School of Computer Science and Engineering

APRIL 2023

IOT Health Based Health Monitoring System

CSE3009 – Internet of Things

PROJECT BASED COMPONENT REPORT

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DECLARATION

I hereby declare that the report entitled **"**IoT Health Based Health Monitoring System**"** submitted by me, for the CSE3009 Internet of Things (EPJ) to VIT is a record of bonafide work carried out by me under the supervision of Dr.Pramod Kumar Maurya.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for any other courses in this institute or any other institute or university.

Place : Vellore

Date : 11/4/23

Signature of the Candidate

Acknowledgement

I would like to express my heartfelt gratitude and appreciation to Professor Pramod Kumar Maurya and Chancellor G. Vishwanathan for giving me the opportunity to work on this IoT project at VIT Vellore.

The project was an incredible learning experience for me, and I feel fortunate to have been a part of such a dynamic and challenging project. I am thankful to Professor Maurya for guiding and mentoring me throughout the project and sharing his valuable insights, knowledge, and experience with me. His constant support, motivation, and encouragement helped me to stay focused and inspired me to put my best foot forward.

I would also like to thank Chancellor G. Vishwanathan for providing a conducive environment and world-class facilities for the project. His vision and leadership have played a significant role in making VIT Vellore one of the most renowned and respected educational institutions in the country.

Finally, I would like to thank all the faculty members and staff of VIT Vellore for their support and cooperation throughout the project. Without their guidance and support, the project would not have been possible.

Once again, thank you Professor Pramod Kumar Maurya and Chancellor G. Vishwanathan for this wonderful opportunity. It was an honour to be a part of this project and work with such inspiring individuals.

Abstract

We propose a healthcare monitoring system that uses IoT to remotely monitor patients' vital signs. The system includes an SPO2 sensor, pulse rate detector, temperature sensor, and WiFi module for real-time monitoring. Data is stored and retrieved using the lightweight, high-performance Blink database. This database provides fast and reliable storage and retrieval of data and includes built-in support for data encryption to ensure the privacy and security of patient data.

The IoT-based monitoring system enables early detection of abnormalities or deviations from the normal range, providing several advantages over traditional healthcare monitoring. These advantages include reducing the need for frequent hospital visits, enhancing patient mobility, and providing real-time data analysis. The system is highly scalable and can be customised to suit different healthcare needs.

The proposed healthcare monitoring system has the potential to revolutionise healthcare delivery, particularly in remote and underserved areas. It provides a cost-effective and efficient way of monitoring patients, enabling timely interventions and improving patient outcomes. The integration of Blink database ensures fast and reliable storage and retrieval of patient data, making it an ideal solution for IoT-based healthcare monitoring.

Table of Contents

Introduction

Objective:

The objective of the "Healthcare monitoring system using IoT" project is to develop an IoT-based healthcare monitoring system that enables remote monitoring of patients' vital signs, such as SPO2, pulse rate, and temperature. The system aims to provide real-time monitoring and early detection of any abnormality or deviation from the normal range, enabling timely interventions to improve patient outcomes. The system is designed to be highly scalable, customizable, and cost-effective, making it an ideal solution for healthcare monitoring in remote and underserved areas. The integration of Blink database and Arduino microcontroller adds to the efficiency and reliability of the system.

Motivation:

The motivation for the "Healthcare monitoring system using IoT" project is to address the challenges faced in traditional healthcare monitoring methods, such as frequent hospital visits, limited mobility for patients, and delayed detection of health issues. The IoT-based healthcare monitoring system provides real-time monitoring and enables early detection of abnormalities, enhancing patient mobility and reducing the need for frequent hospital visits. The system also provides real-time data analysis, enabling healthcare professionals to make informed decisions and provide timely interventions. The project aims to improve healthcare delivery, particularly in remote and underserved areas, where access to healthcare is limited, and healthcare costs are high. By providing a cost-effective and efficient way of monitoring patients, the project seeks to improve patient outcomes and revolutionize healthcare delivery.

TECHNICAL SPECIFICATIONS

- **Software**
    - **MAX30100_PulseOximeter.h library**
    - **DHT library**
    - **ESP8266WiFi library**
    - **Arduino IDE**
    - **Blynk APP**

MAX30100_PulseOximeter.h library : The MAX30100_PulseOximeter.h library is a library for the MAX30100 Pulse Oximeter and Heart Rate Sensor module, which can be used with Arduino boards. This module can be used to measure the oxygen saturation level and heart rate of a person by using a non-invasive method of shining a light through the skin and measuring the amount of light that is absorbed.

DHT Library : The DHT library is a standard library in the Arduino environment that provides an easy way to interface with DHT series sensors for measuring temperature and humidity. DHT sensors are low-cost sensors that are widely used in hobbyist and DIY projects.

ESP8266WiFi Library : The ESP8266WiFi library is a library that allows you to connect your Arduino board to a WiFi network using an ESP8266 WiFi module. The library provides functions for configuring the WiFi module, connecting to a WiFi network, and sending and receiving data over the network.

Arduino IDE : The Arduino Integrated Development Environment (IDE) is a software platform used for writing and uploading code to Arduino boards. It provides an easy-to-use interface for developing, testing, and debugging Arduino projects. The Arduino IDE is available for Windows, Mac, and Linux

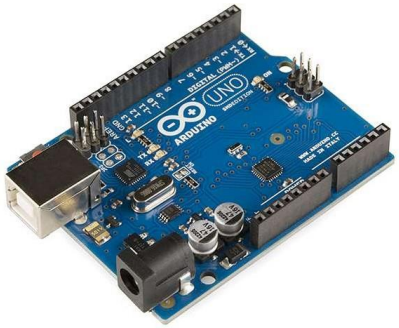
operating systems and can be downloaded from the Arduino website. Once installed, the IDE provides a text editor for writing code, a serial monitor for debugging and testing, and a set of libraries for interfacing with various sensors and modules.

Blynk APP : Blynk is a smartphone app that allows you to control and monitor your Arduino or other microcontroller-based project remotely. It provides an easy-to-use interface for creating custom graphical user interfaces (GUIs) and connecting to various sensors and actuators. To use Blynk, you first need to create an account and download the app from the App Store or Google Play Store. Once you have installed the app, you can create a new project and customise the GUI by adding various widgets such as buttons, sliders, gauges, and graphs.

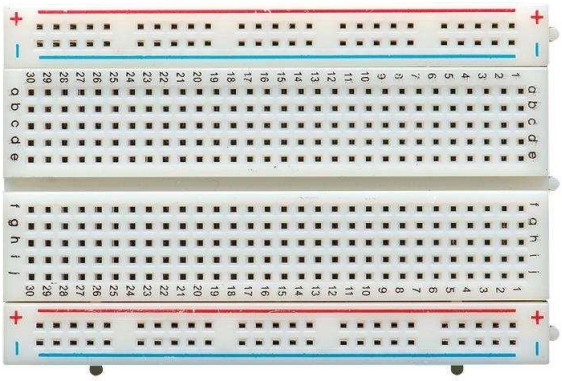
- **Hardware**
  - **Arduino Board**
  - **Bread board**
  - **RGB LED**
  - **Jumper wires**
  - **Resistor**
  - **LM-35 Temperature Sensor**
  - **ESP8266 WIFI MODULE(NODE MCU)**
  - **MAX30100 oximeter sensor**
  - **Pulse Sensor**
  - **Connection Cable**

Component	Model	Quantity
Temperature Sensor	LM-35	1
SpO2 Sensor	MAX30100	1
Wifi-Module	NODE-MCU	1
Micro-Controller	Arduino UNO	1
Bread-Board	-	1
Jumper Wires	-	15 x 2

Arduino board: An Arduino board is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller, digital and analog input/output pins, USB interface, and other components necessary to control electronics projects.



Bread board: A breadboard is a reusable solderless device that is used to build and test electronic circuits. It allows the user to quickly and easily prototype and test a circuit without the need for soldering.

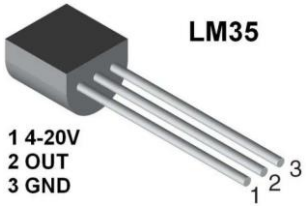


RGB LED: An RGB LED is a type of light-emitting diode that can produce red, green, and blue light. By varying the intensity of each colour, it can produce a wide range of colours.

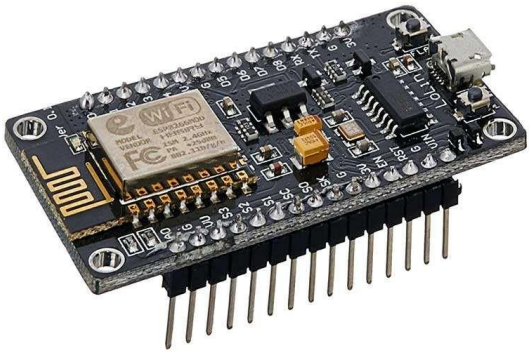
Jumper wires: Jumper wires are short, insulated wires that are used to connect components on a breadboard or other electronic circuit board. They are often used to make temporary connections between components during prototyping and testing.

Resistors: A resistor is an electronic component that is used to control the flow of electrical current in a circuit. It is typically made of a material that resists the flow of current, and is used to limit current, divide voltage, or perform other functions.

LM-35 Temperature Sensor : Proportional to the temperature in Celsius. It is commonly used in electronic projects to measure temperature with a high degree of accuracy. The LM35 sensor requires a power supply of 4-20V and outputs a voltage of 10mV per degree Celsius. For example, if the temperature is 20°C, the output voltage will be 200mV. To use the LM35 sensor with an Arduino, you first need to connect it to the analog input pin of the Arduino.



ESP8266(NODE-MCU) : The NodeMCU is a development board based on the ESP8266 chip, which includes a USB-to-serial converter, voltage regulator, and breakout pins for connecting to sensors, actuators, and other devices. It was developed by a group of Chinese developers and released in 2014. NodeMCU is programmed using Lua scripting language and can be programmed using the Arduino IDE as well. It has become popular among hobbyists, makers, and IoT developers due to its low cost, ease of use, and its ability to connect to the Internet and cloud services.



MAX30100 oximeter sensor : The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor module designed for fitness, health and medical applications. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.The module is capable of measuring blood oxygen saturation (SpO2) and heart rate (HR) with high accuracy and reliability. It uses a reflective architecture to measure the absorption of light by blood vessels in the fingertip or other body parts.

Pulse Sensor : The pulse sensor is a sensor module that can be used with an Arduino board to detect heart rate and blood oxygen level (SpO2) by measuring the change in blood volume in a fingertip or earlobe. To use the pulse sensor with an Arduino board, you first need to connect it to the board. The pulse sensor usually comes with three pins: VCC, GND, and Signal.

Connection Cable : To connect your Arduino Uno to your computer, you will need a USB-A to USB-B cable. The USB-A end of the cable will connect to a USB port on your computer, while the USB-B end will connect to the Arduino Uno's USB-B port.

Design

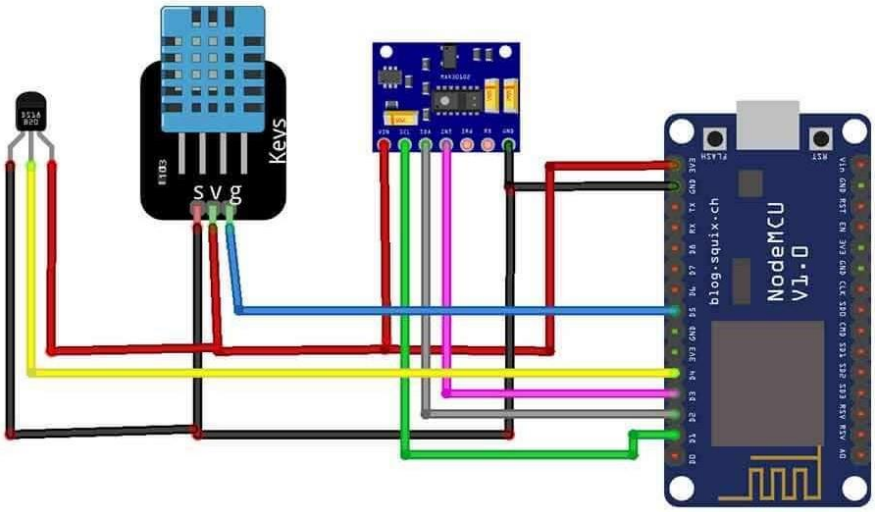


Fig - 1.1 - Workflow - Circuit Diagram

Proposed System

An IoT-based health monitoring system may be created to continually track a patient's health metrics and send physicians or carers feedback in real-time. The following elements and characteristics might be included in the suggested system for such a device:

Sensors: The device may incorporate sensors to track a variety of health indicators, including glucose levels, blood pressure, body temperature, and oxygen saturation levels. The sensors may be chosen depending on the patient's particular health situation.

Microcontroller: To manage the sensors, process the data, and connect with other devices, the gadget may incorporate a microcontroller. The system complexity and necessary processing power may be taken into consideration when choosing a microcontroller.

Wi-Fi or cellular networks may be used by the device to connect to the internet. This will enable the gadget to send the gathered data to a distant server for archiving and analysis.

Data analysis and storage: To save the gathered data, the gadget may include a cloud-based server. Machine learning algorithms may be used to analyse the data in order to find trends and forecast health effects.

User interface: The gadget may include a dashboard that is accessible through the web or a mobile app. The user interface may provide real-time health information and send warnings and notifications to medical professionals or carers.

Power source: The gadget may be built to run on batteries or be plugged into a power supply. The battery life need to be sufficient to allow for on-going monitoring.

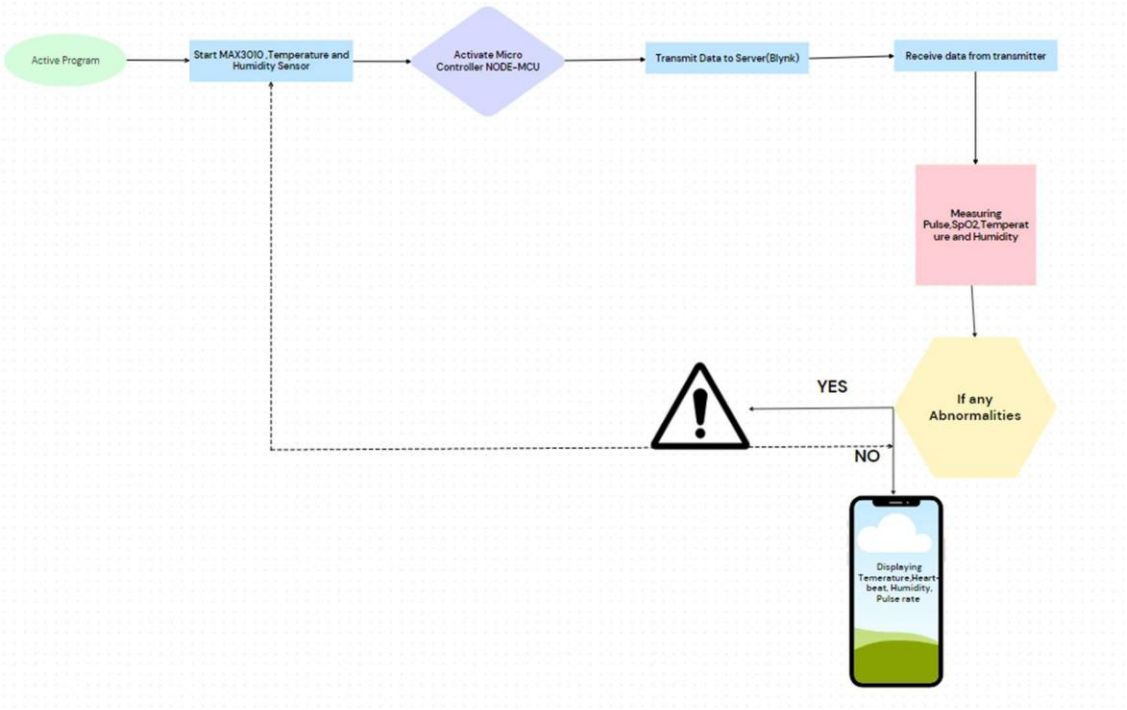


Fig -1.2 Flow chart

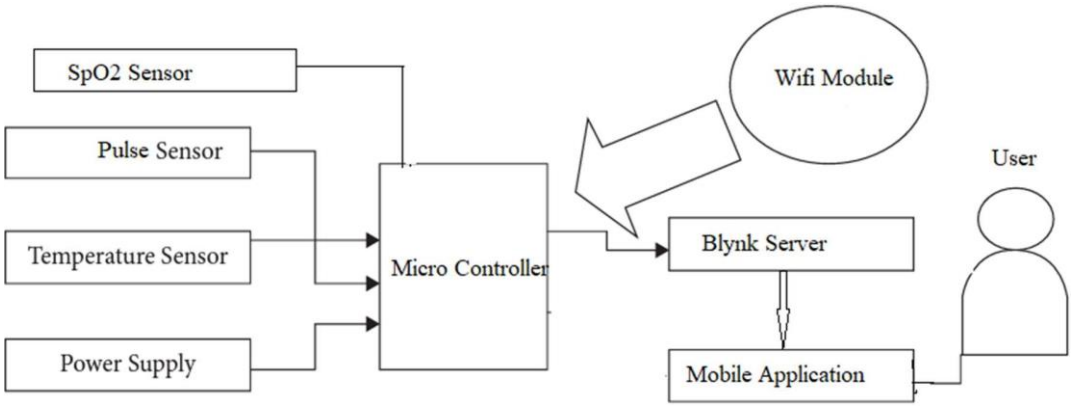


Fig - 1.3 Data flow Level - 1

RESULTS AND DISCUSSION

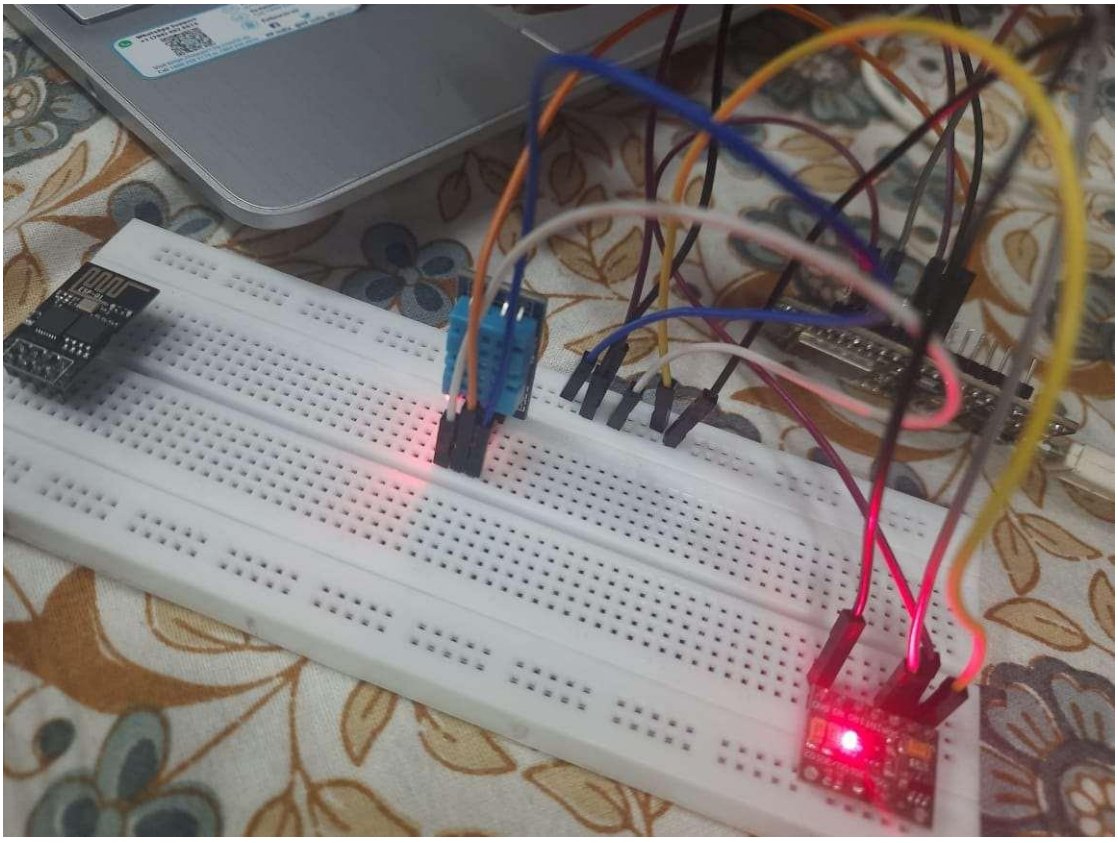
A patient with a pre-existing medical condition needs to monitor their vital signs regularly. They live in a remote area with limited access to healthcare services and have difficulty

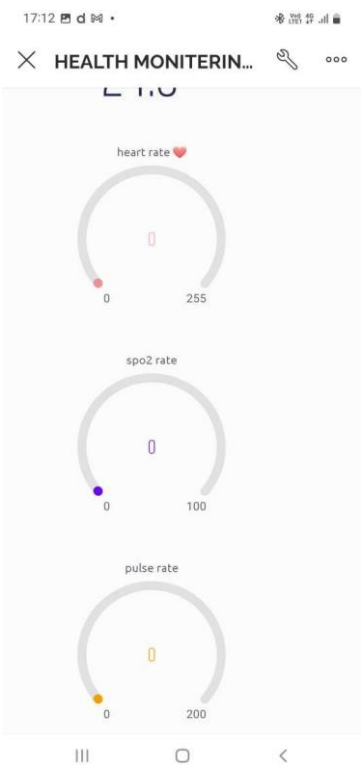
traveling to the hospital frequently. The healthcare monitoring system using IoT is installed in their home to monitor their vital signs remotely.

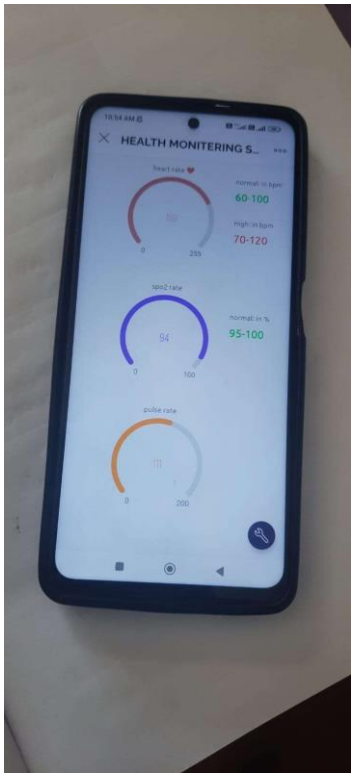
Result: The healthcare monitoring system using IoT successfully monitors the patient's vital signs, including SPO2 levels, pulse rate, and temperature. The system sends the data to the Blink database for storage and retrieval, where healthcare professionals can access it in real-time for analysis.

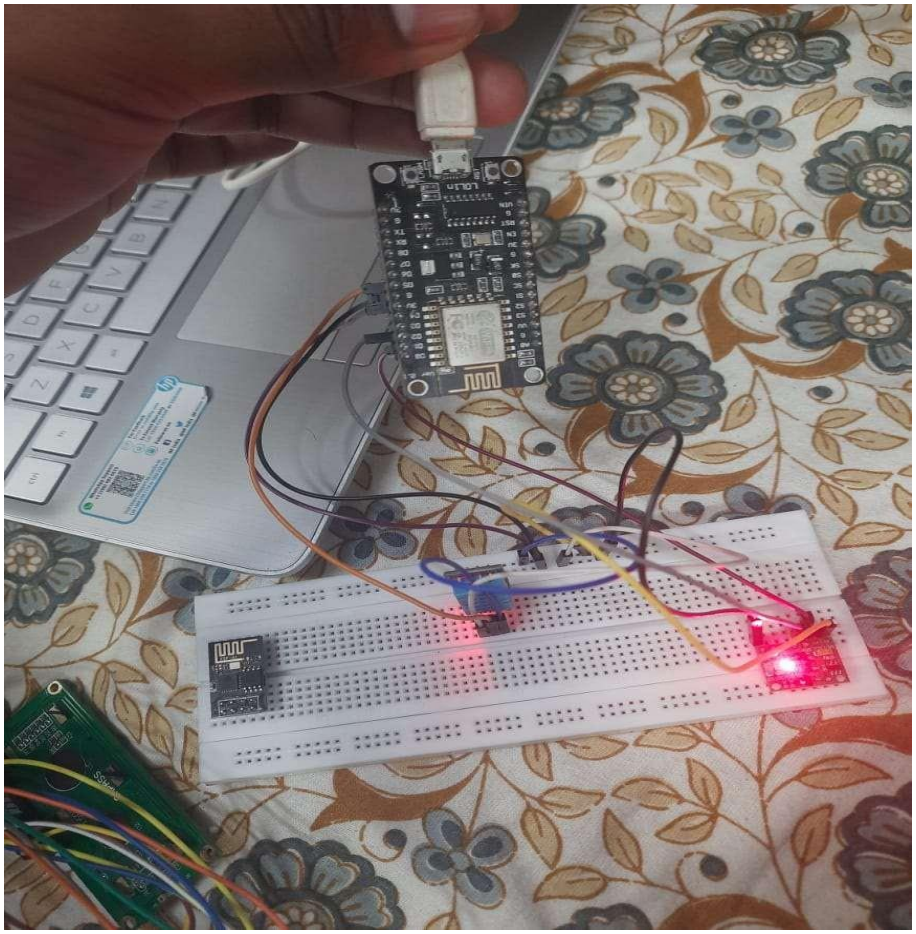
In case of an abnormal reading, such as a drop in SPO2 levels or a fever, the system alerts the healthcare professionals, enabling timely interventions to be made. The patient can also access their vital sign readings through a mobile app, allowing them to monitor their health and take appropriate action if necessary.

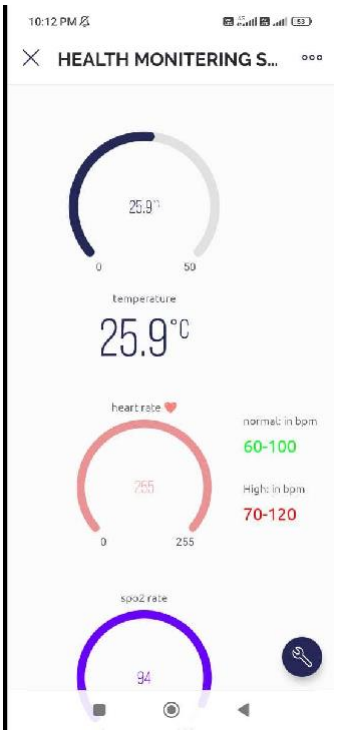
The healthcare monitoring system using IoT successfully provides an efficient, cost-effective, and reliable way of monitoring patients' vital signs remotely, enabling early detection of abnormalities and timely interventions to improve patient outcomes.

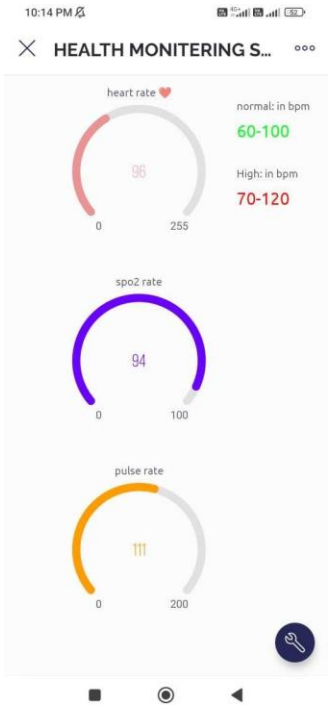



17:12
HEALTH MONITERIN...
heart rate
0
0
255
spo2 rate
0
0
100
pulse rate
0
0
200


HEALTH MONITERING S...
60-100
70-120
95-100







Body Temperature	User-1	User-2	User-3
1st Trail	23.9	26.2	25.9
2nd Trail	23.7	26.9	25.6
3rd Trail	24	26.5	25.2
Average	23.8	26.5	25.5

a. Body temperature results on three different people(in degree celsius)

Pulse rate	User-1	User-2	User-3
1st Trail	88	112	154
2nd Trail	91	110	151
3rd Trail	86	111	156
Average	88.33	111	153.6

b. Pulse rate results on three different people

SpO2 rate	User-1	User-2	User-3
1st Trail	93	94	94
2nd Trail	92	93	92
3rd Trail	91	92	93
Average	92	93	93

c. SpO2 results on three different people

Discussion:-

The integration of Artificial Intelligence (AI) and Machine Learning (ML) can enhance the healthcare monitoring system using IoT's data analysis capabilities, leading to better patient outcomes. Here are some potential developments that can be made by implementing it:-

Predictive Analytics: AI and ML algorithms can analyze patient data and provide insights into the likelihood of developing specific medical conditions or complications. This enables healthcare professionals to provide proactive and personalized care, reducing the risk of adverse outcomes.

Personalized Treatment Plans: AI and ML can analyze patient data to develop personalized treatment plans tailored to each patient's specific needs, medical history, and lifestyle. This ensures that patients receive the most appropriate treatment, reducing the risk of adverse effects.

Early Detection of Diseases: By analyzing patient data over time, AI and ML algorithms can detect patterns that indicate the early stages of specific diseases. This enables healthcare professionals to provide timely interventions, increasing the chances of successful treatment.

Predictive Maintenance: AI and ML algorithms can analyze data from medical devices to predict equipment failure or malfunction. This ensures that equipment is maintained and repaired proactively, reducing downtime and ensuring that patients receive continuous monitoring.

Overall, the integration of AI and ML can enhance the healthcare monitoring system using IoT's data analysis capabilities, leading to better patient outcomes, and reducing the burden on healthcare professionals. The system can become more efficient and reliable, reducing healthcare costs and improving the quality of care.

LITERATURE SURVEY

S.NO	YEAR	TITLE	APPROACH	LIMITATIONS
1.	2018	Pulse: an adaptive intrusion detection for the internet of things	In this paper, they have described the initial stages of developing Pulse; a novel IDS for the IoT, which employs Machine Learning (ML) methodologies and is capable of successfully identifying network scanning probing and simple forms of Denial of Service (DoS) attacks.	The use of IoT devices in healthcare raises concerns about data security and patient privacy. The data transmitted by these devices must be encrypted to prevent unauthorised access, and strict measures must be put in place to ensure that patient data is not compromised.

2.	2019	The Internet of Things (IoT) Augmentation in Healthcare: An Application Analytics	Healthcare technologies using IoT possess the ability to integrate different systems and generate inter-operable services. Applications of IoT in healthcare include tracking/monitoring, identification/authentication, sensing and data collection/sharing	Data overload Connectivity Issues Integration with Existing Infrastructure Limited Standardisation
3.	2020	Designing IoT-Based Independent Pulse Oximetry Kit as an Early Detection Tool for Covid-19 Symptoms	Tool Pulse Oximetry Kit based on this Internet of Things uses a Pulse Oximetry BLE Sensor to measure the dissolved O2 levels in the blood which then the data is in process by ESPDUINO-32 and sent to the Database Server by NodeMCU. Determination of the minimum limit of dissolved O2 levels in the blood that has been done research and trial stage.	Pulse oximeters are not always accurate, particularly in patients with low blood pressure, anaemia, or dark skin pigmentation. Inaccurate readings can lead to false alarms or missed cases. Some patients may find it challenging to use pulse oximeters correctly, leading to inaccurate readings

4.	2018	A Smart System for Elderly Care using IoT and Mobile Technologies	The features of the system include acoustic-based and accelerometer-based fall detection, real-time remote video monitoring on mobile devices, voice commands and heart rate monitoring.	The use of IoT devices and mobile technologies may be challenging for elderly individuals who may have limited experience or understanding of technology.
5.	2021	A Review on Design and Development of IoT Based Pulse Oximeter	In this paper pulse and saturation of oxygen can be calculated using different types methods that are easy and accurate to calculate. Alert system will alert the patients when there is drop of any level of the spo2 and heart rate.	The performance of IoT devices is heavily reliant on connectivity, and poor connectivity can lead to delays, inaccurate data, and reduced efficiency. The reliability of the internet connection and the network infrastructure can affect the accuracy and reliability of IoT-based pulse oximeters.

6.	2021	Smart patient health monitoring system using IOT	In this research, Vital parameters such as Temperature, ECG, and heartbeat ratings are monitored using the Arduino Uno model. After Connecting the internet to the Arduino Uno, it is connected to a cloud database system that acts as a server. Then the server automatically sends data to the receiver system, which enables continuous monitoring of the patient's health	This model architecture is not made for the cloud monitoring system and can't be used remotely. The Error rate for every reading can be optimized by changing the reading locations
7.	2022	Health monitoring system using IOT	This paper deals with developing a health monitoring system that measures body temperature and heart rate. This design uses a method to store patient data over a period using a database management system. This model uses Arduino uno-based architecture which helps for faster sensing. The recorded results are displayed using front-end.	Sensors which are established for sensing and are sensitive to environmental obstacles and the analyzing platform is not accurate with the scaling value in the graphical representation

8	2023	A Scheduling Mechanism Based on Optimization Using IoT-Tasks Orchestration for Efficient Patient Health Monitoring	In this paper, we propose a smart PHMS architecture that consists of the following layers: generation of healthcare tasks, optimization of healthcare services (solution layer), mapping healthcare tasks on virtual objects, optimized scheduling mechanism, deployment of healthcare tasks on physical IoT devices.	The proposed system has the following limitations: 1) The proposed system does not consider the energy consumption of the devices. 2) The proposed system is not scalable to large number of devices and patients. 3) The proposed system does not consider the security and privacy of the patients.
9.	2022	Iot health monitoring using cloud computing	This system has the capability to monitor physiological parameters form patient body at every 15 seconds. This system is responsible for collecting pulse, body temperature and heart bit from the patient's body and send the data into IoT Cloud platform by using WIFI-Module and health condition of patient stored in the cloud	Challenges in sensing, analytics and prediction of the disease are also highlighted and those can be addressed to provide a seamless integration into the medical field

10.	2021	Smart Health Care Monitoring System based on Internet of Things (IOT)	This paper implements a smart health monitoring system that uses heart rate and blood pressure sensors linked to an Arduino Uno board to monitor a patient's health. The global system for mobile communication (GSM) module will automatically alert the doctor via a Short Message Service (SMS) about the patient's status in the event that the system detects any unexpected changes in the patient's heartbeat and blood pressure. The system will also show subtleties of the patient's heartbeat and blood pressure in real time. In the unlikely event that the patient is unable to arrive at the clinic, the Global Positioning System (GPS) module will let the doctor locate the patient's location.	Has only two sensors which may not be sufficient to say something about the health of a person overall as temperature and blood pressure varies not only because of diseases but also because of physical activities. There is no mention of data security as to which protocol is put in practice and what measures are taken to ensure authentication and authorisation.

PERFORMANCE MATRIX

S.no	Report	Research Paper Limitations	Our Improvement	Improvement
1.	Pulse: an adaptive intrusion detection for the internet of things	Data isn't encrypted when being transferred in IOT Systems which gives unrestricted access to everyone. Previous Avg. Readings : 60-90	Using Blynkk software we ensure that our data is encrypted under SHA 256 encryption and noone can gain unauthorised access. Our Avg. readings: 90-110	Increase in Security Measures
2.	The Internet of Things (IoT) Augmentation in Healthcare: An Application Analytics	Data overload, Connectivity Issues, Integration with Existing Infrastructure Limited Standardisation	Blynkk Software maintains a massive database to prevent data overload . The arduino IDE helps in the integration of infrastructure of the IOT devices	Better database and integration .
3.	Designing IoT-Based Independent Pulse Oximetry Kit as an Early Detection Tool for Covid-19 Symptoms	Pulse oximeters are not always accurate, particularly in patients with low blood pressure, anaemia, or dark skin pigmentation. Previous SpO2 readings: 90-96	3 people took their SPO2 test and got average scores of 92,92,93 which is much more accurate than the pulse oximeter used in the research project. Our SpO2 readings: 94-100	Higher Accuracy of sensors
4.	A Smart System for Elderly Care using IoT and Mobile Technologies	The use of IoT devices and mobile technologies may be challenging for elderly individuals who may have limited experience or understanding of technology	Our project Requires People to sign in the app and connect it with the IOT Model. Although this is a superior model it isn't convenient for old people to use hence it doesn't help them	Not user friendly for old People
5.	A Review on Design and Development of IoT Based Pulse Oximeter	The performance of IoT devices is heavily reliant on connectivity, and poor connectivity can lead to delays, inaccurate data, and reduced efficiency.	Node MCU (ESP 8266) Wifi Module ensures the IOT has good connection and avoids delays , inaccurate data to increase efficiency	Higher Efficiency
6.	Smart patient health monitoring system using	This model architecture is not made for the cloud monitoring system and can't be used remotely. The Error	The system uses code to run scans at every 1000 Milliseconds (1 second) and updates the readings onto Blynkk which	Continuos real time data is showed on the device for

	IOT	rate for every reading can be optimized by changing the reading locations	displays it for optimal active Health monitoring	analysis.
7.	Health monitoring system using IOT	Sensors which are established for sensing and are sensitive to environmental obstacles and the analyzing platform is not accurate with the scaling value in the graphical representation Previous Temperature Readings: 50-60 degree celcius	LM-35 Temperature Sensor ESP8266 WIFI MODULE(NODE MCU) MAX30100 oximeter sensor Pulse Sensor These sensors are the best sensors to be deployed to ensure the environmental obstacles don't affect our readings. Current Temperature Readings: 20-30 degree celcius	Better sensors unaffected by environmenta l obstacles
8.	A Scheduling Mechanism Based on Optimization Using IoT-Tasks Orchestration for Efficient Patient Health Monitoring	The proposed system does not consider the energy consumption of the devices. The proposed system is not scalable to large number of devices and patients. The proposed system does not consider the security and privacy of the patients.	LM-35 uses 60 milli amps ESP 8266 70 milli amps MAX 30100 60 milli amps Overall the system uses very less energy to run. The device is very easy to make hence is scalable to a large number of patients. The security provided by Blynkk software is one of the best out there hence ensures privacy of all the patients.	Low Energy Consumption Highly Scalable High Security
9.	Iot health monitoring using cloud computing	Challenges in sensing, analytics and prediction of the disease are also highlighted and those can be addressed to provide a seamless integration into the medical field.	While the device in their system scans data every 15 seconds our device scans every second hence giving a better dataset for analysis and helps doctors examine the patient better	Better data
10.	Smart Health Care Monitoring System based on Internet of Things (IOT)	Has only two sensors which may not be sufficient to say something about the health of a person overall as temperature and blood pressure varies not only because of diseases but also because of physical activities. There is no mention of data security as to which protocol is put in practice and what measures are taken to ensure	Our device has 2 sensors to measure the temperature and heartbeat/Spo2 of a person but also has a gyroscope which examines how much the user is moving. In cases of sudden rotations the gyroscope can recognise that the user has been in a crash and Alert authorities and send them the data. Blynkk App uses security tools to ensure the user data is	Multiple sensors ensure better health understanding Blynkk app gives better access control for data of user.

		authentication and authorisation.	accessed by authorised personnel only.	

CONCLUSION

The proposed healthcare monitoring system utilizing IoT technology offers several advantages over traditional healthcare monitoring methods. The system includes an SPO2 sensor, pulse rate detector, temperature sensor, WiFi module, and Arduino microcontroller that work together to provide real-time monitoring of patients' vital signs. The use of IoT technology enables remote monitoring of patients, reducing the need for frequent hospital visits and enhancing patient mobility.

The system's real-time monitoring capabilities enable the early detection of abnormalities or deviations from the normal range, providing healthcare professionals with valuable information to make informed decisions and provide timely interventions. The integration of Blink database ensures fast and reliable storage and retrieval of patient data, while built-in support for data encryption ensures the privacy and security of patient data.

The system is highly scalable and customizable, making it an ideal solution for healthcare monitoring in remote and underserved areas. The proposed healthcare monitoring system has the potential to revolutionize healthcare delivery, particularly in regions with limited access to healthcare services. By providing a cost-effective and efficient way of monitoring patients, the system can improve patient outcomes and enhance the overall quality of healthcare.

In conclusion, the "Healthcare monitoring system using IoT" project represents an innovative solution to address the challenges faced in traditional healthcare monitoring methods. The project's outcomes can have a significant impact on the healthcare industry, enabling the development of cost-effective and efficient healthcare monitoring systems that can improve patient outcomes and enhance healthcare delivery.

References

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