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IOT BASED HEALTH MONITORING SYSTEM

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering
for the course Design Thinking and Innovation- SCSBDPROJ

by

MANDAVA SREE HARSHITH (43111327)

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
CATEGORY - 1 UNIVERSITY BY UGC
Accredited with Grade “A++” by NAAC I Approved by AICTE
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SCHOOL OF COMPUTING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

APRIL - 2025

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BONAFIDE CERTIFICATE

This is to certify that Design Thinking and Innovation- SCSBDPROJ is the Bonafide work of **MANDAVA SREE HARSHITH(43111327)** who carried out the Design Product entitled **"IOT- BASED HEALTH MONITORING SYSTEM**" as a team under my supervision from January 2025 to April 2025.

Design Supervisor

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Head of the Department

Dr. L. LAKSHMANAN, M.E., Ph.D.

Submitted for Viva voce Examination held on____________________

Internal Examiner **External Examiner**

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DECLARATION

I **MANDAVA SREE HARSHITH (43111327),** hereby declare that the Design Product Report entitled **"IOT- BASED HEALTH MONITORING SYSTEM"** done by me under the guidance of **Dr. J Cruz Antony,MCA.,Ph.D.,** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Computer Science and Engineering**.

DATE:

PLACE: Chennai **SIGNATURE OF THE CANDIDATE**

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I am pleased to acknowledge my sincere thanks to the **Board of Management** of **Sathyabama Institute of Science and Technology** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T. SASIKALA M.E., Ph. D**, **Dean**, School of Computing, and **Dr. L. LAKSHMANAN M.E., Ph.D.,** Head of the Department of Computer Science and Engineering, for providing me with necessary support and details at the right time during the progressive reviews.

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ABSTRACT

Project Title: IoT-Based Health Monitoring System

The IoT-Based Health Monitoring System is an intelligent, compact, and portable solution developed to address the growing need for continuous and real-time tracking of vital health parameters, particularly in remote, rural, and home-based care environments. The system employs an ESP8266-based microcontroller to serve as the central processing unit, integrating multiple biomedical sensors to monitor key health indicators. A MAX30102 pulse oximeter sensor is used to measure both heart rate (beats per minute) and blood oxygen saturation (SpO_2), which are essential markers of cardiovascular and respiratory health. Additionally, a digital temperature sensor is included to accurately detect the body temperature of the user.

The real-time readings from these sensors are immediately displayed on a 16x2 LCD screen with an I2C interface, providing instant visual feedback to the user or caregiver. For remote monitoring capabilities, the system is equipped with an ESP8266 Wi-Fi module, which transmits the collected health data to a cloud-based platform such as ThingSpeak. This cloud integration enables healthcare providers, family members, or remote clinics to access and analyze the patient's health status over time, identify abnormal trends, and make informed medical decisions without physical presence. The combination of real-time data acquisition, wireless transmission, and cloud visualization makes this system a cost-effective and scalable alternative to traditional hospital-based monitoring equipment. Moreover, its modular and upgrade-friendly architecture allows for the integration of additional sensors like ECG modules, motion detectors, or blood pressure sensors in future versions, making it a robust foundation for advanced health monitoring and telemedicine solutions.

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CHAPTER – 1

INTRODUCTION TO DESIGN THINKING

In today's fast-paced world, where chronic diseases and age-related health issues are on the rise, the need for continuous and remote health monitoring has become more critical than ever. Traditional healthcare systems often rely on scheduled checkups and manual diagnosis, which can delay detection and treatment. To overcome this limitation, the integration of Internet of Things (IoT) technologies in healthcare has paved the way for innovative and efficient health monitoring solutions. This project proposes an **IoT-based Health Monitoring System** utilizing **NodeMCU ESP8266 Wi-Fi module**, aimed at providing real-time, continuous monitoring of patients' vital signs from remote locations.

The system is designed to monitor key health parameters such as **body temperature**, **heart rate**, and **pulse rate**. These sensors collect real-time physiological data, which is then processed and transmitted wirelessly via the **NodeMCU ESP8266 Wi-Fi module** to a cloud server or IoT platform. From there, the data can be accessed through a mobile app or web interface by doctors, caregivers, or family members. This continuous flow of data allows for real-time health tracking and early detection of potential health problems.

The main objective of this system is to provide a **low-cost, energy-efficient, and scalable solution** for remote patient monitoring. The **NodeMCU ESP8266** enables stable and reliable wireless communication over Wi-Fi networks. By using commonly available components, the system ensures affordability and ease of deployment, especially in under-resourced areas.

This project demonstrates the potential of IoT in revolutionizing the healthcare sector by shifting from hospital-based care to **home-based and preventive care**. With further development, such systems can be expanded to monitor additional parameters like oxygen saturation (SpO2), ECG, or blood pressure, making them highly versatile and applicable to a wide range of patients

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1.1 OBJECTIVE :-

The primary objective of the **IOT-Based Health Monitoring System** is to design a reliable ,user -friendly , and cost-effective solution that can detect body temperature,heart rate and pulse rate and give accurate information. This project aims to collect real-time physiological data, which is then processed and transmitted wirelessly to a cloud server .Below are the specific objectives of the project.

- **To design and implement a real-time health monitoring system** that can continuously measure and transmit vital signs such as heart rate and body temperature.
- **To integrate the NodeMCU ESP8266 Wi-Fi module** for enabling wireless data transmission to a remote server or IoT platform.
- **To create a cloud-based system or web interface** where real-time health data can be monitored remotely by healthcare providers, caregivers, or family members.
- **To develop an alert notification mechanism** that sends warnings via SMS, email, or web alerts when any health parameter exceeds the predefined threshold.
- **To reduce the need for frequent hospital visits** by enabling remote supervision and care, especially for elderly or chronically ill patients.
- **To build a cost-effective and energy-efficient system** using commonly available hardware components for easy deployment in rural or underdeveloped areas.
- **To contribute to the development of smart healthcare solutions** that align with modern trends in IoT and remote patient monitoring.

1.2 ORIGIN OF THE PROJECT: -

The **IOT-based Health Monitoring System** originated from the need to monitor patients' vital signs remotely and in real time. With the rise in chronic illnesses and limited access to medical facilities in rural or remote areas, healthcare providers began looking for smart solutions to track patient health outside of hospitals.

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The introduction of low-cost Wi-Fi modules such as **ESP8266** made it easier to build compact, affordable health monitoring systems. These devices use sensors to measure parameters like **heart rate, body temperature, and oxygen saturation**, and then send the data wirelessly to cloud platforms or mobile apps, allowing doctors and caregivers to view patient data anytime, anywhere.

The project gained even more attention during the **COVID-19 pandemic**, when reducing physical contact became a priority. This system allowed patients to be monitored safely from home, helping prevent overcrowding in hospitals and minimizing infection risks. As a result, it became a popular and practical choice for student projects, healthcare research, and real-world medical applications.

1.3 PURPOSE AND INNOVATION :-

The IoT-Based Health Monitoring System is designed to offer a **cost-effective, real-time solution for monitoring vital health parameters** remotely. The core purpose of this project is to provide continuous tracking of essential physiological data—such as **heart rate** and **body temperature**—and make it accessible to caregivers and medical professionals via the **internet**, using the **ThingSpeak cloud platform**. By combining a **pulse oximeter (MAX30102)** and an **DS18B20 temperature sensor** with an **NodeMCU ESP8266 Wi-Fi module**, the system ensures that critical health data is collected and wirelessly transmitted without any need for manual intervention. This reduces dependency on physical visits to healthcare facilities, making it particularly valuable for patients in **remote areas**, those with **chronic conditions**, or individuals under **home quarantine**.

The innovation of this project lies in its **practical use of low-cost, off-the-shelf components** to build a system that mirrors the functionality of expensive medical equipment. Traditional health monitoring devices are often bulky, costly, and restricted to hospitals or clinics. In contrast, this system is **portable, scalable, and easy to deploy**, allowing it to be used in home environments, rural health centers, or even in mobile health units. One of the standout features is the system's **cloud integration with ThingSpeak**, which not only enables real-time data visualization but also allows for **custom alerts** when abnormal readings are detected—enhancing safety and enabling prompt action.

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Furthermore, the project is built with **modularity and future scalability** in mind. It can be easily upgraded to include additional health sensors, such as **ECG, blood pressure, or motion sensors**, to track more complex patient conditions. This makes it an excellent foundation for **smart healthcare applications** and **Internet of Medical Things (IoMT)** solutions. By leveraging affordable electronics and cloud technology, this project successfully bridges the gap between healthcare accessibility and modern IoT innovation, providing a strong example of how technology can improve everyday lives.

1.4 CREATIVITY AND COLLABORATION :-

The **IOT- Based Health Monitoring System** project is the result of a thoughtful blend of **creative thinking** and strong **team collaboration**, both of which are essential pillars in the Design Thinking process. From the early stages of brainstorming to the final stages of testing and presentation, every step in this project was shaped through innovation and effective teamwork.

Creativity

Creativity was at the heart of our project, especially when trying to solve a real-world safety problem with limited resources. We began by exploring various ideas and solutions that already exist in the market. However, most of them were either costly, complex, or lacked the ability. That’s when we challenged ourselves to think beyond conventional alarm systems and design a complete safety solution—one that not only detects gas leakage but also takes automatic preventive action to avoid disaster.

Instead of just alerting users with a sound, we introduced the concept of using a stepper motor controlled by a microcontroller to automatically shut off the gas regulator, thus preventing further leakage. This added mechanical response was a creative enhancement to the typical sensor-alarm combination.

Our system was also designed to be standalone, requiring no internet or mobile network. This decision ensured the project could be used in rural areas with limited access to digital infrastructure.

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Collaboration

This project could not have been successful without **collaborative effort**. From the beginning, we distributed responsibilities based on each team member's strengths. Some of us focused on **circuit design and hardware connections**, while others handled **programming and logic development**. Another team member took the lead in **documentation, report writing, and presentation design**.

Whenever we faced challenges such as sensor calibration issues or motor synchronization problems we tackled them as a team. Each obstacle became an opportunity for group problem-solving and shared learning.

By combining **technical knowledge**, **creative design**, and **teamwork**, we created a solution that is not only functional but also impactful. The project taught us the value of shared responsibility, open communication, and constructive criticism skills that are vital in any real-world engineering challenge.

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CHAPTER – 2
PROCESS OF DESIGN THINKING

The **Design Thinking** process is a user-centered, iterative approach to problem-solving. Based on the **IoT-Based Health Monitoring System** project from the Arduino Project Hub, here's how we can break down the **Design Thinking** process applied to this project:

- **Empathize**

  Goal: Understand the needs of the users (patients and caregivers).

  In this project:

  - Identified that many people, especially the elderly or those in remote areas, lack access to continuous health monitoring.
  - Aimed to provide real-time health data to doctors or family members.

- **Define**

  Goal: Clearly articulate the problem you're trying to solve.

  Problem Statement Example:

  - "Patients in remote areas or under home care lack real-time health monitoring, which can lead to late diagnosis and ineffective treatment."

- **Ideate**

  Goal: Brainstorm and explore different ways to solve the problem.

  In this project:

  - Considered using IoT and sensors to collect vital signs like temperature and heart rate.
  - Chose the WiFi module (ESP8266) to transmit data.

- **Prototype**

  Goal: Build a simple, working version of the solution.

  Prototype in the project:

  - Connected sensors to ESP8266.
  - Used LCD screen or serial monitor for local display.
  - Sent real-time health data to an online platform (ThingSpeak).

- **Test**

  Goal: Try out the solution, gather feedback, and iterate.

  In this project:

  - Tested if sensor readings were accurate and updated online in real time.

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2.1 EMPATHIZE :-

In the **Empathize** phase of the IoT-Based Health Monitoring System project, the goal is to deeply understand the needs, challenges, and experiences of the end users. This involves identifying who the users are and what problems they face in their daily lives, especially related to health monitoring. Many individuals—particularly the elderly and patients recovering at home—struggle with limited access to regular medical checkups and real-time health monitoring. This can lead to delayed diagnoses and increased health risks. By observing their environment and understanding their pain points, the project team can design a more effective, user-focused solution.

Key insights from the Empathize stage:

- **Users include** elderly individuals, post-surgery patients, doctors, and family members.
- **Challenges include** limited access to hospitals, especially in remote areas.
- **Cost and time** involved in frequent hospital visits are often burdensome.
- **Lack of real-time monitoring** can lead to delayed response to health issues.
- **Users need** a simple, non-invasive, affordable system that updates vital signs remotely.
- **Emotional stress** on caregivers and family members due to uncertainty in health status.

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2.2 PROBLEM STATEMENT :-

Access to quality and timely healthcare remains one of the most pressing issues in many parts of the world, particularly in rural, underdeveloped, or economically challenged regions. In these areas, patients especially the elderly and those with chronic illnesses face significant obstacles in managing their health. Regular hospital visits for routine checkups or monitoring are often not feasible due to long distances, lack of transportation, high medical expenses, and limited availability of healthcare professionals. Additionally, many patients recovering at home after surgeries or long-term illnesses require continuous monitoring to detect any signs of relapse or deterioration, yet they often receive minimal supervision during this critical period.

In the absence of a reliable health monitoring system, changes in vital signs such as body temperature and heart rate can go unnoticed, potentially leading to medical emergencies. This gap in monitoring becomes even more dangerous in patients with pre-existing conditions like cardiovascular diseases, diabetes, or respiratory disorders, where minor fluctuations in health parameters can have serious consequences.

Traditional healthcare systems rely heavily on in-person consultations, manual measurements, and delayed communication between patient and doctor. In contrast, today's world increasingly demands smart, connected solutions that can deliver real-time data and proactive alerts. Therefore, there is a growing need for a health monitoring system that can operate continuously, provide accurate real-time health data, and instantly notify caregivers or medical professionals in case of any abnormality.

This project aims to solve these challenges by developing an IoT-based health monitoring system using ESP8266 microcontroller, temperature and heart rate sensors, and internet connectivity. By integrating this technology into daily healthcare routines, patients can receive timely support, doctors can make informed decisions faster, and families can feel more confident and reassured about the health and safety of their loved ones. Ultimately, this system represents a step forward in creating more

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responsive, accessible, and modern healthcare solutions for those who need them the most.

2.3 IDEATION :-

In today's rapidly evolving healthcare landscape, the demand for remote patient monitoring solutions is more critical than ever. Traditional methods of patient monitoring often require physical presence and constant supervision, which may not be feasible in cases involving the elderly, chronically ill, or patients in remote areas. With the emergence of the Internet of Things (IoT), there is a growing opportunity to transform healthcare systems through connected, real-time monitoring solutions.

The ideation of this project stems from the need to develop a low-cost, efficient, and real-time health monitoring system that can help reduce the burden on medical staff while ensuring timely care for patients. The core idea is to create an IoT-based solution using ESP8266 Wi-Fi module for wireless communication. By integrating sensors such as temperature sensors, heart rate sensors, and SpO2 sensors, the system can continuously collect critical health parameters.

These vital signs are processed and transmitted over the internet using the ESP8266 module to a cloud platform or web application where doctors or caregivers can view and analyze the data. This enables real-time monitoring, early diagnosis, and timely alerts in case of any abnormal readings, thus potentially saving lives and improving the quality of care.

The project emphasizes simplicity, affordability, and adaptability, making it suitable not only for hospitals but also for home care environments. The ideation also includes potential scalability by adding more sensors or AI-based analytics in the future, allowing for a more comprehensive and intelligent health monitoring system.

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2.4 PROTOTYPE :-

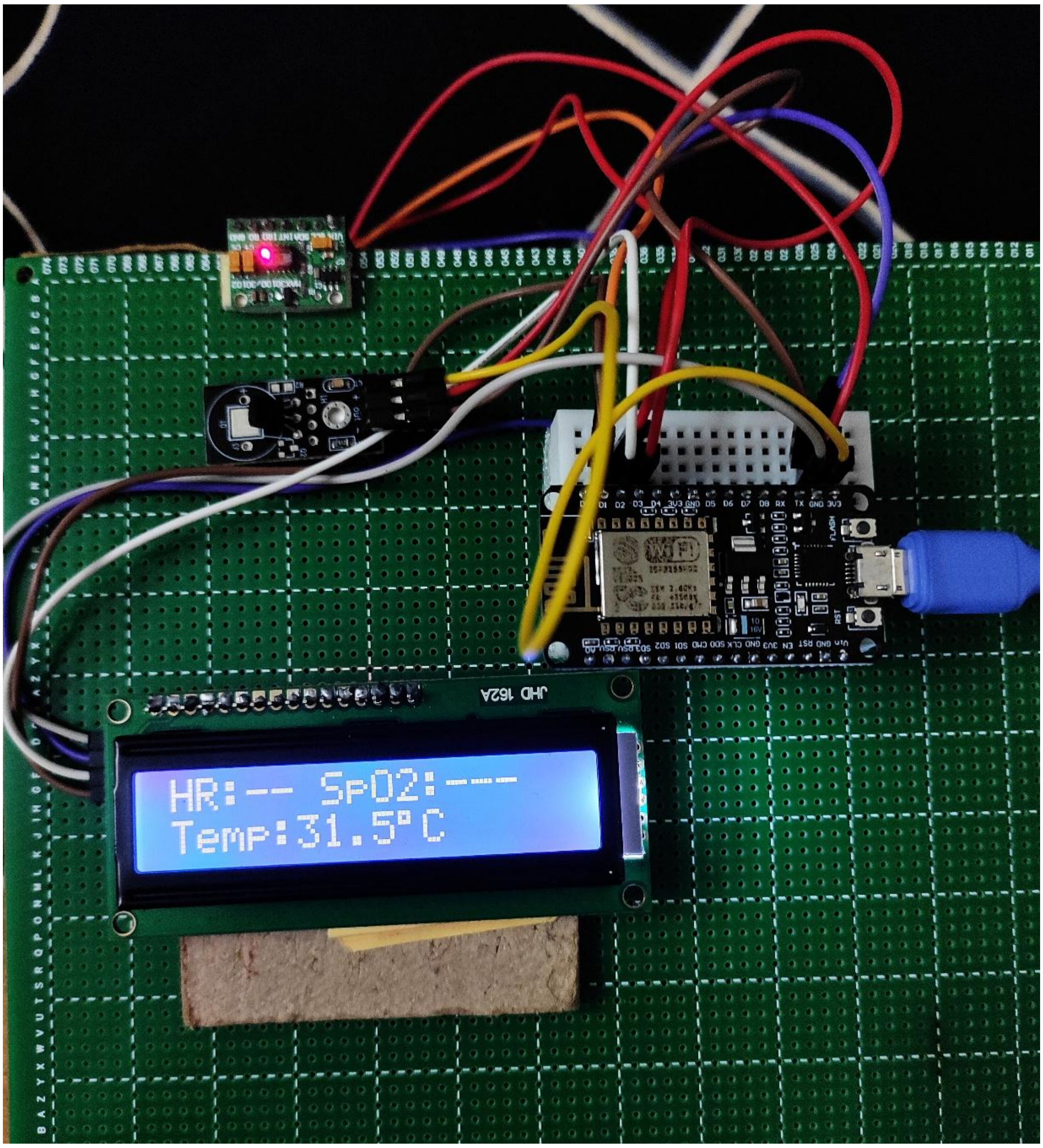

Fig 2.4 Prototype

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2.5 TESTING: -

Testing is a crucial phase in the development of any embedded or IoT system, ensuring the reliability, functionality, and accuracy of the prototype before real-world deployment. For the proposed IoT-based patient health monitoring system, the testing process was carried out in several stages to evaluate both the hardware and software components, as well as the overall integration and communication between the modules. Testing is a crucial phase in the development of any embedded or IoT system, ensuring the reliability, functionality, and accuracy of the prototype before real-world deployment. For the proposed IoT-based patient health monitoring system, the testing process was carried out in several stages to evaluate both the hardware and software components, as well as the overall integration and communication between the modules

Key Testing Parameters

1. Sensor Accuracy: -

- Compare reading from temperature, heart rate, and SpO2 sensor with standard medical devices.
- Tolerance levels and acceptable deviation range tested

2. Data Transmission Rate: -

- Measure the interval between data collection and data upload to the cloud platform.
- Check for delays, dropped packets, or lag in real-time updates.

3. Wi-Fi Connectivity Stability :-

- Test ESP8266's ability to maintain a stable connection over time.
- Include scenarios of weak signal and automatic reconnection after disconnection.

4. System Response Time: -

- Time taken by the system to process sensor data and send it to the cloud.
- Important for applications requiring near real-time monitoring.

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5. Power Consumption: -

- Monitor the power usage of the complete system during normal operation and idle states.
- Useful for evaluating battery-based deployment.

TEST RESULTS TABLE :-

CREATED_AT	ENTRY_ID	HEART RATE	SPO2	TEMPERATURE
2025-04-20 17:07:30 UTC	1	120	100	31.5
2025-04-21 05:56:48 UTC	2	100	98	34.35
2025-04-21 05:57:08 UTC	3	75	94	31.25
2025-04-21 05:57:42 UTC	4	75	99	31.25
2025-04-24 10:46:59 UTC	5	88	97	32.75
2025-04-24 10:47:19 UTC	6	120	72	32.5
2025-04-24 10:48:35 UTC	7	91	100	34
2025-04-24 10:54:21 UTC	8	95	92	32

Table 2.5 :- Testing Results

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CHAPTER – 3
EXISTING PRODUCT

The current product builds upon the evolution of previous systems by integrating wearable health monitoring technology with real-time wireless data transmission and cloud-based analytics. Unlike manual or early electronic systems, this product offers continuous, remote monitoring of vital signs using advanced digital sensors. Data is transmitted securely via the internet to a central platform, where healthcare providers can access real-time updates, receive alerts, and analyze trends over time. The system supports mobility, remote access, and improved patient engagement, addressing the limitations of earlier approaches

3.1 FEATURES:

Manual/Wired Systems*:* In-person monitoring using paper-based records or wired equipment. Limited mobility and no remote tracking capability.

Early Electronic Systems*:* Used within hospitals; provided basic electronic readings but lacked internet connectivity or remote access features.

Early Digital Systems*:* Introduced digital sensors with some por ability, but lacked reliable wireless data transmission or cloud integration.

Early Wearables*:* Wearable devices began storing health data locally (e.g., on the device), but had limited options for real-time remote access or analysis.
Existing product of this project

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CHAPTER – 4
SOFTWARE AND HARDWARE REQUIREMENTS

HARDWARE REQUIREMENTS

1. **NodeMCU ESP8266 AMICA CP2102 WiFi Development Board**

Fig 4.1 NodeMCU 8266

2. **DS18B20 Digital Temperature Sensor Module**

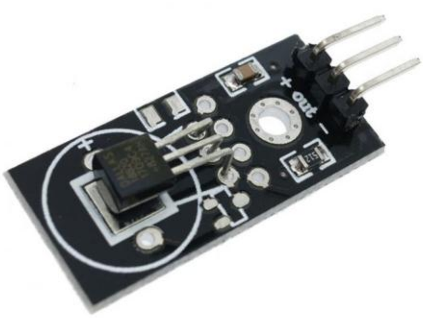

Fig 4.2 DS18B20

3. **MAX30102 Pulse-Ox & Heart Sensor**

Fig 4.3 MAX30102

4. **16x2 LCD Display**

Fig 4.4 16x2 LCD

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5. **16x2 LCD I2C Interface Adapter**

Fig 4.5 16x2 LCD I2C Interface Adapter

6. **Jumper Wires(Male to Male)**

Fig 4.6 Male to Male Jumper Wires

SOFTWARE COMPONENTS

1. **ThinkSpeak account -** A ThingSpeak account is used for creating IoT applications, allowing users to collect, analyze, and visualize data from connected devices in real-time on the ThingSpeak platform, enabling easy integration with sensors and other IoT components.
2. **Libraries for the Sensors and ESP8266** – Libraries for sensors and the ESP8266 are pre-written code modules that simplify the integration and communication between sensors and the ESP8266 Wi-Fi microcontroller, enabling easier data collection, processing, and wireless transmission without the need for an external controller

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CHAPTER - 5
STANDARD SPECIFICATIONS

This IOT- Based Health Monitoring System has been designed with standard embedded components ensuring accuracy, efficiency, and safety. The following are the key technical specifications of the system:

1. NodeMCU ESP8266 AMICA CP2102 WiFi Development Board

- **Type**:- Wi-Fi Microcontroller (SoC - System on Chip)
- **Memory**:- 512 KB to 16 MB (depends on module version)
- **Operating Voltage**:- 3.0V – 3.6V (Typically 3.3V)
- **Featutres**:-Station (STA) mode, Soft Access Point mode, STA+AP mode

2.DS18B20 TEMPERATURE SENSOR

- **Type:-** Digital Temperature Sensor
- **Temperature:-** -55°C to +125°C
- **Operating Voltage:-** 3.0V to 5..5V
- **Features:-** Each sensor has a unique 64-bit serial code

3.MAX30102 PULSE OXIMMETER

- **Type:-** Integrated Pulse Oximetry and Heart-Rate Monitor Module
- **Measurements:-** Blood Oxygen Saturation and Heart rate
- **Operating Voltage:-** 1.8V and 3.3V
- **Features:-** Ambient light cancellation

4.I2C:-

- **Type:-** Serial Communication Protocol
- **Addressing:-** Each device has a unique 7-bit address

5.LCD DISPLAY(16X2)

- **Display Lines:-** 2 lines x 16 characters
- **Voltage:-** 5V

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CHAPTER – 6
PROPOSED PRODUCT

A portable and wireless health monitoring system using sensors, and the NodeMCU ESP8266 module is designed to track vital signs like heart rate and body temperature in real time. The heart rate sensor detects pulses through light-based measurement, while the temperature sensor (DS18B20) reads body temperature.

Once it processes this data, it uses the ESP8266 Wi-Fi module to send the information to a cloud platform like ThingSpeak. ThingSpeak allows remote access and visualization of the data, enabling healthcare providers or caregivers to monitor the patient's condition from anywhere.

This system is low-cost, easy to implement, and useful in remote or underserved areas. It supports early detection of health issues and is ideal for applications in telemedicine, elderly care, and wearable health devices.

This entire system is designed to be low-cost and easy to implement, making it ideal for developing countries or regions with limited access to healthcare infrastructure. It also has potential use cases in telemedicine, wearable technology, and smart healthcare systems. By providing early warning signs through continuous data collection and remote monitoring, this kind of health monitoring system can contribute significantly to preventive healthcare and emergency response efficiency.

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6.1 Block Diagram

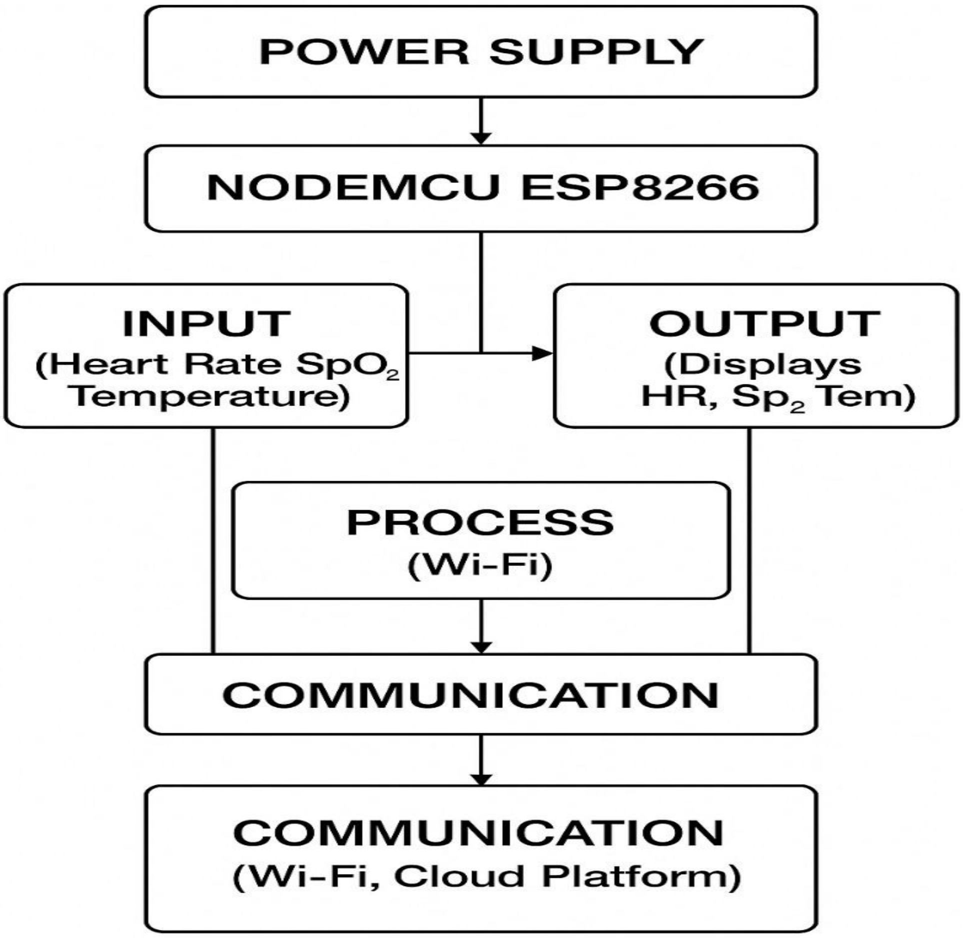

Fig 6.1: Block Diagram

The block diagram shows an IoT-based health monitoring system where the MAX30102 measures heart rate and SpO_2, and the DS18B20 measures body temperature. Data is processed by the ESP8266, displayed on a 16x2 LCD, and sent to ThingSpeak via Wi-Fi for remote monitoring. Jumper wires connect the modules, and Arduino IDE with sensor libraries simplifies programming, enabling continuous local and online health tracking..

6.2 ARCHITECTURE DIAGRAM

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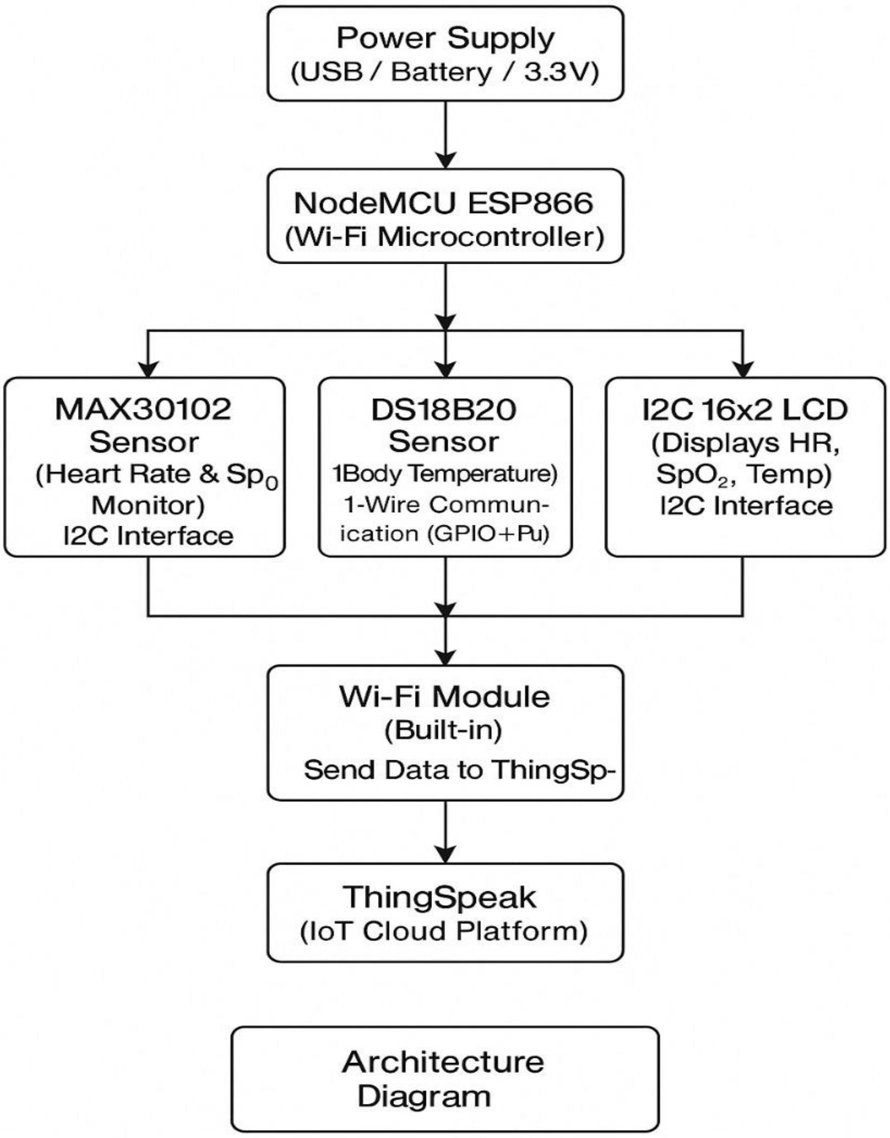

Fig 6.2 : Architecture Diagram

Real-time health data from the MAX30102 and DS18B20 sensors is collected by the ESP8266 microcontroller, displayed on a 16x2 LCD, and uploaded to ThingSpeak. A stable 5V power supply and jumper wires ensure reliable operation and modular connections. This architecture enables real-time monitoring, remote access, and scalability for smart healthcare and telemedicine applications.

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6.3 FLOW DIAGRAM

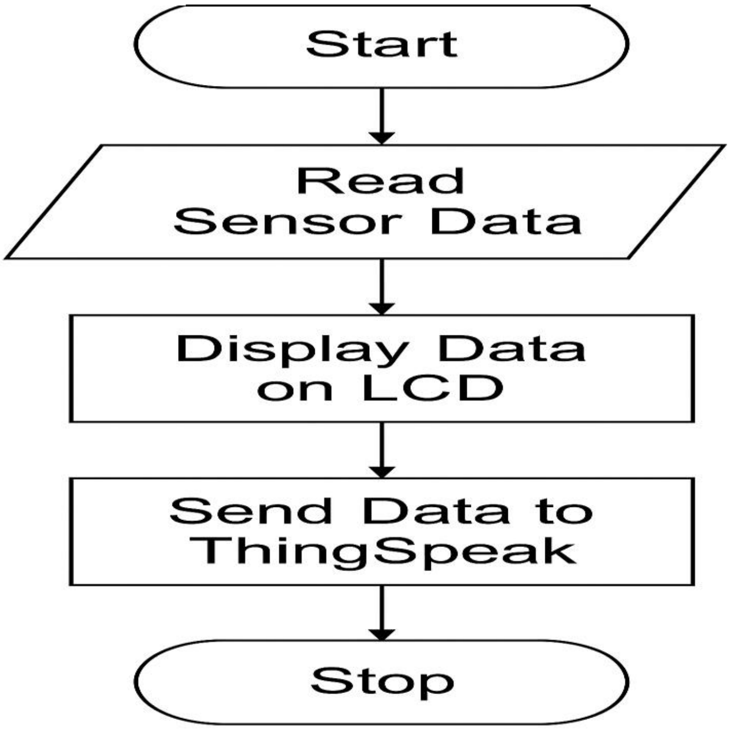

Fig 6.3 : FLOW CHART

Flow Diagram of Health Monitoring System

The flow diagram outlines the logical operation of the system. It starts with powering the device and initializing all modules including the sensors, LCD, and Wi-Fi. The data is read from from the MAX30102 (pulse and SpO2) and DS18B20 (temperature) sensors. This data is displayed on the 16x2 LCD for local viewing. Simultaneously, the ESP8266 module uploads the data to ThingSpeak for remote monitoring. The process loops continuously, allowing real-time health tracking. This flow ensures constant sensing, display, and wireless transmission of vital health metrics.

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6.4 DESIGN / CIRCUIT DIAGRAM

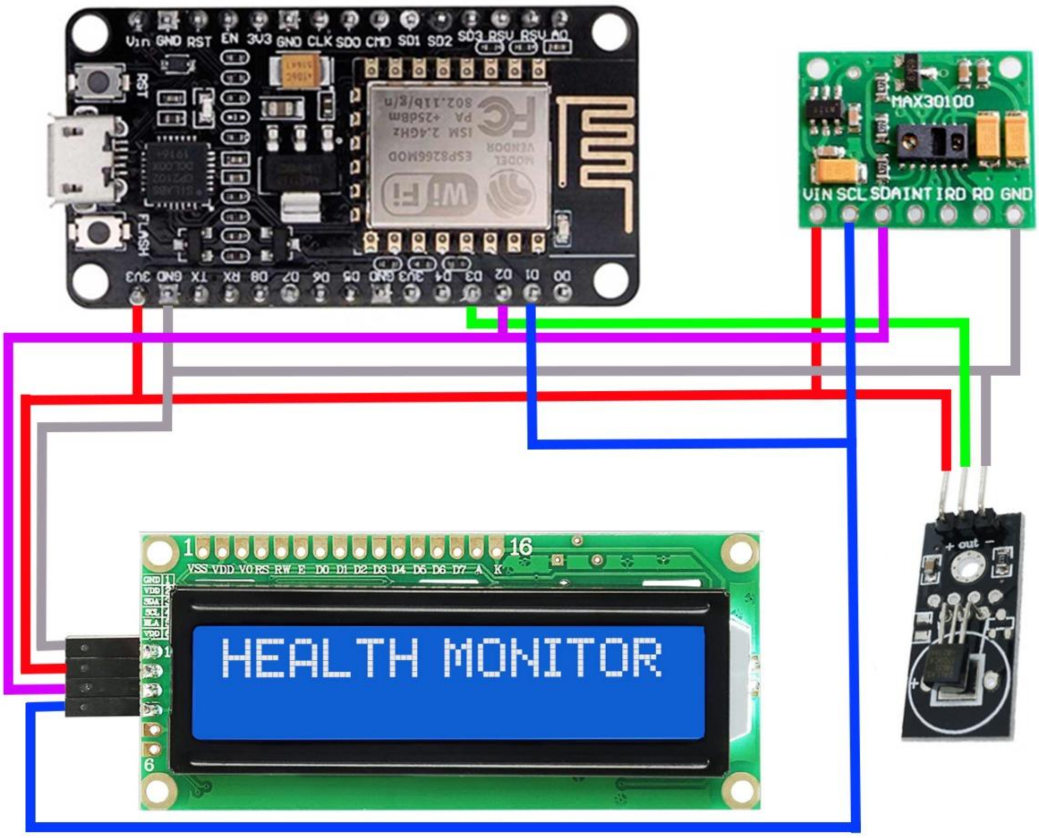

Fig 6.4: Design / Circuit Diagram

MAX30102 Pin	Connects To NodeMCU
VIN	3.3V
GND	GND
SCL	D1 (GPIO5)
SDA	D2 (GPIO4)

Table 6.4.1: MAX30102 to ESP8266

DS18B20 Pin	Connects To NodeMCU
VCC	3.3V
GND	GND
DATA	D3 (GPIO0)

Table 6.4.2: DS18D20 to ESP8266

LCD Pin	Connects To NodeMCU
VCC	3.3V
GND	GND
SDA	D2 (GPIO4)
SCL	D1 (GPIO5)

Table 6.4.3: I2C 16X2 LCD to ESP8266

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CHAPTER - 7
FEASIBILITY STUDY

A feasibility study is a crucial part of the design thinking process, especially when planning to implement a project like a Health Monitoring System. This study examines whether the proposed solution is viable and practical, considering various factors such as technical, economic, operational, and legal feasibility.

1. Technical Feasibility

- NodeMCU ESP8266 AMICA CP2102 WiFi Development Board
- MAX30102 Pulse Oximeter & Heart Rate Sensor
- DS18B20 Temperature Sensor
- 16x2 LCD Display (with or without I2C module)
- 9V Battery
- Jumper Wires and Breadboard
- Real-time Monitoring: Continuously tracks vital signs such as heart rate, blood oxygen levels, and body temperature.
- Wireless Data Transmission: Utilizes the ESP8266 module to send data to cloud platforms, enabling remote monitoring.
- User Interface: Displays readings on an LCD screen for immediate feedback

2. Economic Feasibility

Estimated Cost:

COMPONENT	QUANTITY	PRICE
16x2 LCD (Blue)	1	97
Male to Male Jumper Wires	20	37
MAX30102 Pulse Oximeter Heart Rate Sensor Module	1	99
Type A to Micro Usb cable	1	150
NodeMCU ESP8266 AMICA CP2102 WiFi Development Board	1	256
DS18B20 Digital Temperature Sensor Module	1	68
16x2 LCD I2C Interface Adapter	1	75
170 points solderless breadboard	1	75
	TOTAL	857

Table 7.1: Estimated Cost

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3. Operational Feasibility

User Interaction:

- **Ease of Use:** The system is designed for straightforward operation, with readings displayed on an LCD and data transmitted automatically.
- **Maintenance:** Minimal maintenance is required, primarily involving battery replacement and occasional sensor calibration.

4. Legal and Ethical Feasibility

Considerations:

- **Data Privacy:** The system collects sensitive health data, necessitating compliance with data protection regulations.
- **Medical Accuracy:** While suitable for monitoring, the system is not a certified medical device and should not replace professional medical equipment.

5. Time Feasibility

Development Timeline:

- Assembly and Wiring: 1–2 hours
- Programming and Testing: 2–4 hours
- Total Estimated Time: 3–6 hours

Conclusion:

The IoT-Based Health Monitoring System using ESP8266 is a technically and economically feasible project for personal, educational, and prototyping purposes. Its simplicity, affordability, and ease of assembly make it an excellent choice for individuals seeking to explore IoT applications in healthcare. However, for clinical or commercial use, further development, compliance with medical standards, and rigorous testing would be necessary.

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CHAPTER – 8
PROTOTYPE AND IMPLEMENTATION

Prototype of Health Monitoring System

The IoT-based Health Monitoring System integrates various sensors with an ESP8266 to monitor vital health parameters, such as heart rate, oxygen saturation (SpO2), and body temperature. The core components of the prototype include:

- **MAX30102 Sensor:** Used to measure the heart rate and SpO2 of the user.
- **DS18B20 Temperature Sensor:** Measures the body temperature of the user.
- **16x2 LCD Display:** Displays the real-time health data collected by the sensors.
- **NodeMCU ESP8266 AMICA CP2102 WiFi Development Board:** A compact Wi-Fi-enabled microcontroller that allows for both data processing and wireless transmission to an IoT platform for remote monitoring, eliminating the need for an external processor.

The components are interconnected as follows:

- The **MAX30102 sensor** is connected to the ESP8266 via the **I2C interface**, using D1 (GPIO5) for SCL and D2 (GPIO4) for SDA.
- The **DS18B20 temperature sensor** is connected to **D3 (GPIO0)** of the ESP8266 for temperature readings using a single digital data line
- The **I2C 16x2 LCD display** is also connected via the **I2C interface**, sharing the same lines with the MAX30102: D1 (GPIO5) for SCL and D2 (GPIO4) for SDA.

Implementation of Health Monitoring System

The Health Monitoring System was implemented through a combination of hardware components and software coding. The implementation is explained below:

Hardware setup : The hardware consists of the following main components:

- ➢ DS18B20 Digital Temperature Sensor module
- ➢ MAX30102 Pulse-Ox & Heart Rate Sensor
- ➢ 16x2 LCD Display with I2C Interface
- ➢ NodeMCU ESP8266 AMICA CP2102 WiFi Development Board
- ➢ Jumper Wires

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1. **Circuit Design & Wiring:**
   - Connect the MAX30102 and DS18B20 sensors to the ESP8266 using appropriate pins (SDA, SCL, and D0).
   - Connect the ESP8266 Wi-Fi module using software serial communication, making sure to use a voltage divider for proper level shifting (to avoid damaging the module).
   - Attach the I2C 16x2 LCD to the ESP8266 module to display the health data in real time.
2. **IoT Cloud Integration:**
   - Configure the ESP8266 module to connect to a Wi-Fi network.
   - Program the ESP8266 module to send the collected data (heart rate, SpO2, temperature) to a cloud platform such as ThingSpeak.
   - Set up a cloud dashboard to visualize the health data in real time.
3. **Power Supply:**
   - Power the system using a 9V battery or USB connection to the ESP8266.
4. **Testing & Operation:**
   - Test the system by monitoring real-time health data on the LCD and ensuring it transmits to the cloud platform correctly.
   - Check that the sensors provide accurate readings and that the data is successfully updated in the IoT cloud.

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CHAPTER – 9
TESTING

Testing is a crucial phase in the development of any system as it ensures that the product performs its intended functions accurately, reliably, and safely under various conditions. The Health Monitoring System underwent rigorous testing to verify its operational efficiency, accuracy in sensor response.

The testing process was conducted in both controlled and semi-controlled environments. The main objective was to observe the sensor's behavior on different patients and to check whether the temperature sensor, heart rate sensor, pulse rate sensor, and the LED screen functioned properly.

Key Testing Parameters :

1. Initial Setup and Power On Test:

- **Objective:** Ensure components power up correctly.
- **Procedure:** Power the system and check the LCD for startup messages and the ESP8266 Wi-Fi module's status.

2. Sensor Functionality Test (Heart Rate, SpO2, and Temperature):

- **Objective:** Verify sensor readings are accurate.
- **Procedure:** Test the MAX30102 sensor (heart rate and SpO2) and DS18B20 sensor (temperature). Check LCD for display updates.

3. Wi-Fi Connectivity Test (ESP8266 and IoT Cloud Integration):

- **Objective:** Ensure data transmission to the cloud.
- **Procedure:** Check the ESP8266 connection in the Serial Monitor and verify data appears on the cloud platform (ThingSpeak/Blynk).

4. Real-Time Monitoring and Data Accuracy Test:

- **Objective:** Test consistency and accuracy of health data.
- **Procedure:** Simulate normal conditions, and verify data on LCD and cloud platform.

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CHAPTER - 10
APPLICATIONS

Applications of the Health Monitoring System

The IoT-Based Health Monitoring System is an innovative solution that leverages sensors, microcontrollers, and cloud connectivity to monitor vital health parameters such as heart rate, oxygen saturation (SpO2), and body temperature in real time. By integrating IoT technology, the system provides continuous, remote monitoring capabilities that are essential in modern healthcare. This makes it especially useful in situations where timely intervention can be life-saving, and physical access to healthcare professionals is limited.

Key Applications:

1. **Remote Patient Monitoring:**
   Doctors and caregivers can monitor patients from a distance, ensuring timely medical support without the need for hospital visits.
2. **Hospital Patient Tracking:**
   Enables real-time monitoring of multiple patients within hospitals, allowing healthcare professionals to respond quickly to any emergencies.
3. **Home Healthcare:**
   Empowers individuals to monitor their own health daily, reducing dependency on routine hospital checkups and enabling early diagnosis.
4. **Rural and Remote Healthcare:**
   Offers a cost-effective and accessible solution for health monitoring in remote areas with limited access to healthcare facilities.
5. **Post-Surgery Recovery Monitoring:**
   Patients recovering at home after surgeries can be closely observed to ensure stable health conditions.
6. **Fitness and Wellness Tracking:**
   Can be used by athletes or fitness enthusiasts to monitor physical activity levels and physiological responses during workouts.
7. **Medical Research and Data Collection:**
   Collects valuable health data that can be analyzed for trends, supporting medical studies and the development of new treatments.

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CHAPTER - 11
FUTURE ENCHANCEMENTS

Future Enchancements of the Health Monitoring System

The Health Monitoring System can be significantly enhanced to improve its functionality, reliability, and versatility. Several potential upgrades could make it more effective in giving the results, as well as expanding its applicability in different environments.

- **Integration with Mobile Apps:**

  Developing dedicated Android/iOS apps for real-time monitoring and alerts, allowing users to access health data conveniently on smartphones

- **Advanced Sensors**:

  Adding more biomedical sensors like ECG, blood pressure, glucose, and respiratory rate sensors for a more comprehensive health assessment.

- **AI-Based Health Prediction:**

  Using machine learning algorithms to analyze health data trends and predict potential health issues before they become critical

- **Emergency Response Integration:**

  Automatically notifying emergency services (ambulance, doctors) when vital signs exceed critical levels, ensuring faster medical response.

- **Cloud Data Analytics Dashboard:**

  Providing more advanced cloud dashboards with graphical trends, patient history, and downloadable reports for doctors and caregivers.

- **Wearable Device Design:**

  Miniaturizing the system into a wearable form like a smartwatch or wristband to enhance portability and user comfort.

- **Battery Optimization:**

  Using low-power components and rechargeable batteries to improve energy efficiency and allow long-term use without frequent charging.

- **Data Security and Encryption:**

  Implementing stronger encryption protocols to ensure secure transmission and storage of sensitive health data over the internet.

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CHAPTER – 12

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APPENDIX

A. Components Used

- NodeMCU ESP8266 AMICA CP2102 WiFi Development Board
- MAX30102 Pulse Oximeter and Heart Rate Sensor
- DS18B20 Temperature Sensor
- I2C 16X2 LCD
- Breadboard and Jumper Wires
- Power Supply (Battery or USB)

B. Software and Tools

- ThingSpeak (for cloud monitoring)
- Serial Monitor (for testing and debugging)

C. Important Code Snippets

- **Sensor Initialization:**

```
MAX30102.begin();
```

- **Wi-Fi Setup:**

```
WiFi.begin(HEALTH, 123456789);
while (WiFi.status() != WL_CONNECTED) {
  delay(500);}
```

- **Data Upload to ThingSpeak:**

```
ThingSpeak.setField(1, heartRate);
ThingSpeak.setField(2, SpO2);
ThingSpeak.setField(3, temperature);
ThingSpeak.writeFields(2920671, 2LCTFO2K4UEXD0UP);
```

D. Circuit Connections Summary

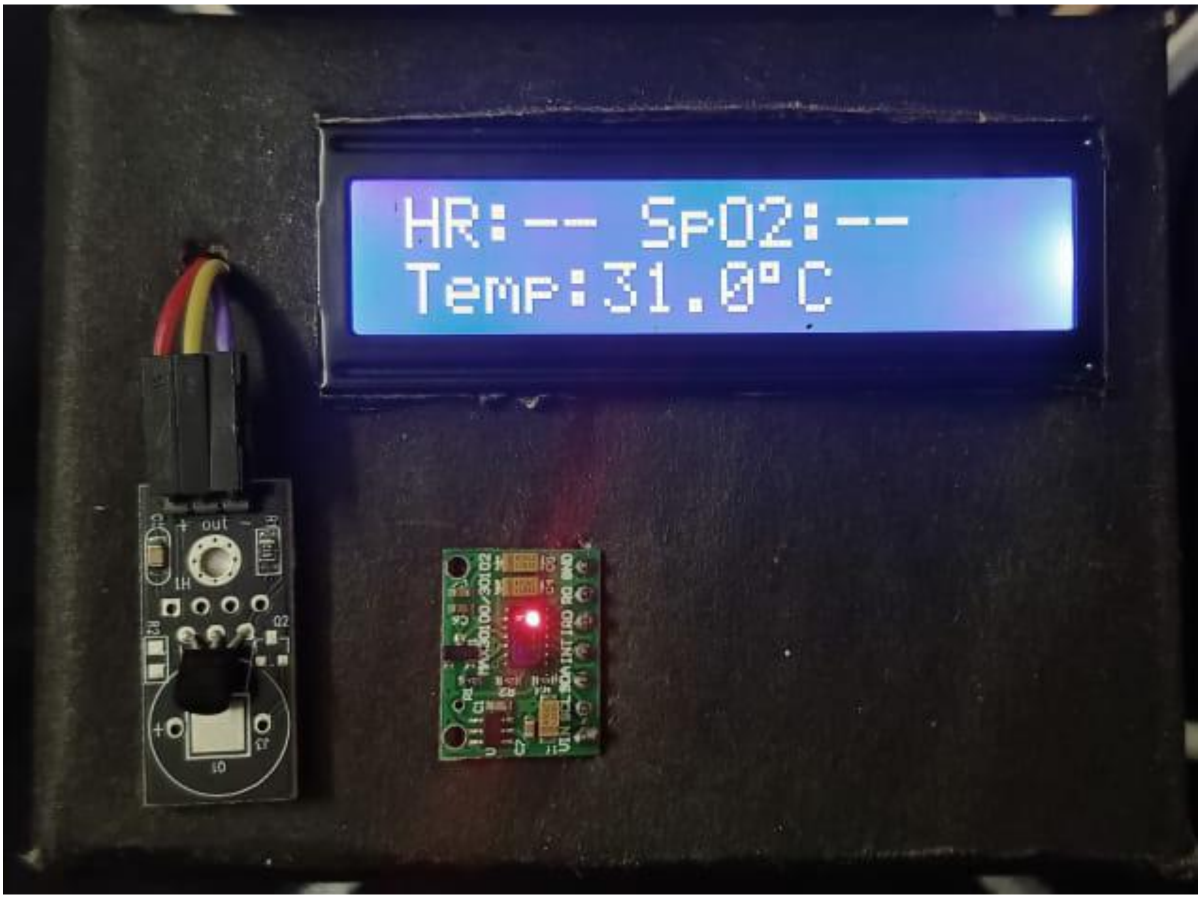
- **MAX30102 sensor** connected to **ESP8266** using **I2C communication**:
  - SDA → D2 (GPIO4)
  - SCL → D1 (GPIO5)
- **DS18B20 temperature sensor** connected to **ESP8266** using a **digital pin**:
  - Data Pin → D3 (GPIO0)
- **16x2 LCD Display with I2C Interface** connected to **ESP8266**:
  - SDA → D2 (GPIO4)
  - SCL → D1 (GPIO5)

``

E. Basic Working Flow

- Sensors collect health data (heart rate, SpO2, temperature).
- ESP8266 can run simple programs directly
- Data is displayed on the LCD screen.
- Data is transmitted to the cloud via the ESP8266 module.
- Cloud platform displays and stores the data for remote monitoring.

A. SCREENSHOT OF PRODUCT



Product