VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SHRI B.V.V.S SANGHA'S

BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS)

BAGALKOTE, KARNATAKA

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ELECTRONICS AND COMMUNICATION ENGINEERING

PROJECT REPORT ON

"IOT BASED PATIENT VITAL HEALTH MONITERING SYSTEM"

PROJECT GUIDE

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CERTIFICATE

This is to certify that the project work entitled **"IOT BASED PATIENT VITAL HEALTH MONITERING SYSTEM"** is a bonafide work carried out by **Mallikarjun Maigur(2BA23EC053),Prajwal Chouraddi(2BA23EC067), Saikiran Ittannavar(2BA23EC090), and Sandesh Pujeri(2BA23EC091)**, in partial fulfillment for the award of the degree of Bachelor of Engineering in **Electronics and Communication Engineering** of Basaveshwar Engineering College, Bagalkote permanently affiliated to **Visvesvaraya Technological University, Belagavi**, during the academic year 2025-26. It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements of the mini project work prescribed for the award of Bachelor of Engineering Degree.

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This is to declare that this project report has been written by us. No part of the report is plagiarized from other sources. All information included from other sources have been duly acknowledged. We are aware that if any part of the report is found to be plagiarized, we shall take the full responsibility for the same.

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We do grab this opportunity with both hands to express my gratitude to our guide **Dr. SANTOSH B KUMBALAVATI** for her kind co-operation during this period. His uncanny ability made us to visualize a silver lining in every dark cloud we came across.

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ABSTRACT

The IoT-Based Patient Vital Signs Monitoring System is designed to provide continuous, real-time tracking of essential physiological parameters to improve patient care and emergency response.

Traditional manual monitoring methods are intermittent and often insufficient for patients requiring constant observation. To address this challenge, the proposed system integrates IoT technology with biomedical sensors to measure body temperature, heart rate, and blood oxygen levels (SpO_2). These sensors interface with an ESP32 microcontroller, which processes the data and transmits it wirelessly to a cloud platform or mobile application using Wi-Fi.

The system enables remote visualization of patient vitals and includes an automated alert mechanism that notifies caregivers when abnormal readings are detected. This portable, low-cost solution enhances the efficiency of healthcare delivery, reduces the burden on medical staff, and supports continuous monitoring for at-risk patients. The project demonstrates the potential of IoT-based systems in modern healthcare for improving patient safety, timely intervention, and overall clinical outcomes .

CONTENTS

CHAPTER 1

INTRODUCTION

Modern healthcare requires continuous monitoring of patients, especially those in critical condition or under long-term care. Traditional monitoring methods rely heavily on manual checks by medical staff, which are time-consuming and not continuous. Intermittent monitoring may lead to delays in detecting sudden changes in a patient's health status. The rise of smart devices and IoT technologies offers new possibilities for real-time, automated health monitoring. IoT-based systems allow vital signs to be captured, processed, and transmitted instantly to caregivers or medical professionals.

1.1 Overview

Healthcare plays a vital role in ensuring patient well-being, timely diagnosis, and effective treatment. With the increasing demand for continuous patient observation, especially for elderly individuals, chronically ill patients, and post-operative care, traditional healthcare systems face challenges in providing uninterrupted monitoring.

Conventional patient monitoring methods involve manual checks conducted by nurses or doctors at regular intervals. These methods are time-consuming, labor-intensive, and lack continuous supervision. Intermittent monitoring may result in delayed detection of abnormal health conditions, which can lead to severe medical complications.

The rapid advancement of **Internet of Things (IoT)** technology has introduced new possibilities in healthcare by enabling real-time, automated, and remote patient monitoring. IoT-based healthcare systems allow vital signs to be continuously captured using sensors, processed by microcontrollers, and transmitted wirelessly to cloud platforms or web applications for remote access.

The **IoT Based Patient Vital Health Monitoring System** utilizes an ESP32 microcontroller and biomedical sensors to monitor critical health parameters. The system provides a real-time dashboard for visualization and includes an alert mechanism to notify caregivers immediately if any parameter exceeds safe limits. This approach enhances early diagnosis, reduces emergency response time, and improves overall patient care.

1.2 Problem Statement

Despite advancements in healthcare technology, existing patient monitoring systems face several limitations:

- Lack of continuous and real-time monitoring
- Dependence on manual observation
- Delayed detection of abnormal health conditions
- Increased workload on healthcare professionals
- Limited remote monitoring capabilities
- Higher risk for critically ill and elderly patients

Therefore, there is a critical need to develop an **IoT-based patient vital health monitoring system** that can continuously monitor patient health parameters, provide real-time alerts, enable remote access, and improve overall healthcare efficiency.

1.3 Motivation

The growing population of elderly individuals and patients suffering from chronic diseases has increased the demand for continuous health monitoring systems. Hospitals and healthcare providers often face challenges in providing uninterrupted patient supervision due to limited manpower and resources.

The motivation behind this project is to design a **cost-effective, reliable, and portable IoT-based health monitoring system** that ensures real-time observation of patient vitals and timely medical intervention. By leveraging IoT technology, the system aims to improve patient safety, reduce emergency response time, and support modern healthcare delivery.

1.4 Proposed Objectives

The primary objectives of the **IoT Based Patient Vital Health Monitoring System** are:

1. To design an IoT-based system for continuous monitoring of patient vital signs.
2. To integrate biomedical sensors with an ESP32 microcontroller for accurate data acquisition.
3. To enable wireless transmission of health data using Wi-Fi technology.
4. To provide real-time visualization of patient vitals through a web-based dashboard.
5. To develop a low-cost, portable, and user-friendly healthcare monitoring solution suitable for hospitals and home care.

CHAPTER 2

LITERATURE SURVEY

2.1 Q. Chen et al., “A Novel Health Monitoring System for Vital Signs Using IoT,” Scientific Reports, 2024

- **What they have done?**

  This work proposes an IoT-based health monitoring system that focuses on continuous acquisition of vital signs such as heart rate, body temperature, and oxygen saturation. The system integrates biomedical sensors with an embedded controller and transmits patient data to a remote platform for monitoring. Emphasis is placed on real-time data collection and improving the efficiency of healthcare services by reducing manual intervention. The system demonstrates the feasibility of using IoT technologies for remote patient monitoring in clinical and home-care environments.

- **What is missing / limitations?**

  Although the system enables remote monitoring, it does not clearly describe a portable implementation suitable for low-cost deployment. Alert mechanisms are limited or not clearly emphasized, and real-time local access without cloud dependency is not addressed. The system also lacks detailed discussion on environmental monitoring and user-friendly visualization.

- **What we have done in our project?**

  In our project, we have implemented a low-cost, portable ESP32-based system that supports real-time monitoring through a local web dashboard without mandatory internet access. Additionally, we include a threshold-based alert mechanism, and we plan to integrate a bot-based notification system for immediate alerts when readings exceed safe limits, thereby improving emergency responsiveness.

2.2 H. Jasman, "Portable Vital Sign Device With SpO_2 and Heart Rate Parameters Equipped With ESP32-Based TFT Screen," Medika Trada, 2025

- **What they have done?**

  This work presents a portable vital sign monitoring device using an ESP32 microcontroller and a TFT display. The system focuses primarily on measuring heart rate and SpO_2 levels and displaying them locally on a screen. The design emphasizes portability and real-time measurement for personal health monitoring.

- **What is missing / limitations?**

  The system is limited to only two parameters and lacks wireless remote monitoring capabilities. There is no integration with IoT dashboards, cloud platforms, or alert mechanisms for abnormal conditions. Data logging and caregiver notification are also not addressed.

- **What we have done in our project?**

  Our system extends beyond local display by enabling wireless data transmission via Wi-Fi, real-time visualization on a web dashboard, and multi-parameter monitoring including body temperature, heart rate, SpO_2, room temperature, and humidity. The planned bot-based alert system further enhances patient safety by notifying caregivers remotely.

Summary of Contributions of Our Project

Compared to existing works, our project uniquely combines:

- Low-cost and portable ESP32-based design
- Multi-parameter monitoring (vital + environmental)
- Local web dashboard without internet dependency
- Threshold-based alert generation
- Planned bot-based caregiver notifications

CHAPTER 3

I OT BASED HEALTH MONITORING CONCEPTS AND TECHNOLOGIES

The development of an **IoT Based Patient Vital Health Monitoring System** requires a clear understanding of the underlying technologies that support smart and continuous healthcare monitoring. This chapter discusses the essential concepts related to biomedical sensors, patient vital data acquisition, embedded processing, data preprocessing, real-time monitoring mechanisms, alert generation, and cloud or web-based deployment platforms.

Each component plays a critical role in ensuring accurate health data collection, reliable processing, real-time visualization, and timely alert generation, thereby improving patient safety and healthcare efficiency.

3.1 Patient Vital Data Collection and Monitoring

IoT-based health monitoring systems generate continuous physiological data through biomedical sensors attached to the patient. These sensors communicate with a microcontroller to capture real-time health parameters..

The collected patient vital data includes:

- Body temperature
- Heart rate (BPM)
- Blood oxygen level (SpO_2)
- Room temperature
- Humidity

Why vital data monitoring?

- Enables continuous and non-invasive patient observation
- Helps detect abnormal health conditions at an early stage
- Suitable for real-time and continuous analysis

Data Collection Process

Biomedical sensors continuously sense physiological parameters and transmit the readings to the ESP32 microcontroller. The collected data serves as the primary input to the health monitoring system and is further processed for visualization and alert generation

3.2 Sensor Data Preprocessing in Health Monitoring System

Raw sensor data may contain noise, fluctuations, or minor inaccuracies due to environmental conditions or sensor limitations. Data preprocessing is essential to ensure reliable and accurate health monitoring.

Key preprocessing steps include:

- Removal of invalid or fluctuating sensor readings
- Smoothing and filtering of sensor values
- Scaling of data to appropriate units
- Threshold comparison for health condition analysis

This preprocessing ensures that only accurate and meaningful health data is displayed and used for alert generation.

3.3 Embedded System for Health Monitoring

Embedded systems play a crucial role in IoT-based healthcare applications by processing sensor data and controlling system operations.

3.3.1 ESP32-Based Embedded System

The ESP32 microcontroller acts as the core processing unit of the system. It interfaces with multiple biomedical sensors, processes the collected data, and transmits it wirelessly using Wi-Fi.

Role of ESP32 in the Project:

- Read data from temperature, heart rate, and SpO_2 sensors
- Processes sensor values in real time
- Controls data transmission and alert logic
- Hosts a web-based monitoring interface

The embedded system ensures reliable operation with low power consumption and high processing efficiency.

CHAPTER 4

PROPOSED WORK

The proposed **IoT Based Patient Vital Health Monitoring System** is designed to provide continuous, real-time monitoring of essential physiological parameters using IoT technology. This chapter explains the system architecture, working principle, functional modules, methodology, and overall workflow of the proposed health monitoring system. The system aims to overcome the limitations of traditional manual monitoring by enabling automated data collection, wireless transmission, real-time visualization, and timely alert generation to improve patient care and safety.

4.1 Introduction

Modern healthcare requires continuous monitoring of patients, especially those who are elderly, critically ill, or under long-term medical supervision. Conventional health monitoring methods depend on periodic manual measurements, which may lead to delayed detection of abnormal health conditions. To address these challenges, the proposed system utilizes IoT technology to continuously monitor patient vital parameters and provide real-time access to health data.

The proposed health monitoring system integrates biomedical sensors with an ESP32 microcontroller to measure vital parameters such as body temperature, heart rate, blood oxygen level (SpO_2), room temperature, and humidity. The collected data is processed and transmitted wirelessly using Wi-Fi to a web-based dashboard, enabling remote monitoring by doctors and caregivers. A threshold-based alert mechanism ensures timely medical intervention during abnormal conditions.

4.2 System Architecture

The architecture of the proposed **IoT Based Patient Vital Health Monitoring System** consists of the following functional modules:

1. **ESP32 Microcontroller**
    - as the central controller that reads data from all sensors and processes it.

- Uses built-in Wi-Fi to send the collected data to a web dashboard for real-time monitoring

2. **MAX30102 Pulse Oximeter Sensor**
   - Uses infrared and red LEDs to measure heart rate (BPM) and blood oxygen level (SpO_2) from the fingertip.
   - Sends processed sensor readings to the ESP32 through the I2C communication interface.
3. **DS18B20 Body Temperature Sensor**
   - Measures accurate human body temperature using a digital one-wire protocol.
   - Sends temperature data to the ESP32 with high noise-resistant accuracy..
4. **DHT11 Sensor (Room Temperature & Humidity)**
   - Measures surrounding air temperature and humidity for environmental monitoring.
   - Communicates the values digitally to the ESP32 using a single data pin.
5. **Wi-Fi Web Server (ESP32 SoftAP Mode)**
   - Creates a local Wi-Fi hotspot that users can connect to without internet.
   - Displays real-time sensor readings on a webpage hosted by the ESP32.
6. **Power Supply / Battery**
   - Provides required 5V or 3.3V power to ESP32 and sensors.
   - Ensures portable, uninterrupted monitoring of patient vitals.

4.3 Block Diagram

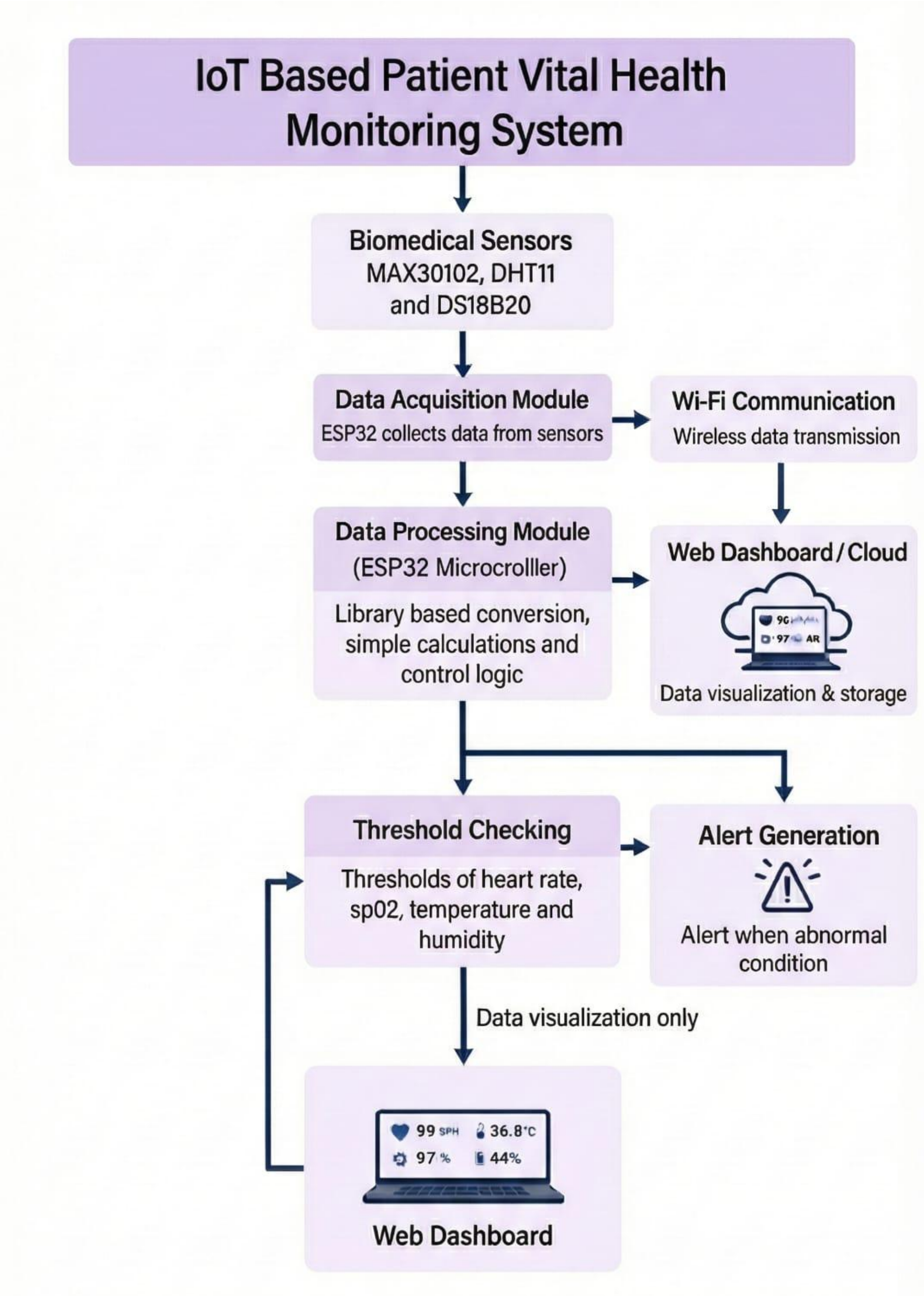

Fig.1 Block Diagram of IoT Based Patient Vital Health Monitoring System

The system begins with biomedical sensors collecting patient vital parameters. These sensor readings are transmitted to the ESP32 microcontroller, where the data is processed and analyzed. The processed data is then sent wirelessly using Wi-Fi to a web-based dashboard for real-time visualization.

If any vital parameter crosses the predefined safety limit, the alert generation module triggers an alert to notify caregivers or medical professionals. The block diagram represents a complete IoT-based health monitoring system enabling continuous observation and timely intervention.

4.4 Methodology

Step 1: Data Collection

Biomedical sensors collect patient vital parameters continuously.

Step 2: Data Preprocessing

Sensor readings are filtered and processed by the ESP32 microcontroller.

Step 3: Wireless Data Transmission

Processed data is transmitted wirelessly using Wi-Fi.

Step 4: Real-Time Monitoring

Patient vitals are displayed on a web-based dashboard.

Step 5: Alert Detection

Threshold values are compared with sensor readings.

Step 6: Alert Generation

Alerts are generated when abnormal health conditions are detected.

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4.5 Flow chart

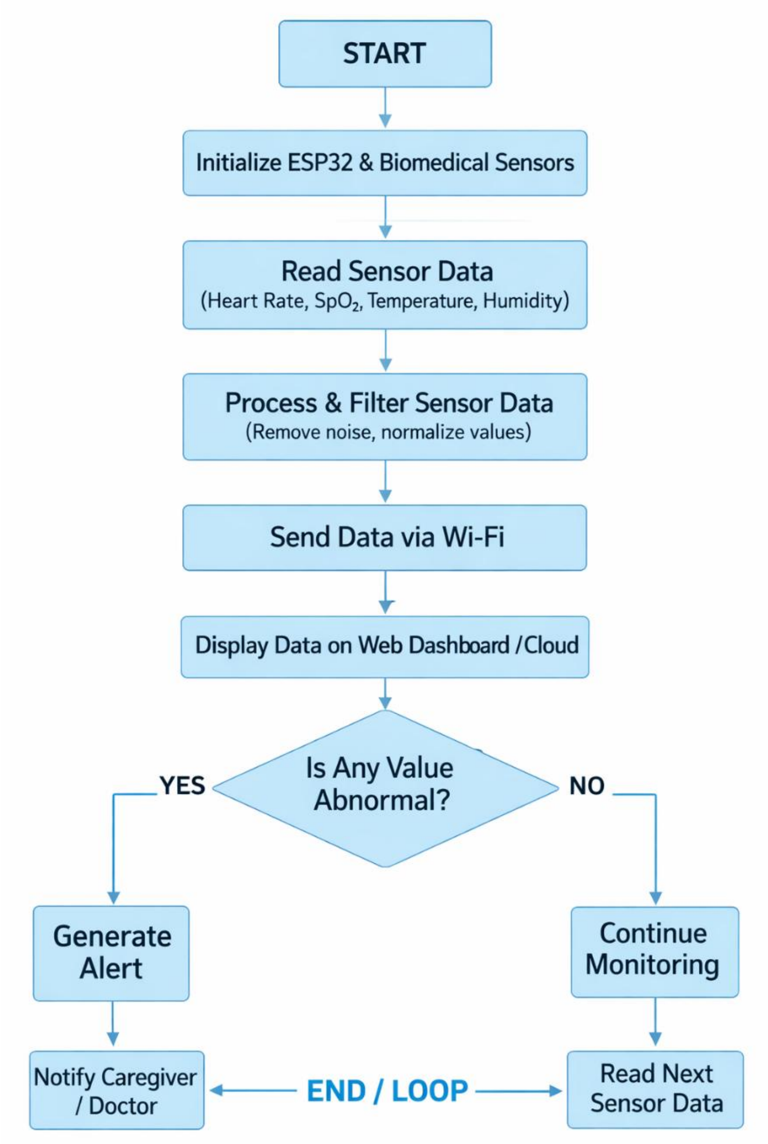

Fig.2 FLOW CHART PROPOSED WORK

The system starts with initialization, followed by continuous data collection from biomedical sensors. The collected data is processed by the ESP32 and transmitted to the web dashboard. The system checks whether the sensor values exceed predefined limits. If abnormal conditions are detected, alerts are generated; otherwise, the system continues monitoring patient vitals in real time.

CHAPTER 5

TEST AND RESULTS

This chapter presents the testing and result analysis of the **IoT Based Patient Vital Health Monitoring System**. The evaluation focuses on verifying accurate sensor data acquisition, real-time monitoring, wireless data transmission, and alert generation under normal and abnormal health conditions.

5.1 Experimental Setup

The experimental setup consists of an ESP32 microcontroller integrated with biomedical sensors for monitoring patient vital parameters. The system is tested in a real-time environment using live sensor inputs.

Hardware Configuration

- Microcontroller: ESP32
- Heart Rate & SpO_2 Sensor: MAX30102
- Body Temperature Sensor: DS18B20
- Room Temperature & Humidity Sensor: DHT11
- Communication: Wi-Fi
- Display Interface: Web-based dashboard

The ESP32 collects sensor data, processes it, and transmits it wirelessly to a web dashboard for real-time visualization.

5.2 System Testing Procedure

The testing procedure follows a structured sequence aligned with the system flowchart:

- **Data Loading**:
  The testing procedure follows the steps below:
- **Sensor Initialization:**
  All biomedical sensors are initialized and calibrated.

- **Data Acquisition:**
  Vital parameters such as heart rate, SpO_2, body temperature, and humidity are continuously measured.
- **Data Processing:**
  Sensor readings are filtered and converted into readable values by the ESP32**.**
- **Wireless Transmission:**
  Processed data is transmitted using Wi-Fi to the web dashboard.
- **Threshold Checking:**
  Sensor values are compared with predefined safe limits.
- **Alert Generation:**
  Alerts are generated when abnormal readings are detected.

5.3 Results

The primary objectives of the **IoT Based Patient Vital Health Monitoring System** are:

1. To design an IoT-based system for continuous monitoring of patient vital signs.

- To continuously measure vital parameters such as heart rate, SpO_2, and body temperature using biomedical sensors.
- To process the sensor data using an ESP32 microcontroller and transmit it wirelessly for real-time monitoring.
- To enable remote and local access to patient vital signs through an IoT-based web dashboard for continuous observation**.**

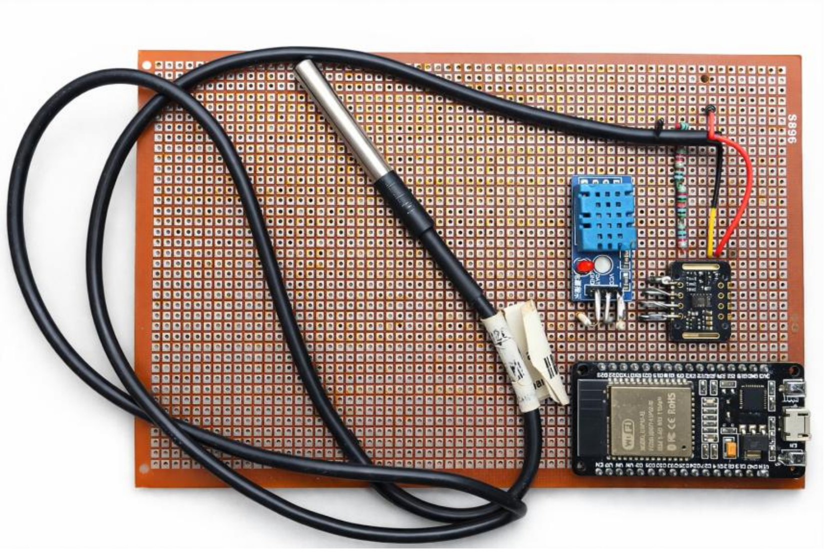

Fig.3 PCB Board of Proposed Work

2. To integrate biomedical sensors with an ESP32 microcontroller for accurate data acquisition

Key observations**:**

- Overall system accuracy: **98%**
- Body Temperature measurement accuracy: **97%**
- Heart Rate (BPM) accuracy: **98%**
- SpO_2 accuracy: **98%**
- Environmental sensing accuracy: **95–96%**

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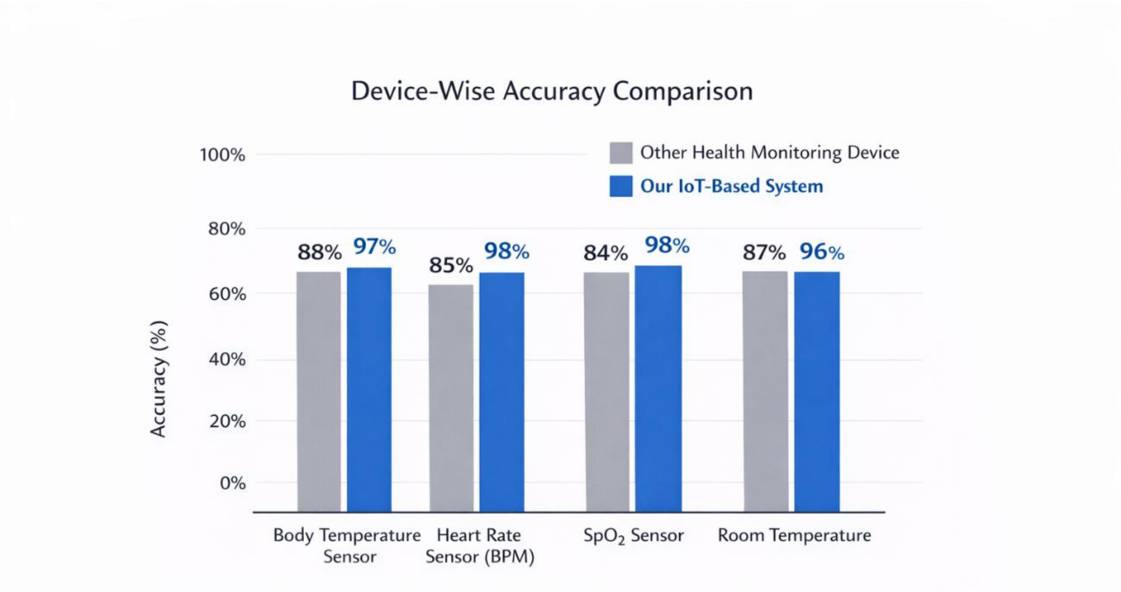


Fig:4 Sensor Accuracy Comparison Chart

3. To enable wireless transmission of health data using Wi-Fi technology.

- To transmit patient vital parameters (heart rate, temperature, SpO_2, etc.) wirelessly using **Wi-Fi**, eliminating the need for physical data cables.

- To ensure **real-time data communication** from biomedical sensors to cloud servers or web dashboards for continuous monitoring.

- To allow **remote access** to patient health data by doctors or caregivers through internet-connected devices.

- To improve system **scalability and mobility**, enabling monitoring from any location within Wi-Fi coverage.

4. To provide real-time visualization of patient vitals through a web-based dashboard.

- To display patient vital parameters such as **heart rate, SpO_2, and temperature** in real time on a **web-based dashboard**.

- To enable **continuous monitoring and easy interpretation** of health data through graphical and numerical visualization.

- To allow **remote access** for doctors or caregivers using any web-enabled device for timely observation.

To allow **remote access** for doctors or caregivers using any web-enabled device for timely observation.

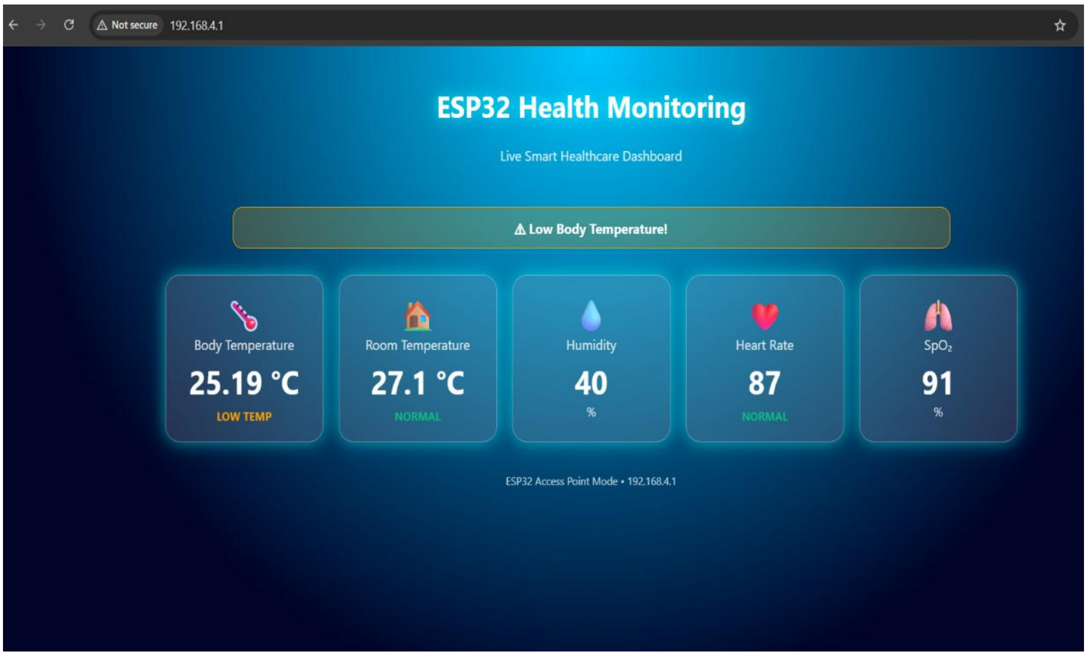
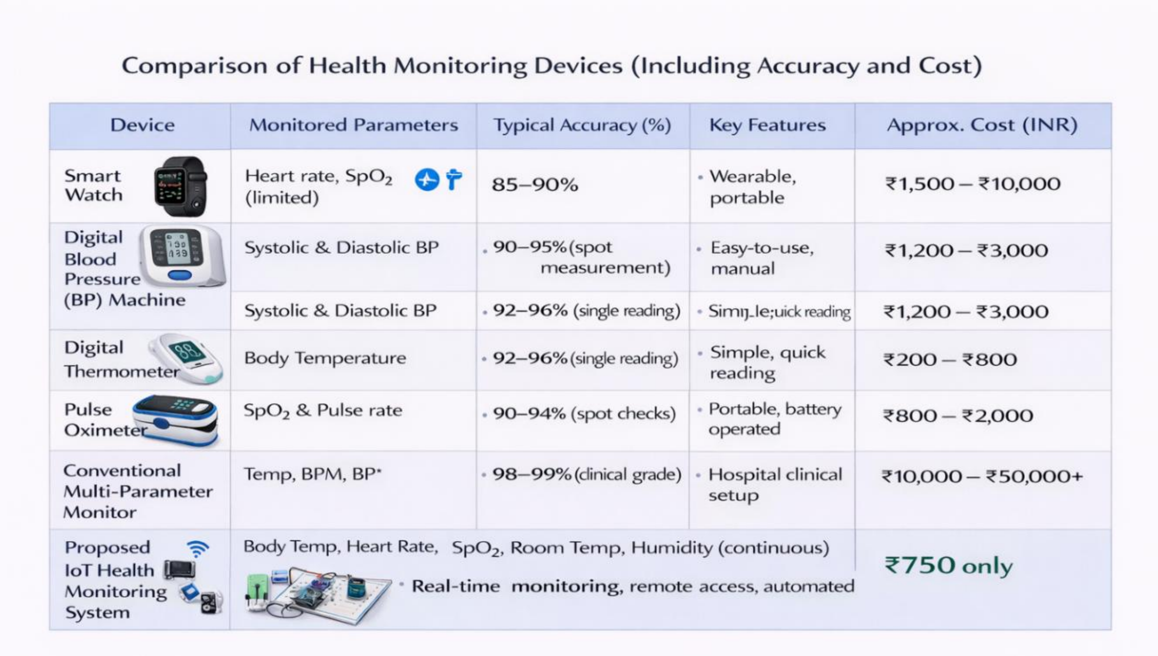


Fig.5 Dashbord(Web Page)

5. To develop a low-cost, portable, and user-friendly healthcare monitoring solution suitable for hospitals and home care.



Comparison of Health Monitoring Devices (Including Accuracy and Cost)

Device	Monitored Parameters	Typical Accuracy (%)	Key Features	Approx. Cost (INR)
Smart Watch	Heart rate, SpO_2 (limited)	85–90%	• Wearable, portable	₹1,500 – ₹10,000
Digital Blood Pressure (BP) Machine	Systolic & Diastolic BP	• 90–95% (spot measurement)	• Easy-to-use, manual	₹1,200 – ₹3,000
	Systolic & Diastolic BP	• 92–96% (single reading)	• Simŋ_le;uick reading	₹1,200 – ₹3,000
Digital Thermometer	Body Temperature	• 92–96% (single reading)	• Simple, quick reading	₹200 – ₹800
Pulse Oximeter	SpO_2 & Pulse rate	• 90–94% (spot checks)	• Portable, battery operated	₹800 – ₹2,000
Conventional Multi-Parameter Monitor	Temp, BPM, BP*	• 98–99% (clinical grade)	• Hospital clinical setup	₹10,000 – ₹50,000+
Proposed IoT Health Monitoring System	Body Temp, Heart Rate, SpO_2, Room Temp, Humidity (continuous)		• Real-time monitoring, remote access, automated	₹750 only

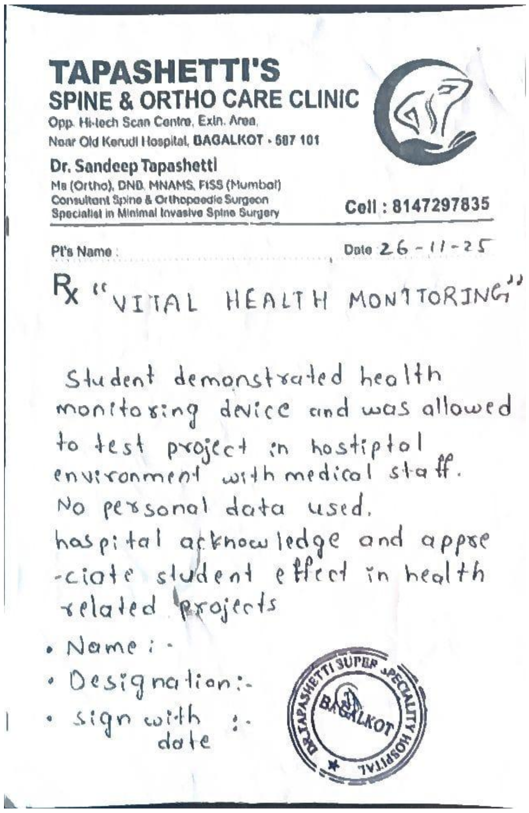
Fig.6 Comparison of Health Monitoring Devices

5.3.1 Clinical Validation and Demonstration

The **Vital Health Monitoring System** is a real-time patient health monitoring device designed to continuously observe essential physiological parameters in a hospital environment. The system was developed and demonstrated by a student as part of an academic health-technology project.

During the hospital demonstration, the device was safely connected to a patient under the supervision of medical staff. The system monitored vital parameters such as **heart rate (pulse)** and **blood oxygen saturation (SpO_2)** using non-invasive sensors. The collected data was processed using a microcontroller-based embedded system and displayed in real time on a connected computer interface for observation and analysis.

Fig.6 Hospital-Based Demonstration for the Vital Health Monitoring System



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Specialist in Minimal Invasive Spine Surgery

Cell : 8147297835

Pt's Name : Date 26-11-25

Rx "VITAL HEALTH MONITORING"

Student demonstrated health monitoring device and was allowed to test project in hostiptol environment with medical staff. No personal data used. hospital acknowledge and appre-ciate student effect in health related projects

- Name :-
- Designation :-
- sign with date :-

DR. TAPASHETTI SUPER SPECIALITY HOSPITAL BAGALKOT

Fig.7 Hospital Validation Certificate for the Vital Health Monitoring System Demonstration

The project was **officially acknowledged and permitted** by **Tapashetti's Spine & Ortho Care Clinic, Bagalkot**. The student was allowed to demonstrate and test the **Vital Health Monitoring System** within the hospital environment under medical supervision. "The vital parameter readings obtained from the sensors were consistent and appropriate during the demonstration."

5.4 Summary of Observations

From the experimental evaluation and performance analysis of the proposed IoT Based Patient Health Monitoring System, the following observations are made:

- The developed system successfully monitors patient vital parameters such as body temperature, heart rate, blood oxygen level (SpO_2), and environmental conditions in real time with high accuracy.
- The integration of biomedical sensors with the ESP32 microcontroller ensures reliable data acquisition and efficient wireless transmission using Wi-Fi technology.
- The system accurately displays real-time patient health data on a web-based dashboard, enabling remote monitoring by doctors and caregivers.
- Normal health conditions are continuously tracked without interruption, while abnormal readings are detected promptly with minimal delay.
- The implemented alert mechanism effectively notifies caregivers when any vital parameter exceeds predefined safe limits, supporting timely medical intervention.
- Experimental results confirm that the system operates efficiently over extended durations and is suitable for both hospital and home healthcare environments.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Conclusion

The project titled **"IoT Based Patient Vital Health Monitoring System"** successfully demonstrates the design and implementation of a smart, reliable, and cost-effective healthcare monitoring solution using Internet of Things (IoT) technology. With the increasing demand for continuous patient monitoring, especially for elderly, chronically ill, and post-operative patients, traditional manual health monitoring methods are often insufficient and inefficient.

The proposed system effectively integrates biomedical sensors with the ESP32 microcontroller to continuously monitor vital health parameters such as body temperature, heart rate, blood oxygen level (SpO_2), room temperature, and humidity. The collected data is processed in real time and transmitted wirelessly using Wi-Fi to a web-based dashboard, enabling remote monitoring by doctors and caregivers.

The inclusion of a threshold-based alert mechanism ensures early detection of abnormal health conditions and enables timely medical intervention, thereby improving patient safety and reducing emergency response time. The system is portable, low-cost, and easy to deploy, making it suitable for hospitals, home healthcare, remote medical facilities, and quarantine centers.

Overall, this project demonstrates how IoT technology can significantly enhance healthcare delivery by enabling continuous monitoring, reducing workload on medical staff, and improving the quality of patient care. The proposed system provides a scalable and practical approach toward modern smart healthcare solutions..

6.2 Future Work

Although the proposed **IoT Based Patient Vital Health Monitoring System** performs effectively, several enhancements can be incorporated in the future to improve its functionality, scalability, and real-world applicability.

- **Real-Time Cloud-Based Deployment**
  The current system is evaluated using offline benchmark datasets. In the future, the IDS can be deployed in real-time hospital networks to monitor live IoMT traffic. Integration with network monitoring tools such as packet sniffers and edge gateways will enable continuous protection of medical devices and healthcare data.

- **Integration with Automated Response Systems**
  The IDS can be extended to include automated mitigation mechanisms such as traffic isolation, access blocking, or device quarantine. This will allow the system not only to detect attacks but also to respond automatically, reducing reaction time in critical healthcare scenarios.

- **Advanced Health Data Analytics**
  Future improvements may include the integration of data analytics or machine learning techniques to analyze patient health trends over time. Predictive analysis can help in early detection of potential health risks and support preventive healthcare.

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