new variants of the NodeMCU continually.

MAX30100 Pulse Oximeter and Heart Rate Sensor.

The module features the MAX30100 – a modern, integrated pulse oximeter and heart rate sensor IC, from Analog Devices. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry (SpO2) and heart rate (HR) signals.

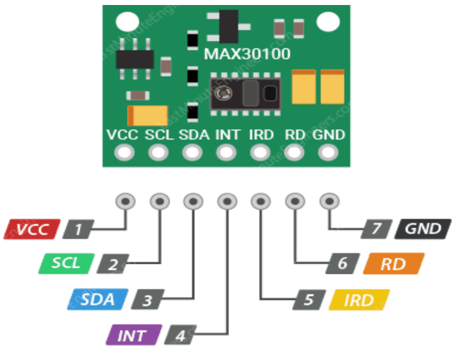

Figure 3: The Diagram of MAX30100 Pulse Oximeter and Heart Rate Sensor.

On the right, the MAX30100 has two LEDs – a RED and an IR LED. And on the left is a very sensitive photodetector. The idea is that you shine a single LED at a time, detecting the amount of light shining back at the detector, and, based on the signature, you can measure blood oxygen level and heart rate.

Technical Specifications.

Power supply	3.3V to 5.5V
Current draw	~600µA (during measurements)
	~0.7µA (during standby mode)
Red LED Wavelength	660nm
IR LED Wavelength	880nm
Temperature Range	-40˚C to +85˚C
Temperature Accuracy	±1˚C

How MAX30100 Pulse Oximeter and Heart Rate Sensor Works?

The MAX30100, or any optical pulse oximeter and heart-rate sensor for that matter, consists of a pair of high-intensity LEDs (RED and IR, both of different wavelengths) and a photodetector. The wavelengths of these LEDs are 660nm and 880nm, respectively.

The MAX30100 works by shining both lights onto the finger or earlobe (or essentially anywhere where the skin isn't too thick, so both lights can easily penetrate the tissue) and measuring the amount of reflected light using a photodetector. This method of pulse detection through light is called Photoplethysmogram.

DS18B20 Temperature Sensor.

Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

Figure 4: The Diagram of DS18B20 Temperature Sensor.

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

Technical Specifications.

- Usable temperature range: -55 to 125 °C (-67 °F to+257 °F)
- 9-to-12-bit selectable resolution.
- Uses 1-Wire interface- requires only one digital pin for communication.
- Unique 64-bit ID burned into chip.
- Multiple sensors can share one pin.
- ±0.5 °C Accuracy from -10 °C to +85 °C.

DHT11 Humidity & Temperature Sensor.

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmers in the OTP memory, which are used by the sensor's internal signal detecting process.

Figure 5: The Diagram of DHT11 Humidity & Temperature Sensor.

The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20-meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

Technical Specifications.

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

Jumper wires (Connectors).

Jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. By attaching a jumper wire on the circuit, it can be short-circuited and short-cut (jump) to the electric circuit.

Figure 6: The Diagram of Jumper wires (Connectors).

MAIN WORKING.

The main working of a patient health monitoring system using IOT has the following steps:

Data Collection: The system collects data from the sensors, which includes temperature, humidity, and pulse rate.

Data Processing: The collected data is processed and filtered to remove any noise or unwanted values.

Data Transmission: The filtered data is transmitted from the NodeMCU (ESP8266) to a cloud-based server or healthcare provider using Wi-Fi or other wireless communication technologies.

Data Analytics: The transmitted data is analyzed using machine learning algorithms and other data analytics techniques to provide insights into the patient's health status and identify any potential health issues.

Visualization: The analyzed data is visualized in an easy-to-understand format, allowing healthcare providers to monitor the patient's health status quickly and easily.

Alerts and Notifications: The system can be programmed to send alerts and notifications to healthcare providers or family members if any health parameters fall outside of the normal range or if any potential health issues are identified.

Remote Monitoring: The system allows for remote monitoring of the patient's health status, enabling healthcare providers to provide timely intervention if necessary.

Overall, the patient health monitoring system using IOT provides continuous monitoring of vital signs, temperature, and humidity, enabling healthcare providers to provide proactive and personalized care to the patient.

SOFTWARE PART

Software used: Ardiuno IDE

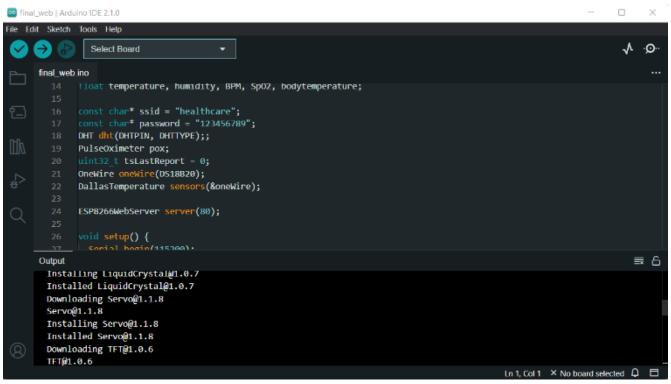

Figure 6: The Diagram of MAIN CODING IN ARDUINO IDE.

FINAL RASULT:

6.1 OUTPUT FOR PROJECT

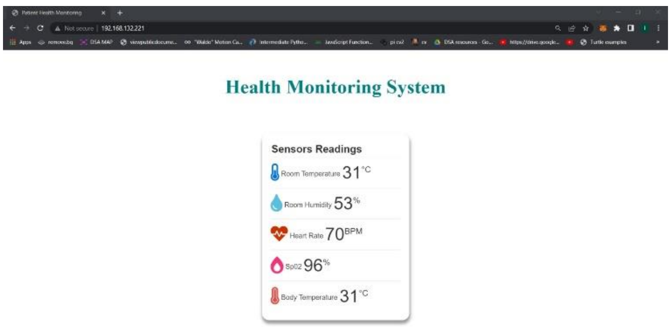

Figure 6: The Diagram of Final output in browser with the help of IP address

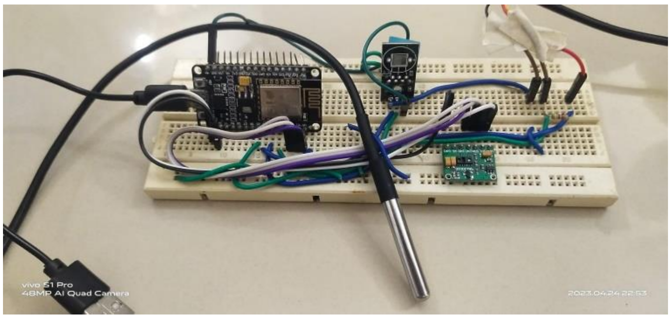

Figure 7 : The main circuit assembly.

CONCLUSION

In conclusion, patient health monitoring systems using IoT have the potential to revolutionize healthcare by providing real-time monitoring and analysis of patient health data. Such systems can help healthcare providers to detect health issues at an early stage, improve patient outcomes, and reduce healthcare costs.

IoT-based health monitoring systems can provide continuous monitoring of vital signs, activity levels, medication adherence, and other health-related data. The collected data can be analyzed using advanced machine learning algorithms and visualized in an intuitive way to help healthcare providers make informed decision. However, the design and implementation of IoT-based health monitoring systems should be carefully considered to ensure their accuracy, reliability, and security. The use of medical-grade sensors, reliable data transmission, and secure storage of patient data is essential to protect patient privacy and ensure the safety of patients.

In addition, the accessibility and affordability of IoT-based health monitoring systems should be considered to ensure that they are accessible to a wide range of patients, including those with limited resources or living in remote areas.

Overall, patient health monitoring systems using IoT have great potential to improve patient outcomes and reduce healthcare costs. By leveraging the power of IoT, healthcare providers can move towards a more proactive and personalized approach to patient care.

COMPARATIVE

Sensors and Data Collection: The types and number of sensors used to collect patient data can vary between different IoT-based health monitoring systems. Some systems may use a limited number of sensors to collect basic vital signs, while others may incorporate multiple sensors to collect a more comprehensive set of health data. The accuracy and reliability of the sensors used can also vary. For example, some systems may use medical-grade sensors, while others may use consumer-grade sensors.

Data Transmission: The method used to transmit the collected patient data to the cloud-based server or healthcare provider can vary between different systems. Some systems may use wireless technologies such as Bluetooth or Wi-Fi, while others may use cellular networks or other proprietary communication protocols. The speed, reliability, and security of the data transmission can also vary between different systems.

Data Analytics and Visualization: The methods used to analyze and visualize the collected patient data can vary between different systems. Some systems may use basic analytics and simple visualizations, while others may use advanced machine learning algorithms and interactive visualizations. The ease of use and effectiveness of the analytics and visualizations can also vary.

User Interface and User Experience: The design and usability of the user interface can vary between different IoT-based health monitoring systems. Some systems may have simple and intuitive user interfaces, while others may have complex and confusing interfaces. The user experience can also vary depending on the design and usability of the system.

Cost and Accessibility: The cost and accessibility of IoT-based health monitoring systems can vary widely. Some systems may be expensive and only accessible to a limited number of patients, while others may be affordable and accessible to a wider range of patients.

Overall, while there is no one-size-fits-all solution for IoT-based health monitoring systems, a well-designed system that uses accurate sensors, reliable data transmission, effective data analytics and visualization, intuitive user interface, and affordable cost can significantly improve patient care and reduce healthcare costs

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