A

Project Stage-II Report on

Health Monitoring Ring

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List of Abbreviations

ECE	: Electronics and Communication Engineering
ECG	: Electrocardiography
IoT	: Internet of Things
M2M	: Machine-to-Machine
PRN	: Permanent Registration Number
BVCOE	: Bharati Vidyapeeth College of Engineering
BV(DU)	: Bharati Vidyapeeth (Deemed to be University)
COE	: College of Engineering
NodeMCU	: Node Microcontroller Unit
Prof.	: Professor
Dr.	: Doctor
HP	: High Performance
DH	: Digital Health
HR	: Heart Rate
BT	: Body Temperature
HW	: Hardware
SW	: Software
ML	: Machine Learning
AI	: Artificial Intelligence
HR	: Human Resources
OT	: Occupational Therapy
PPE	: Personal Protective Equipment
NB	: Northbound
SB	: Southbound
FB	: Facebook
ID	: Identification
API	: Application Programming Interface
DB	: Database
SQL	: Structured Query Language
HTML	: HyperText Markup Language

CSS	: Cascading Style Sheets
JS	: JavaScript
SEO	: Search Engine Optimization
UX	: User Experience
UI	: User Interface
NLP	: Natural Language Processing
RPM	: Revolutions Per Miniute
OS	: Operating System
CP	: Control Panel
TCP	: Transmission Control Protocol
IP	: Internet Protocol
HTTP	: Hypertext Transfer Protocol
HTTPS	: Hypertext Transfer Protocol Secure
FTP	: File Transfer Protocol
SMTP	: Simple Mail Transfer Protocol
DNS	: Domain Name System
JSON	: JavaScript Object Notation
XML	: eXtensible Markup Language
PHP	: Hypertext Preprocessor
ASP	: Active Server Pages
JSP	: JavaServer Pages
W3C	: World Wide Web Consortium

Abstract

This project report focuses on the design and development of a health monitoring ring using the Xiao ESP32S3 microcontroller and MAX30100 pulse oximeter sensor. The primary goal of the project is to provide real-time measurement and monitoring of key health metrics, such as heart rate and blood oxygen saturation levels, using a wearable device.

The health monitoring ring offers a user-friendly, non-invasive approach to health tracking, making it a valuable tool for fitness enthusiasts, individuals with medical conditions, and those seeking to maintain a healthy lifestyle. The system integrates the Xiao ESP32S3 microcontroller with the MAX30100 pulse oximeter sensor to capture and process health data efficiently.

The project demonstrates the potential of combining modern technology with health monitoring, enabling continuous health tracking in a compact, wearable format. The system's successful implementation lays the foundation for further advancements in personalized health management, offering users convenient and accessible ways to monitor their health.

By providing a comprehensive overview of the project's design, implementation, and potential impact, this report highlights the benefits of integrating advanced technologies in health monitoring and personal wellness.

Chapter 1

Introduction

In the modern era, monitoring personal health has become a significant aspect of maintaining overall well-being. With advances in technology, there is an increasing demand for efficient, accessible, and cost-effective methods to track vital signs. This project introduces a health monitoring ring designed using the ESP32 Xiao S3 microcontroller, which facilitates the measurement of heart rate (BPM) and blood oxygen saturation (SpO2) levels. This wearable device aims to provide users with a seamless, user-friendly experience that integrates health tracking into their daily routine.

The primary objective of this project is to offer an affordable and easy-to-use solution for individuals seeking to monitor their health metrics regularly. By harnessing the capabilities of the ESP32 Xiao S3, a compact yet powerful microcontroller, and utilizing the Arduino IDE for programming, the project endeavors to create a versatile and practical wearable device. The ring's design, featuring a Velcro wrap-around to fit comfortably on the user's finger, ensures that the device can be worn with ease while still providing accurate measurements.

Existing health monitoring systems have brought numerous advantages, such as enabling patients to share their health data in real-time with caregivers. However, these systems often rely on fixed monitoring setups, making them effective primarily when patients are in the hospital or bedridden. While systems such as Remote Patient Monitoring (RPM) offer convenience and potential cost savings, they come with challenges, including skepticism regarding reliability and accessibility.

Moreover, the diversity of devices and lack of standardization in real-time health monitoring can hinder seamless data exchange and interoperability among various components. Rural areas and smaller healthcare institutions may face connectivity challenges, impacting the efficiency of RPM systems. Concerns about data privacy and reliability also present obstacles that need to be addressed.

In contrast, this project aims to overcome these limitations by providing a cost-effective and user-friendly health monitoring solution. The health monitoring ring is designed to be portable, allowing users to monitor their health at home without being confined to a hospital setting. With its wireless connectivity and compact design, the ring offers the potential for better data interoperability and patient engagement.

The innovative health monitoring ring empowers individuals to take control of their health by offering real-time data on their vital signs. Regular monitoring can assist users in maintaining optimal health, detecting potential issues early, and making informed decisions regarding their lifestyle and wellness choices. This technology can be beneficial for people with pre-existing conditions who need to monitor their health metrics closely.

Overall, the health monitoring ring represents a significant step forward in making health data more accessible to the general public. As technology continues to evolve, the future may bring even more integrated and sophisticated health tracking devices that can further enhance individuals' quality of life. This project demonstrates how modern technology can be leveraged to improve personal health monitoring and contribute to better healthcare outcomes.

Chapter 2

Literature Review

The literature surrounding health monitoring systems using the Internet of Things (IoT) and cloud computing highlights the significant impact of these technologies on modern healthcare. This chapter reviews various research works focusing on remote health monitoring systems, in-home patient monitoring, and the utilization of wearable devices and smart textiles for data collection and transmission.

Zhang, **Hong** and **Li**, **Ding** [1] discuss the crucial role of IoT and cloud computing in modern telemonitoring health systems. They employ a Raspberry Pi board to gather physiological data from body sensors, which is then made accessible via a webpage. This setup enables effective communication between doctors and patients, allowing for remote healthcare without the need for in-person visits. Their work demonstrates the potential of IoT and cloud computing in revolutionizing healthcare delivery.

Narote, **Sandipann P** and **Bhujbal**, **Pradnya N** and **Narote**, **Abbhilasha S** and **Dhane**, **Dhiraj M** [2] present a remote health monitoring system utilizing a Body Wireless Sensor Network (BWSN) to gather patient health parameters. These parameters are collected by a Raspberry Pi microcontroller and transmitted wirelessly to healthcare providers. This research emphasizes the potential for wireless technology to enhance patient care by providing real-time data to medical professionals.

Mhd. Hossain [3] underline the significance of in-home patient monitoring systems. Their approach involves collecting data from various body parameters using biosensors, wearable devices, and smart textiles. This data is then securely transmitted to a central server using Ciphertext Policy Attribute-Based Encryption (CP-ABE), highlighting the importance of data security in healthcare.

Electronics For You [4] advocate for the development of specialized healthcare monitoring systems for the elderly due to the increasing aging population. Their system conducts regular health check-ups by measuring body parameters and reporting the data to doctors. The results are displayed in a web application, facilitating seamless interaction between doctors and patients.

rohitxsh [5] emphasize the benefits of IoT in healthcare, particularly in enhancing patients' quality of life. Their research focuses on educating patients on healthy eating habits and effective workout routines to improve their overall well-being.

Khan ,**Mohammad Monirujjaman**and **Mehnaz**, **Safia** and **Shaha**, **Antu** and **Nayem**, **Mohammed** and **Bourouis**, **Sami** [6] propose a remote mobile health monitoring system that eliminates the need for additional hardware. By recording patient health parameters through a smartphone and transmitting the data via a web interface, their system simplifies the process of remote monitoring, making healthcare more accessible and convenient for patients.

Dole, **Manisha V.** and **Yerigeri**, **Prof. V.V.** [7] address challenges associated with using wearable tracking devices. They emphasize ensuring data accuracy, validity, and integrity across devices while also prioritizing user experience. Their research underscores the need for supporting software that can seamlessly integrate with these devices to improve usability and patient outcomes.

In summary, the literature demonstrates the potential of IoT and its e-Health applications in transforming the telemedicine health system. This transformation leads to seamless information flow between doctors and patients, making healthcare more cost-effective and improving the quality of patient treatment. Key aspects of monitoring include prevention and effective early intervention during medical emergencies. These advances have the potential to reshape the healthcare industry and improve patient care on a global scale.

Table 2.1: Comparison of Healthcare Techniques

Techniques/Methodology	**Advantages**	**Disadvantages**
IoT-based health monitoring	Real-time monitoring	Security and privacy concerns
Cloud computing	Accessibility from anywhere	Dependence on network reliability
Wearable tracking devices	Continuous monitoring	Battery life limitations
Remote health monitoring	Improved healthcare	Potential data loss or delays
Telemedicine	Cost-effective care	Technical issues can impact delivery
Smartphones for monitoring	Portability and ease of use	Limited processing power

This comparison of healthcare techniques highlights the various advantages and disadvantages associated with different approaches, providing a foundation for future advancements and improvements in the field.

Chapter 3

Objectives

The objective of the Health Monitoring Ring is to create a portable and reliable device capable of monitoring critical health metrics such as blood oxygen saturation (SpO2) and heart rate (BPM). The aim is to develop a wearable ring that provides nearly accurate and real-time readings of these vital signs. By enabling individuals to monitor their health conveniently and continuously, the ring empowers them to gain crucial insights into their physiological state as soon as possible.

This wearable technology not only aids individuals in keeping track of their well-being but also facilitates early detection of potential health issues. The Health Monitoring Ring seeks to offer a user-friendly solution that can seamlessly integrate into daily life, providing timely feedback on vital health parameters. Through this innovative approach, the ring contributes to proactive health management and improved quality of life for its users.

The aim of the project focuses on providing a user-friendly solution for fitness enthusiasts to monitor their health statistics. By offering a reliable and affordable device, the project seeks to empower users to track their heart rate and SpO2 levels efficiently.

3.1 Deliverables

The expected outcomes of the project include:

- A fully functional, portable device for monitoring heart rate and SpO2.
- Compatibility with platforms such as ThingSpeak and Blink for data visualization and analysis.
- A user-friendly design that can be worn as a ring for convenient use.

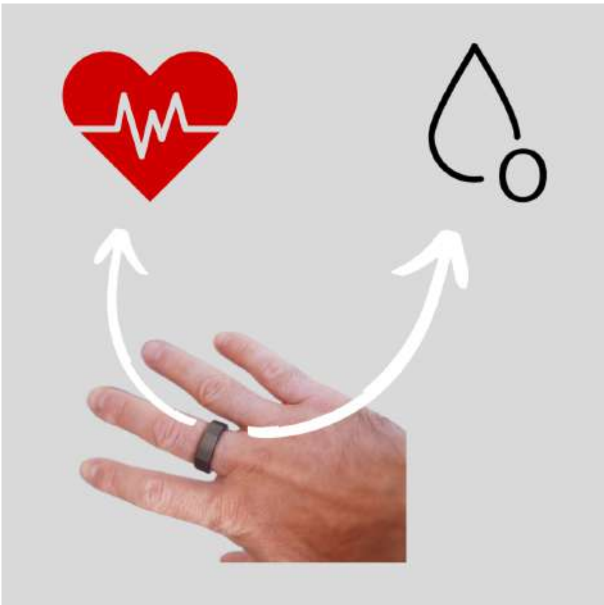


Figure 3.1: sensing BPM and Spo2

Chapter 4

Methodology

This chapter presents the methods and techniques used in the project, including an explanation of the experimental setup, design process, and justification for chosen methodologies.

Methods and Techniques: We monitored the sensor's readings each time a measurement was taken and found that starting from the 7th reading up to the 20th reading provided the most reliable data. By averaging these readings, we obtained a result that closely matched professional medical devices.

Experimental Setup and Design Process: For the ring design, various materials such as clay and plastic were initially tested, but they did not provide an ideal fit. While experimenting, we discovered that velcro worked exceptionally well, offering an easy-to-adjust and secure fit for different finger sizes.

Justification for Chosen Methodologies: The choice of methodologies was informed by thorough research and testing. By consulting research papers, we identified the optimal board and sensor for the project. Additionally, extensive testing allowed us to fine-tune the code and confirm the best approach for obtaining accurate readings. This research and iterative testing process provided the foundation for the successful development of the health monitoring ring.

Data Collection and Analysis: It involves using sensors to gather information on heart rate and SpO2 levels. The data is then transmitted to platforms such as ThingSpeak or Blink for analysis and visualization, enabling users to track their health statistics over time.

4.1 Flowchart of the Methodology

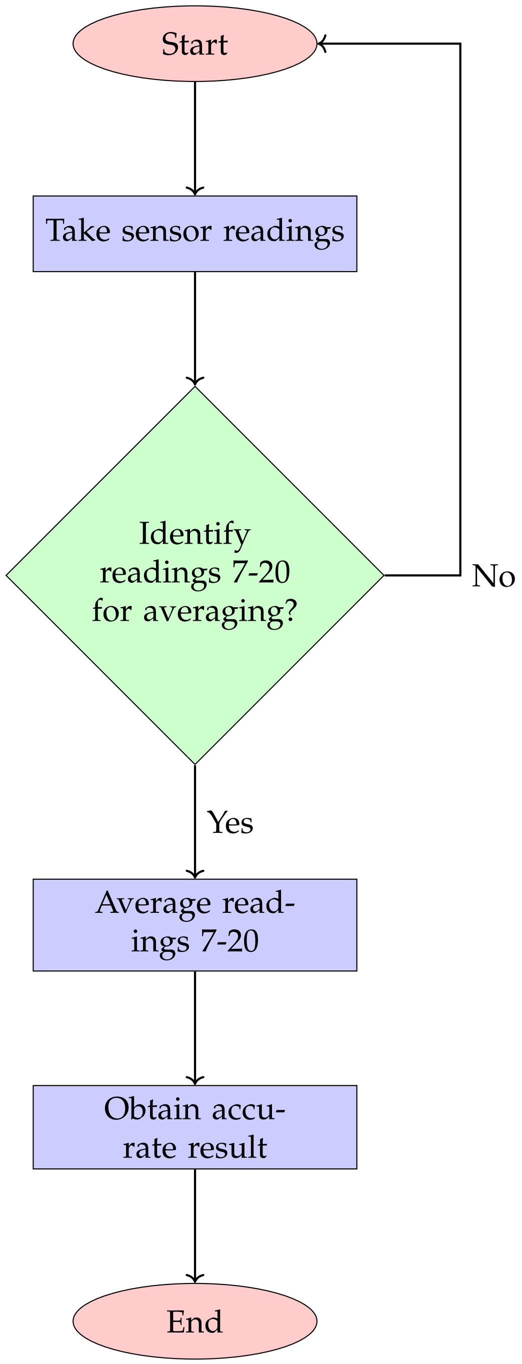


Figure 4.1: Flowchart of the methodology for health monitoring ring.

4.2 Potential Challenges and Limitations

While the chosen methodologies offer significant benefits, potential challenges may include:

- **Sensor Accuracy**: Ensuring the accuracy and consistency of sensor readings can be challenging.
- **Connectivity**: Maintaining stable connectivity for data transmission may be an issue in certain environments.
- **User Engagement**: Encouraging users to regularly use the device and engage with the data can be a challenge.

Chapter 5

Design and Implementation

This chapter provides a comprehensive analysis of the design and implementation of the project. It covers the details of the hardware design, including the circuit diagrams, schematics, and layouts. Additionally, it discusses the functions of the components and the software tools and programming languages used to achieve the project goals. The chapter also explores the principle and working of the project.

5.1 Hardware Design

The hardware design forms the foundation of the project and involves the careful selection and integration of key components to achieve the project's objectives. The primary elements of the hardware design include the Xiao ESP32 S3 microcontroller, the MAX30100 sensor, and a Velcro ring structure to house the sensors.

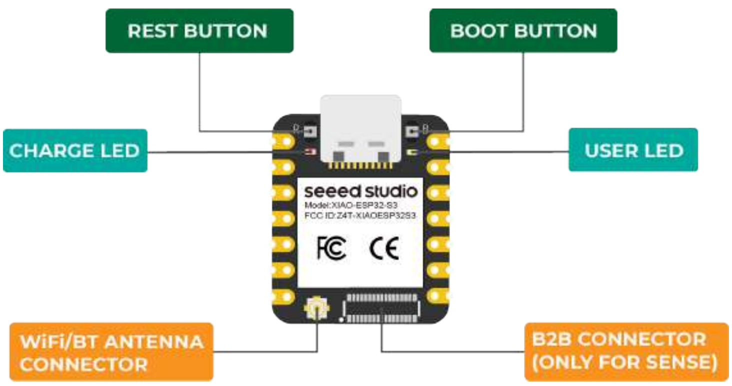


Figure 5.1: Xiao ESP32 S3 Pin

5.1.1 Xiao ESP32 S3

The **Xiao ESP32 S3** microcontroller serves as the central processing unit for the project. It is chosen for its versatility and ability to manage data processing, communication, and control of the sensors. The microcontroller's compatibility with various communication protocols, including Wi-Fi and Bluetooth, allows for seamless data transmission and remote monitoring.

Figure 5.2: Xiao ESP32 S3 Microcontroller

The **ESP32 S3 pinout** is designed to support a wide range of peripheral devices, including sensors, actuators, and communication modules. Its flexibility and small form factor make it an ideal choice for wearable applications such as the one in this project.

Table 5.1: ESP32S3 Xiao Pin Names and Internal GPIO Pin Numbers

Pin Names on NodeMCU Development Kit	Xiao ESP32S3 Internal GPIO Pin Number
D0	GPIO3
D1	GPIO1
D2	GPIO21
D3	GPIO22
D4	GPIO6
D5	GPIO23
D6	GPIO19
D7	GPIO18
D8	GPIO5
D9	GPIO12
D10	GPIO15

5.1.2 MAX30100 Sensor

The **MAX30100 sensor** is a critical component in the project, as it measures heart rate and SpO2 levels, providing essential health data for the user. The sensor's high level of accuracy and reliability makes it a popular choice for monitoring vital signs in real time.

Figure 5.3: MAX30100 Sensor

The **MAX30100 sensor** employs photoplethysmography (PPG) to measure the user's heart rate and SpO2 levels. PPG is a non-invasive optical technique that measures changes in blood volume in the capillaries. The sensor uses LEDs (light-emitting diodes) to emit red and infrared light into the skin. As blood flows through the capillaries, it absorbs the light, and the sensor measures the amount of light absorbed and reflected.

By detecting variations in the intensity of the absorbed and reflected light, the sensor can calculate the user's heart rate and blood oxygen saturation (SpO2). The sensor's advanced algorithms process the PPG signals to provide accurate and real-time readings.

The **sensor's integration** with the Xiao ESP32 S3 microcontroller enables efficient data collection and processing. The microcontroller processes the data received from the sensor and provides real-time health monitoring and feedback to the user.

5.1.3 Velcro Ring Structure

The **Velcro ring structure** plays a crucial role in the project's design, as it houses the sensors and allows the user to wear the device comfortably and securely. This setup ensures that the sensors maintain consistent contact with the user's skin, facilitating accurate readings.

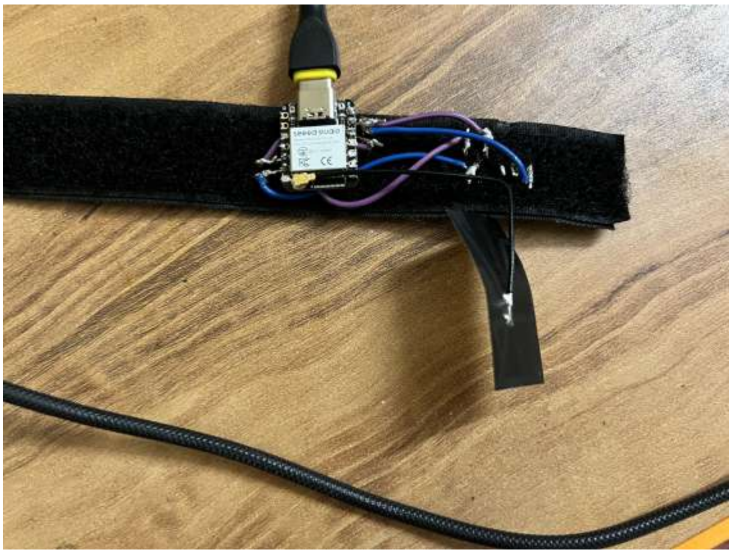


Figure 5.4: Velcro Ring Structure

The **adjustable nature of the Velcro** allows the user to customize the fit for optimal sensor placement, improving data accuracy and reliability.

5.2 Circuit Diagrams and Schematics

The project's circuit diagrams and schematics detail the connections between the different components and the Xiao ESP32 S3 microcontroller. These designs are critical for ensuring efficient data collection, transmission, and processing.

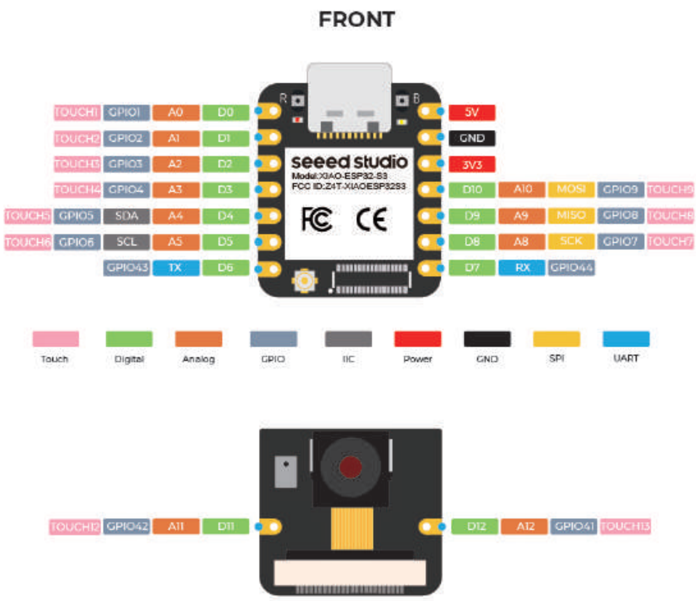


Figure 5.5: ESP32 S3 Pinout Diagram

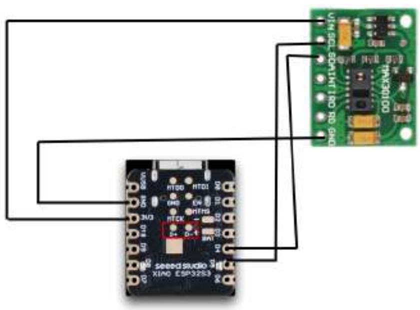


Figure 5.6: Connection Diagram

The **circuit design** involves connecting the MAX30100 sensor to the ESP32 S3 microcontroller using appropriate wiring and connectors. The wiring configuration is optimized for efficient data flow and minimal interference, ensuring the reliability and accuracy of the measurements.

5.3 Component Functions

Each component in the project serves a specific purpose:

- **Xiao ESP32 S3**: Acts as the brain of the system, managing data processing, communication, and control of the sensors. Its compatibility with various communication protocols allows for seamless integration with external platforms.
- **MAX30100 Sensor**: Gathers heart rate and SpO2 data from the user and transmits it to the ESP32 S3 for further analysis and visualization. Its high accuracy and sensitivity make it a vital component for health monitoring.
- **Velcro Ring Structure**: Provides a comfortable and secure way to wear the sensors, ensuring accurate and consistent readings. Its adjustable design allows for customization to fit different users' needs.

5.4 Software Tools and Programming Languages

The project utilizes various software tools and programming languages to achieve its goals:

- **Arduino IDE**: This integrated development environment (IDE) is used to program the Xiao ESP32 S3 microcontroller. It provides a user-friendly interface for coding and debugging, enabling precise control of the sensors and data transmission.
- **ThingSpeak and Blink**: These platforms are employed for data visualization and analysis, enabling users to monitor their health metrics in real time. Data collected from the sensors can be transmitted to these platforms for further processing and interpretation.

The use of **Arduino IDE** simplifies the development process and allows for easy adjustments to the code as needed. The real-time data visualization provided by ThingSpeak and Blink enhances the user experience by presenting health metrics in an accessible and understandable format.

5.4.1 Arduino IDE Setup for Xiao ESP32 S3

Setting up the Arduino IDE for the Xiao ESP32 S3 microcontroller involves a series of steps to ensure the correct configuration and compatibility with the project. Follow these steps to set up the Arduino IDE for the ESP32 S3:

1. **Download and Install Arduino IDE**: Download the latest version of the Arduino IDE from the [official website](`https://www.arduino.cc/en/software`) and install it.

2. **Add ESP32 Board Support**: In the Arduino IDE, navigate to ‘File‘ ¿ ‘Preferences‘. In the ”Additional Boards Manager URLs” field, add the URL `https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json` and save the changes.

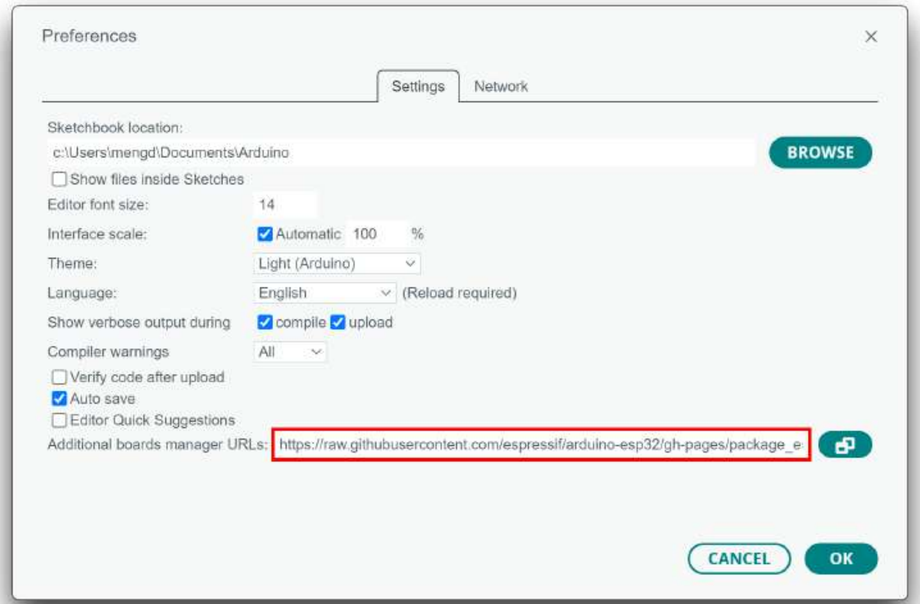


Figure 5.7: Arduino IDE Setup for ESP32

3. **Open Boards Manager**: Go to ‘Tools‘ ¿ ‘Board‘ ¿ ‘Boards Manager‘.

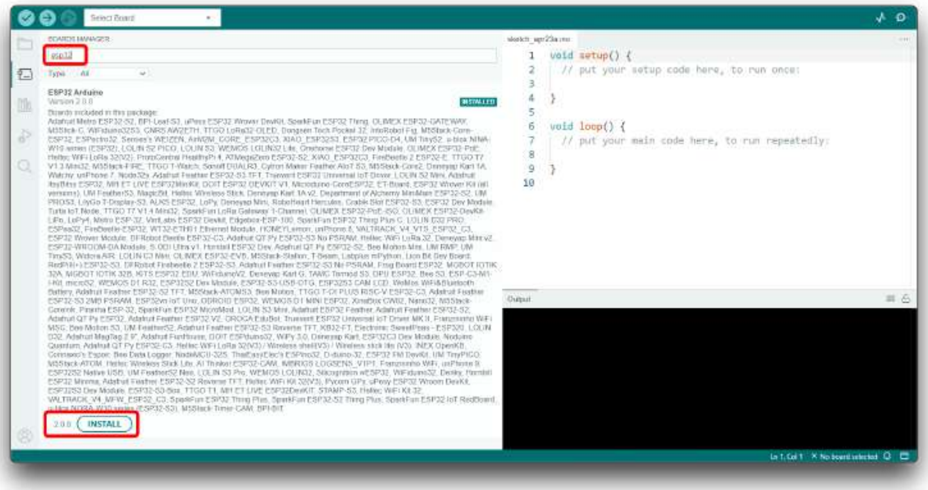


Figure 5.8: Setup for Board Manager

4. **Search for ESP32**: In the Boards Manager search bar, type ”ESP32.”

5. **Install ESP32 Package**: Locate the ESP32 package by Espressif Systems and click ”Install.”

6. **Select ESP32 S3 Board**: Once the installation is complete, go to ‘Tools‘ ¿ ‘Board‘ and select ”ESP32S3 Dev Module” or a similar option based on your board type.

7. **Configure Port**: In ‘Tools‘ ¿ ‘Port‘, select the appropriate port where the Xiao ESP32 S3 is connected.

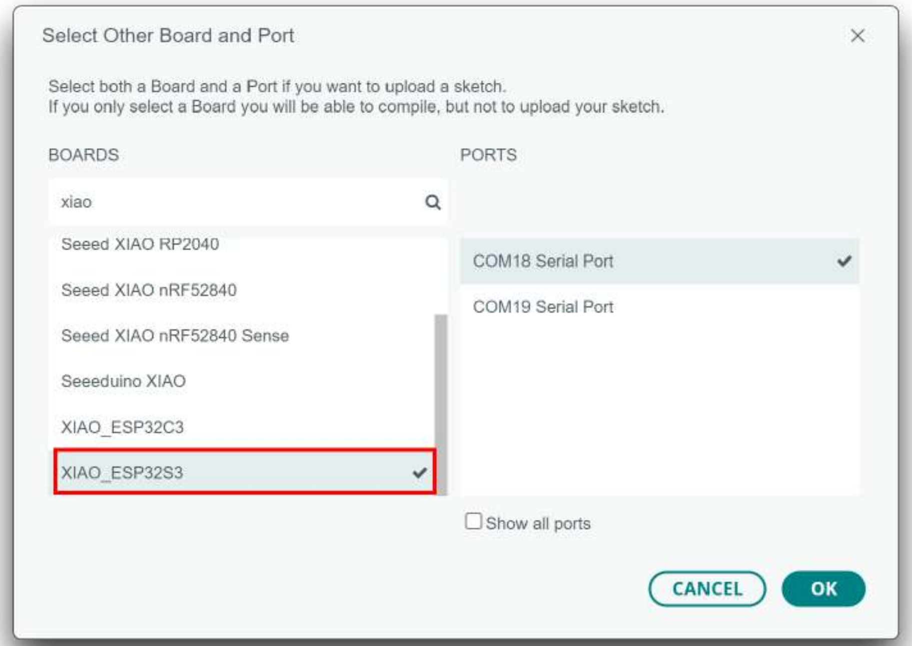


Figure 5.9: Configuration for Xiao ESP32 S3

8. **Upload Sketch**: Write or load your code in the Arduino IDE. Click the upload button to flash it onto the board.

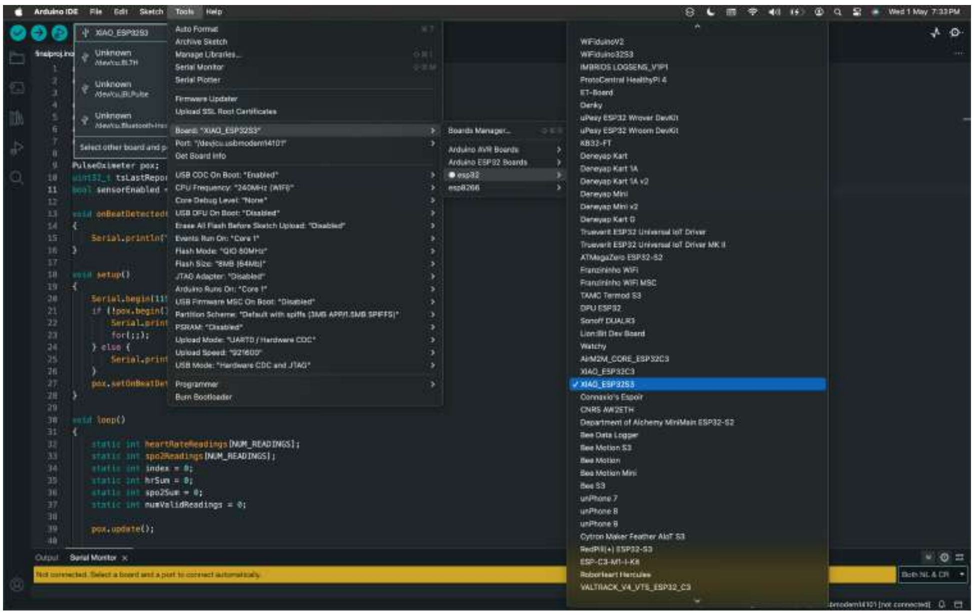


Figure 5.10: Arduino IDE Setup for Xiao ESP32 S3

The setup process ensures that the Arduino IDE is correctly configured to communicate with the ESP32 S3 microcontroller, enabling smooth development and deployment of the project code.

5.5 ThinkSpeak

ThingSpeak is an IoT analytics platform service that allows you to collect, analyze, visualize, and act on data. It's a valuable tool for monitoring and tracking health metrics data collected by your project. By integrating ThinkSpeak into your project, you can transmit data from the ESP32 S3 microcontroller to the ThingSpeak cloud platform for further analysis and visualization.

5.5.1 Setting Up ThinkSpeak

To set up ThinkSpeak for use with your project, follow these steps:

1. **Create a ThinkSpeak Account**: Go to the [ThinkSpeak website](`https://thinkspeak.com/`) and create an account if you don't already have one.

2. **Create a New Channel**: After logging in, navigate to "Channels" and click "New Channel" to create a channel for your project data.

3. **Configure the Channel**: Set up the channel by giving it a name and configuring the data fields you wish to use. For example, you may set up fields for heart rate and SpO2 levels.

4. **Get Channel API Keys**: Once the channel is set up, take note of the channel's write and read API keys, as you'll need them to send and retrieve data.

5. **Integrate with ESP32 S3**: In your Arduino code, use the ThingSpeak library to send data from the ESP32 S3 microcontroller to the ThinkSpeak channel using the write API key.

5.5.2 ThinkSpeak Integration

To integrate ThinkSpeak into your ESP32 S3 project, follow these steps:

1. **Include Libraries**: Include the required libraries in your Arduino sketch, such as ‘WiFi.h‘ for network connectivity and ‘ThingSpeak.h‘ for ThinkSpeak integration.

2. **Connect to WiFi**: Set up the WiFi connection in your sketch using your network’s SSID and password.

3. **Send Data**: Use the ‘ThingSpeak.writeField()‘ function to send data to the specified channel. Provide the channel ID, write API key, field number, and data value as arguments.

4. **Read Data**: You can also use ‘ThingSpeak.readField()‘ to read data from a specified field in a channel using the read API key.

By following these steps, you can successfully integrate ThingSpeak with your ESP32 S3 project to transmit and visualize data.

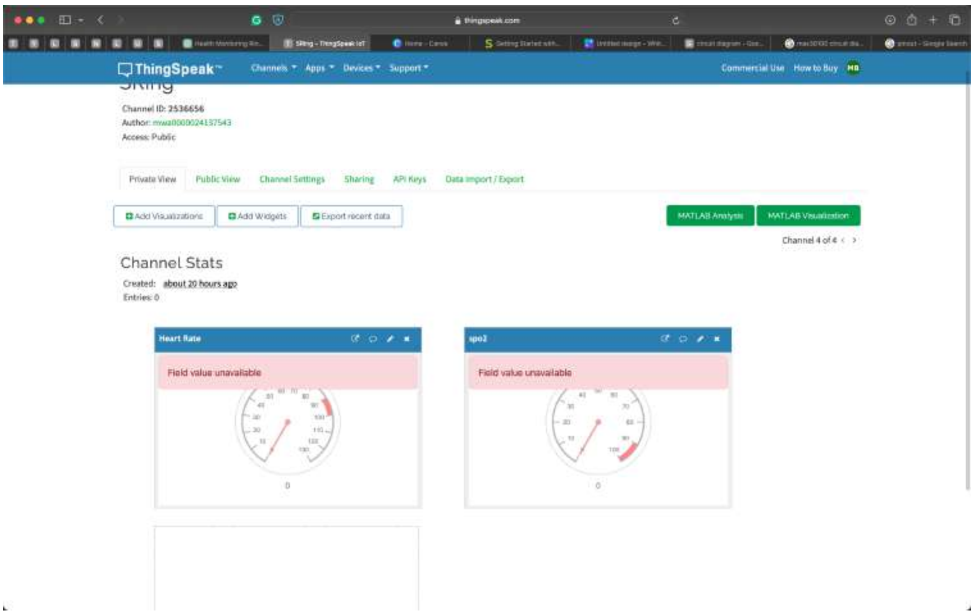


Figure 5.11: Example of a ThingSpeak Data Visualization

These screenshots demonstrate how you can visualize your data on the ThingSpeak platform and monitor your health metrics over time.

5.6 Principle and Working

This section discusses the underlying principle and working of the project.

5.6.1 Principle

The project operates on the principle of IoT-based health monitoring. It utilizes sensors to collect real-time data on vital health metrics such as heart rate and blood oxygen levels (SpO2). This data is processed and analyzed by the microcontroller, and the results are either displayed directly to the user or transmitted to external platforms for further analysis and visualization.

The system aims to provide a non-invasive, wearable device for continuous health monitoring. By leveraging IoT technology, the project can offer remote monitoring capabilities, allowing users and healthcare professionals to track health metrics in real time.

5.6.2 Working

The working of the project can be summarized as follows:

1. **Data Collection**: The MAX30100 sensor continuously collects heart rate and SpO2 data from the user. The sensor ensures accurate and reliable readings by maintaining consistent contact with the user's skin.

2. **Data Processing**: The Xiao ESP32 S3 microcontroller receives the data from the sensor and processes it using predefined algorithms. This includes filtering and analyzing the data for accuracy.

3. **Data Transmission**: Once the data is processed, it can be displayed directly to the user on a connected device, such as a smartphone, or transmitted to an external platform like ThingSpeak or Blink for further analysis and visualization.

4. **Real-Time Monitoring**: Users can monitor their health metrics in real time through the connected device or external platforms. This allows them to track

their health over time and receive alerts if any vital signs fall outside normal ranges.

The integration of hardware and software components enables the project to provide efficient and real-time health monitoring. The use of IoT technology facilitates seamless communication between devices and platforms, making remote monitoring a viable and effective option.

5.7 Data Collection and Analysis

The data collected by the MAX30100 sensor is transmitted to the Xiao ESP32 S3 microcontroller, where it is processed and analyzed. The microcontroller uses the gathered data to provide real-time feedback to the user or transmit the data to external platforms such as ThingSpeak or Blink for visualization and further analysis.

By utilizing these platforms, users can monitor their health metrics, track changes over time, and receive alerts if their vital signs fall outside of normal ranges. The data analysis can also provide valuable insights for healthcare professionals, enabling them to make informed decisions about patient care.

5.8 Summary

In summary, the design and implementation chapter provides a detailed overview of the project's hardware and software components, along with circuit diagrams, schematics, and descriptions of the methods and techniques used. The chapter outlines the setup process for the Arduino IDE with the ESP32 S3 microcontroller, ensuring a smooth development process. The use of real-time data visualization platforms enhances the user experience and provides valuable insights for health monitoring.

Chapter 6

Results and Discussion

This chapter presents the results obtained from the project, i.e, The device successfully provided readings for heart rate (bpm) and SpO2 levels in the Arduino IDE's serial monitor. As it can bee seen in the serial monitor below:

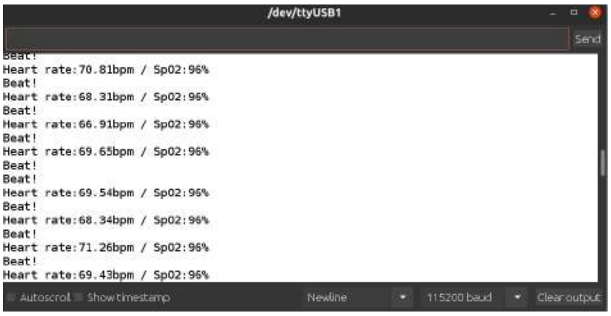


Figure 6.1: Serial Monitor Readings

6.0.1 Patient Readings

Patient Name	**Reading from Ring**
Piyush	bpm 79, SpO2 90
Manav	bpm 83, SpO2 94
Ujjwal	bpm 74, SpO2 91
Akshansh	bpm 80, SpO2 96
Ishaan	bpm 76, SpO2 95

Table 6.1: Readings from the ring for different patients

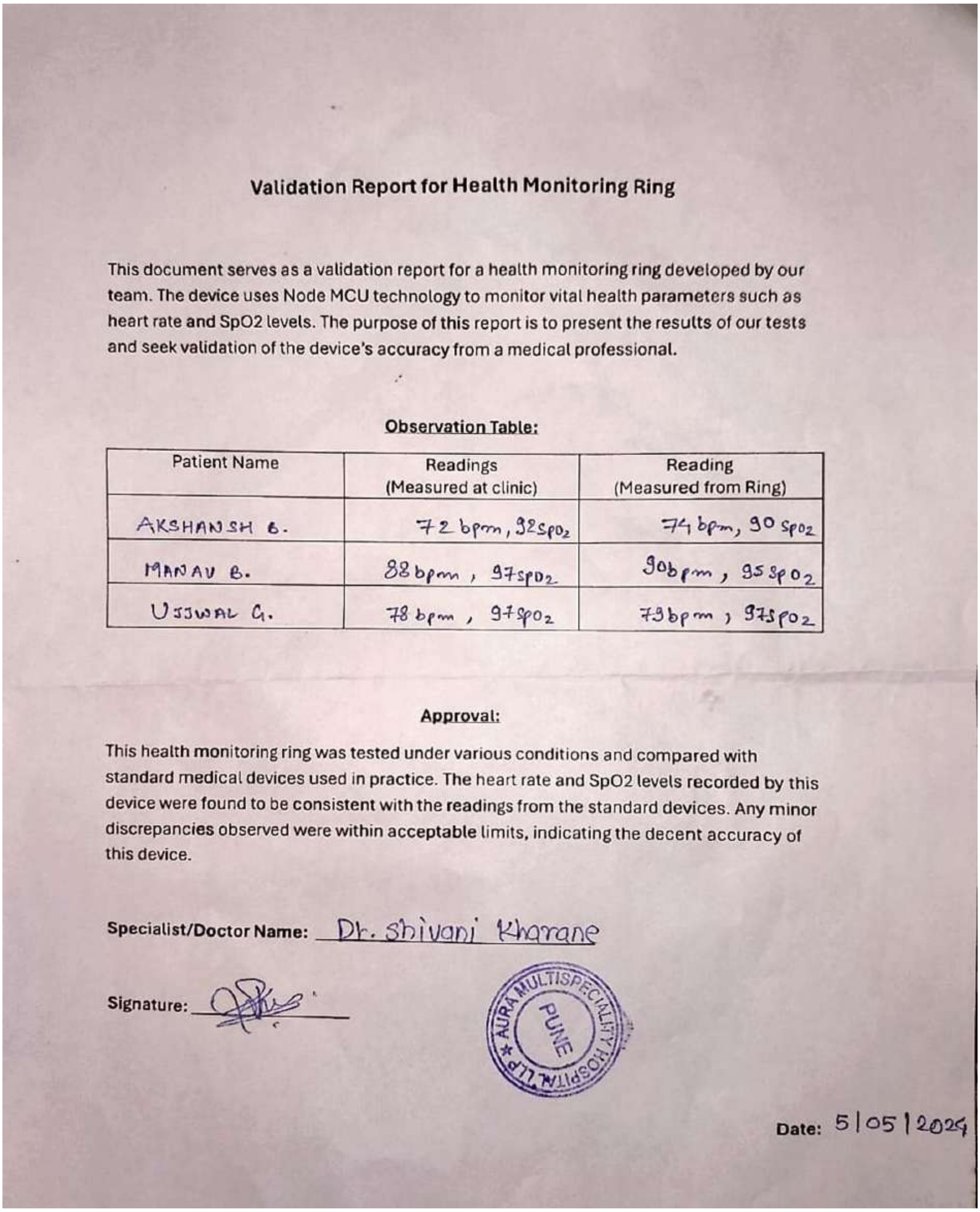
6.0.2 Verification by Doctor

To assess the accuracy of the device, readings were verified by a doctor using standard clinical equipment to measure heart rate (bpm) and SpO2 levels. The device readings were compared with the doctor's measurements taken at the clinic.

Measurement	**Doctor's Reading**	**Device Reading**
Heart Rate (bpm)	72, 88, 78	74, 90, 79
SpO2 Level	92, 97, 97	90, 97, 97

Table 6.2: Comparison of doctor's readings and device readings

Additionally, the verification by the doctor provides confidence in the reliability of the device and its potential use for health monitoring purposes.



Validation Report for Health Monitoring Ring

This document serves as a validation report for a health monitoring ring developed by our team. The device uses Node MCU technology to monitor vital health parameters such as heart rate and SpO2 levels. The purpose of this report is to present the results of our tests and seek validation of the device's accuracy from a medical professional.

Observation Table:

Patient Name	Readings (Measured at clinic)	Reading (Measured from Ring)
AKSHANSH B.	72 bpm, 92 SpO_2	74 bpm, 90 SpO_2
MANAV B.	88 bpm, 97 SpO_2	90 bpm, 95 SpO_2
UJJWAL G.	78 bpm, 97 SpO_2	79 bpm, 97 SpO_2

Approval:

This health monitoring ring was tested under various conditions and compared with standard medical devices used in practice. The heart rate and SpO2 levels recorded by this device were found to be consistent with the readings from the standard devices. Any minor discrepancies observed were within acceptable limits, indicating the decent accuracy of this device.

Specialist/Doctor Name: Dr. Shivani Kharane

Signature:

AURA MULTISPECIALITY HOSPITAL LLP * PUNE

Date: 5/05/2024

Figure 6.2: Doctor′s signed verification document

6.1 Discussion

Interpretation of the Results in the Context of the Objectives: The device successfully provided the data we aimed to gather, fulfilling the objectives of the project.

Analysis of Unexpected Findings or Challenges Encountered: The device demonstrated high accuracy most of the time; however, there were occasional inaccuracies.

Discussion of the Implications of the Results: The project achieved its primary objective of developing a health monitoring ring. With slight improvements in the sensor, the device could achieve even greater accuracy, enhancing its usefulness for health monitoring purposes.

Chapter 7

Conclusion and Future Scope

This chapter summarizes the key findings of the project, reflects on how the objectives were met, and outlines potential future directions for the work.

That is, the project demonstrated that smart health devices can be made more cost-effective while still providing good accuracy, as evidenced by the health monitoring ring we developed. The ring, equipped with velcro for a secure fit, measures and displays readings in real-time.

In terms of meeting objectives, the primary goal of creating a health monitoring ring was achieved, with results that demonstrate its functionality and utility.

The project's significance lies in its contribution to the exploration of IoT and embedded systems, providing valuable insights into the process of designing and manufacturing a smart health device. This experience deepened our understanding of the challenges and opportunities in this field.

7.1 Future Work

Future research and development could focus on making the health monitoring ring more streamlined and less bulky. Enhancing the efficiency and reliability of the sensors could improve the device's performance and user experience.

Additionally, there is potential for extending the project by exploring related areas such as data privacy and security, user experience improvements, and the integration of additional health metrics for more comprehensive monitoring.

Overall, the project has laid a solid foundation for further advancements in smart health devices and provides numerous opportunities for future research and development in this field.

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