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Development of Smart Armband with Emergency Button for Healthcare

Nor Amira Husna Akhir[1], Mohd Hezri Mokhtar[1]

[1]Department of Electrical Engineering Technology, Faculty of Engineering Technology, UTHM Pagoh Campus, Pagoh Higher Education Hub, KM, Jalan Panchor, 84600 Panchor, Johor.

*Corresponding Author: hezri@uthm.edu.my
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Abstract

The project provides a real-time health monitoring service to address the difficulties faced by people managing chronic diseases. For those with chronic conditions, keeping track of their health and managing complicated medication regimens might be too much to handle. This can result in missed visits, ignored prescriptions, and dire repercussions. Monitoring the health of people with impairments or chronic illnesses presents additional obstacles for caregivers and healthcare professionals, particularly when it comes to the elderly. Designing a software-based pulse rate monitoring application, putting in place an armband for tracking emergencies and detecting pulse rates, and fusing emergency alert features in mobile apps are some of the goals. The smart armband that was designed effectively to track the pulse rate of the patient, take care of caregivers real-time for patients and also used as an emergency tracker. Including emergency notification and medical functions in one smart armband is a great way to help people with chronic diseases such as heart disease manage their health and well-being. It provides a thorough and easy-to-use method of managing healthcare

1. Introduction

About 50 years ago, Hormann wanted to share health data with scientists, leading to the idea of an alarm for elderly safety at home. In 1972, Dibner, a psychology professor, came up with a Life Alert to help seniors get emergency assistance, especially when they couldn't reach their phones.

Elderly people face challenges in using mobile health due to not being familiar with technology and resistance to it. In 2010, healthcare costs for those over 65 in the U.S. were three times higher than working-age adults and five times higher than children. Aging increases healthcare expenses, mainly in managing chronic diseases. The ECG monitor is crucial in hospitals as it continuously tracks vital signs, providing alerts for any abnormal readings beyond set ranges. This significantly enhances medical care by ensuring prompt attention to patients' conditions.

To address these issues, a simple smart armband with an emergency button is proposed. This device caters to the elderly who may struggle with technology. The armband monitors heart rate, aligning with recommended activity levels and the emergency button ensures quick help during critical situations, enhancing overall safety for the elderly and potentially reducing healthcare costs.

1.1 Problem Statement

The development of smart armbands with emergency buttons for healthcare is needed for those with chronic medical illnesses or impairments to effectively manage their health, keeptrack of their location, and monitor their heart rate. For those who have several diseases or complicated prescription regimens, this can be a challenging and intimidatingundertaking.

2. Materials and Methods

2.1 Materials

The main components used in this project are Node MCU ESP32 for the Wi-Fi integration. All the components needed and used in this project are shown in Table 1.

Table 1 *The list of components*

List of Components
- Light-emitting diode (LED)
- Push button of 12 ×12 mm × 7.5mm
- Global positioning system (GPS) 6-Neo Module
- HW-278 Heart rate sensor
- Node MCU ESP32
- 180Ω resistor

2.2 Methods

2.2.1 Process of Smart Armband Development

The system used NodeMCU ESP32 microcontroller with Wi-Fi for Internet of Things functions. It acts as a main hub. In the first step, a pulse sensor measures the patient's heart rate and at the same time a GPS module links to the ESP32 for location tracking detection and heart rate data transmission. LED and a push button are provided as additional alerts and reminders for the monitor's user. The Blynk software is connected to ESP32 via Wi-Fi which allows users to control and monitor the system from their phone or tablets. The set up not only tracks the vital signs but also offers a user-friendly interface for quick response to emergencies.

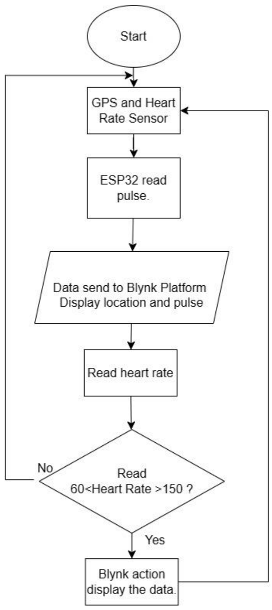


Fig. 1 *Flow of the system monitoring*

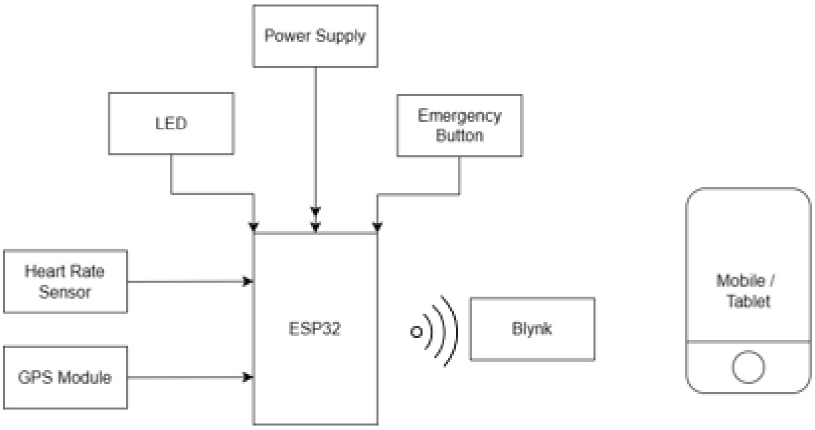
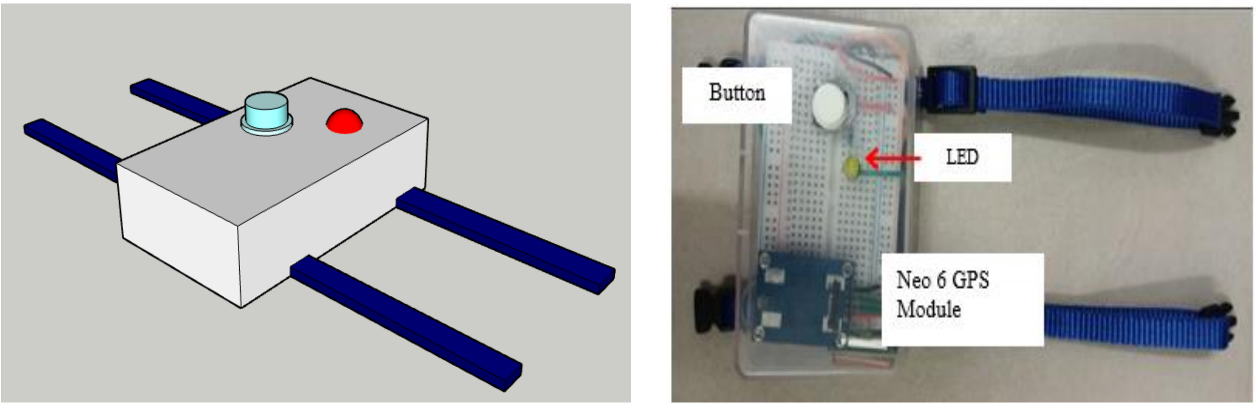


Fig. 2 *Block diagram of the smart armband development*

2.2.2 Armband with Emergency Button

The armband shown in Figure 3 is built based on the design of smartwatch functionality. It is constructed with a low-cost prototype, measuring approximately 10 centimetres in length, 6.5 centimetres in width, and 4 centimetres in height.



(a) (b)

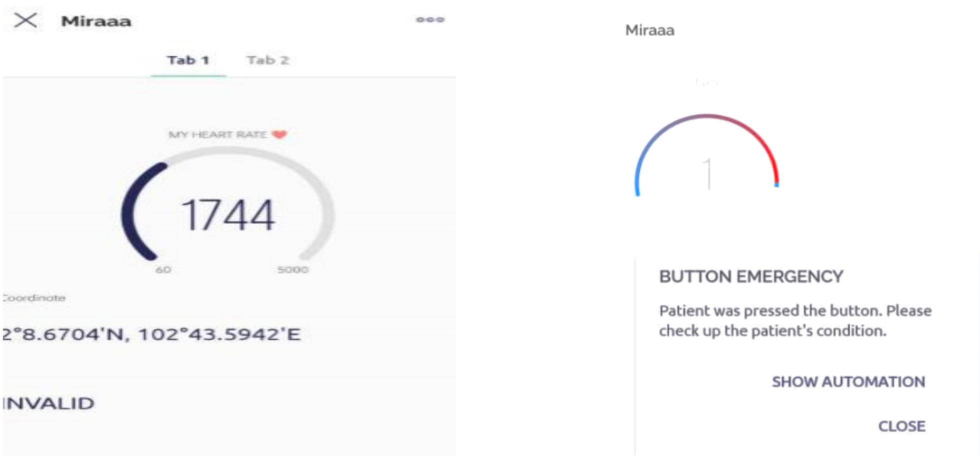
Figure 3 *The design of (a)3-dimension smart armband; (b) The final prototype smart armband*

3. Result and Discussion

The results of testing and troubleshooting during the prototype evaluation were divided into emergency notifications, heart rate data analysis and comparison and GPS tracker functionality. It delves into the details of the project's prototype, which was developed and built successfully. The purpose is to provide readers with in-depth knowledge. The study provides light on each component's usability and functionality, offering a comprehensive knowledge of how they contribute to the prototype's overall efficacy and performance.

3.1 Internet of Things Monitoring System

To develop a user-friendly mobile app using Blynk IoT for real-time monitoring of heart rate and location through a smart armband, the process starts with connecting the apps to Wi-Fi of ESP32 to transmit the data from the heart rate sensor, and displaying heart rate value, and GPS coordinates and speed on the interface. These features include cloud-based storage and web service interaction. Location awareness and easy data sharing. The button for emergency will display the notification as in illustrative Figure 4 below.

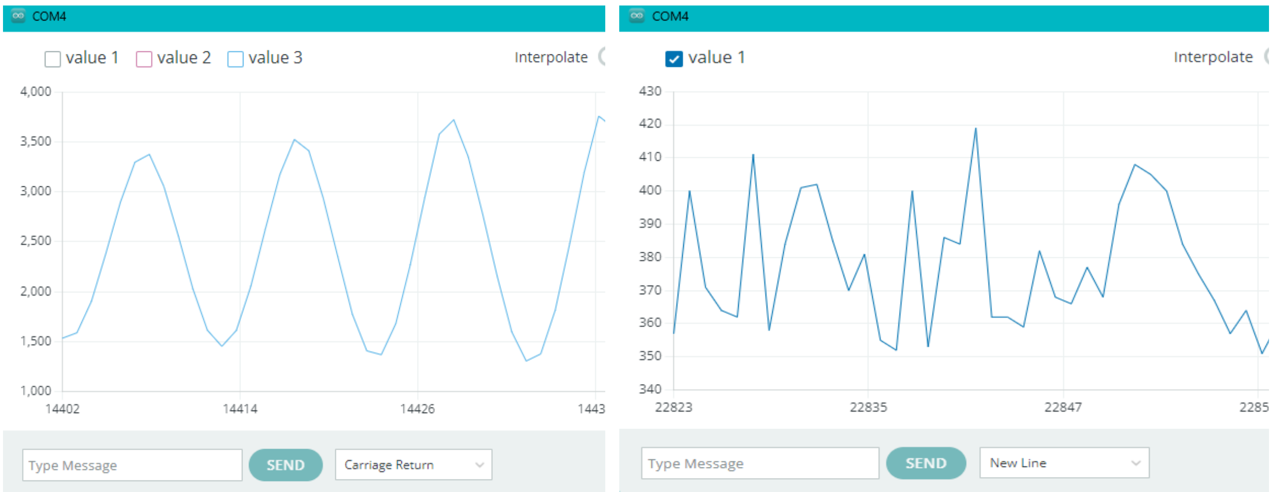


(a) (b)

Fig. 4 *(a) Blynk IoT platform real-time display; (b) Notification emergency after pressing button.*

3.2 Heart Rate Prototype's Sensor Analysis and Comparison

Two levels of heart rate analysis were conducted based on the patient's condition and the armband's position. Initially, the heart rate sensor's performance was evaluated under resting conditions and after exercise. The results were provided by the serial monitor to analyze the pattern of vital signs. Figure 5 illustrates the comparison of the heart rate pattern in both conditions.



(a) (b)

Fig. 5 *(a) Hear rate pattern in rest condition; (b) heart rate pattern after exercise.*

Secondly, the process is analyzing the heart rate error to analyze the data provides insights into the accuracy of heart rate monitoring across the device. The accuracy is determined by calculating the percentage of error first and subtracting 100 to the result of error percentage by using formula:

$$Percentage\ of\ Error = \frac{|Measured - Actual|}{Actual} \times 100\%$$

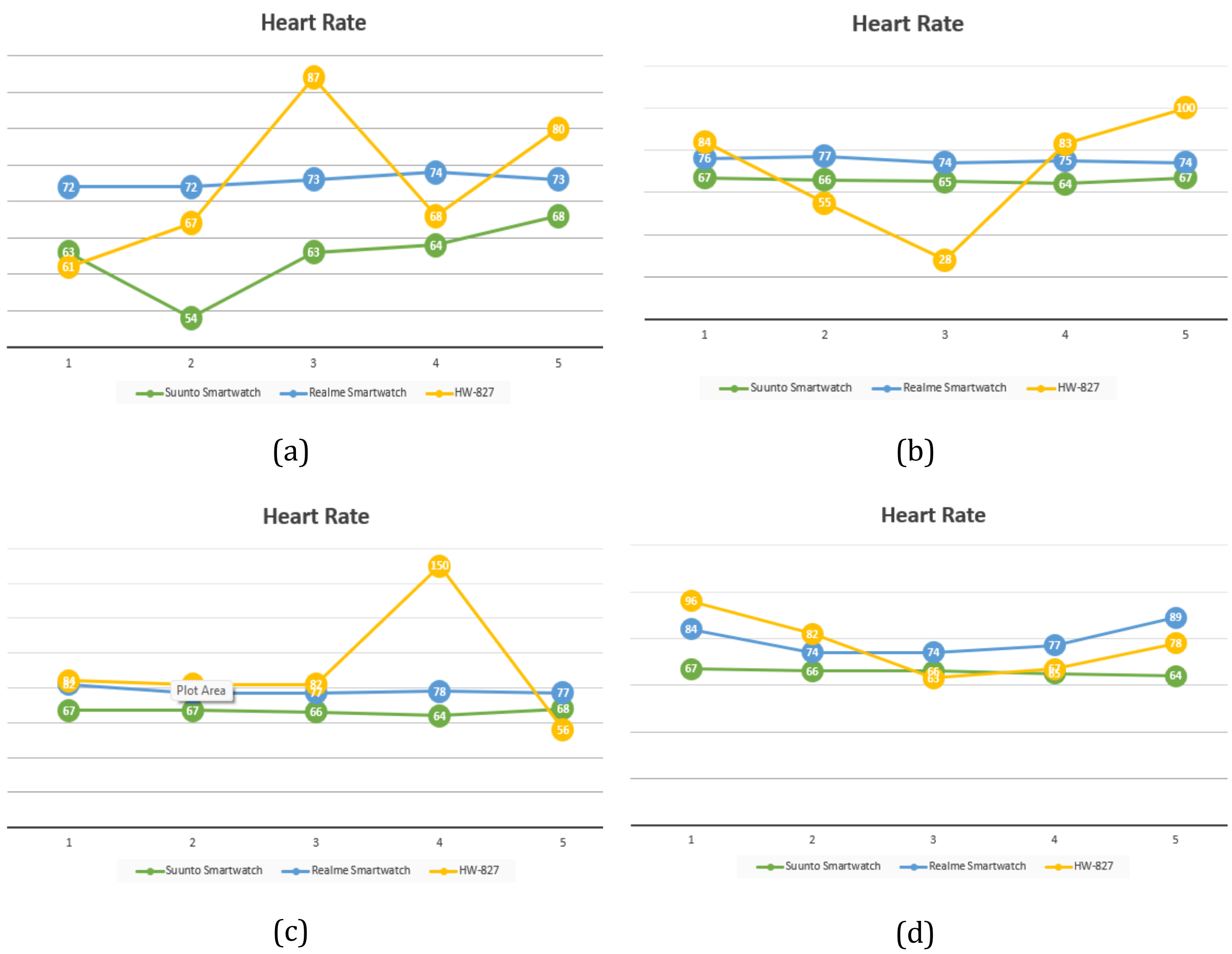


Fig. 6 *Comparison between three devices in (a) first trial, (b) second trial; (c) third trial;(d) fourth trial*

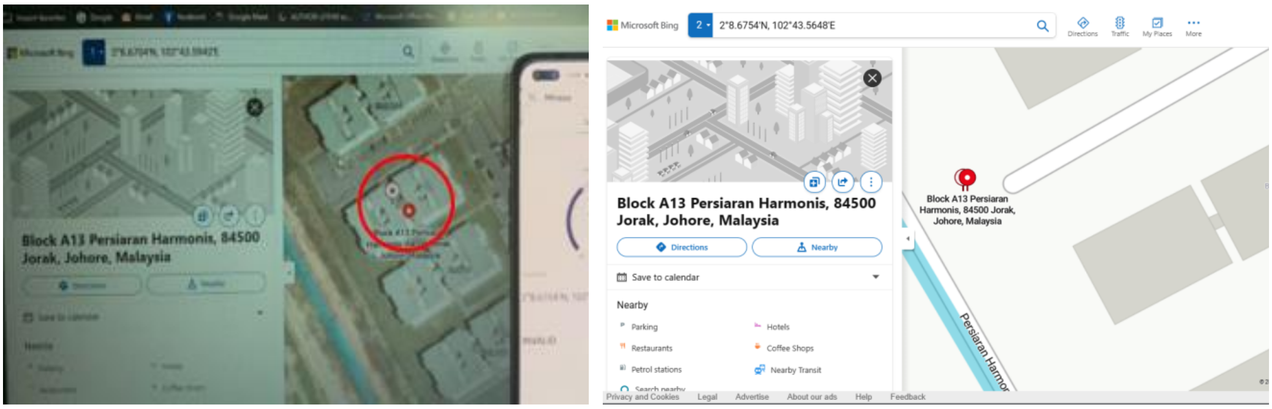
The comparison involves four trials, each with five recorded data points per minute and heart rate sensors placed in different locations. The resulting errors were compared between the armband heart rate (on the right arm) and the Suunto smartwatch (on the left-hand side), as well as between the armband heart rate and the Realme smartwatch. Both smartwatches (on the right-hand side) have different cost values. Figure 6 displays the comparison graph of heart rate data using the armband (HW0827), Suunto smartwatch, and Realme smartwatch.

Table 2 *Percentage error of the comparison between armband's heart rates*

Error %	Trial 1	Trial 2	Trial 3	Trial 4
Suunto vs armband	16.34	26.75	36.75	17.68
Realme vs armband	0.27	6.91	16.11	3.02

3.3 GPS Data and Analysis

The GPS data examination focuses on two categories: the pinned location from the GPS tracker's armband and the user's device as shown in Figure 7.



(a) (b)

Fig. 7 *Comparison of GPS tracker functionality between (a) Location pinned A; (b) Location pinned at B.*

These disparities highlight how environmental elements affect the accuracy of the GPS tracker of smart armband. The primary cause of this observed inaccuracy is signal interference from surroundings.

3.4 Discussion

Accurate readings need an understanding of the subtleties of heart rate sensor performance. While the GPS system in the prototype is functionally effective, due to environmental conditions, its precision is considerably lowered when compared to device GPS satellites. On the plus side, when activated, the emergency button successfully conveys alerts.In summary, the prototype's general functioning is adequate. However, more thorough examination, particularly of the heart rate sensor, is required for precise and dependable pulse data gathering. Continuous monitoring and fine-tuning are essential for optimizing the heart rate sensor's contribution to total data accuracy.

4. Conclusion

The development of a smart armband for the emergency button that is triggered by the push button was successfully developed. Through this project implementation, more information has been acquired, including hardware and software design. The combination of heart rate and user's tracking capabilities in smart armband considerably improves the user's ability to cultivate a thorough understanding of their health. In the process of developing the prototype, a carefully designed circuit diagram was created, accompanied by a detailed study of hardware installation to proactively address potential troubleshooting scenarios. This integrated approach promotes a proactive paradigm for health management by providing individuals with the tools and knowledge they need to make educated decisions about their health.

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