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Swimming Health Monitoring System with Heartbeat and Oxygen Sensor

Husna Madiha Azman[1], Rosli Omar[1]*

[1]Department of Electronic Engineering, Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400, Batu Pahat, Johor, Malaysia

*Corresponding Author Designation

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Abstract: Nowadays, Malaysia and the world has been facing with the increasing drowning cases in the pool, river and even the beach. Drowning cases are the world's third leading cause of accidental accident death and account for seven percent of all death related with the incidents, based on the World Health Organization (WHO). Drowning accidents are estimated at 320 000 deaths worldwide. Basically, drowning happens usually silently and only a few drowning people can wave or scream for help. There are many efforts to stop drowning cases, such as teaching diving, giving advice about how to prevent drowning, and making a protective drowning bracelet. Therefore, a project has been proposed to support a swimmer tracking with bracelet sensors. This project is about a bracelet development to detect the user immediately in case of drowning. The bracelet can also detect a missing victim's body location while it is drowning. The outcome of this project is to enable a person to gain extra protection while he or she is in outdoor place such as river, or beach. Last but foremost, this early stage drowning detection device bracelet will hopefully help to minimize the incident of drowning in a lake, river or sea.

Keywords: Drowning, Bracelet, Health Monitoring Applications

1. Introduction

The primary purpose of this Swimming Health Monitoring System with Heartbeat and Oxygen Sensor is to enable the public or consumer to gain an extra protection when they having a nice time in the swimming pool, river, or beach with their families. This bracelet is appropriate for all ages, young or old, as it detects the pulse oximeter and heart rate monitors automatically [1]. This bracelet uses the MAX30100 sensor to monitor or measure the molecules that carry oxygen in the blood, called hemoglobin, for pulse oximeter and heart rate detection [2]. The result of the verification on the MAX30100 sensor will be displayed on the OLED LCD.

As a primary feature of this device, the NodeMCU ESP8266 Wi-Fi & Bluetooth module was used. The NodeMCU ESP8266 Wi-Fi & Bluetooth module's purpose is to connect all swimming health

Corresponding author: roslio@uthm.edu.my

monitoring system components into a single system. Apart from that, this device utilizes a red led to alert those nearby to the victim's condition by turn on and off the led. Following that, the third user who has the application can monitor the oxygen level and blood pressure through the application. This health monitoring application will display two types of reading: one regarding the victim's condition, and another regarding the victim's latitude and longitude.

The device was developed together with a GPS module feature to determine the exact location. Additionally, this GPS module utilizes a firewall application to establish a connection between Google Maps and the health monitoring application. This device has also been used in safety rescue operations to assist rescue teams in locating missing victims and drowning bodies by creating longitude and latitude (maps) of the device tracking location using geographic information systems (GIS) and remote sensing technology.

2. Methodology

The development of Swimming Health Monitoring System required the integration of two critical components: hardware and software development. This section contains the overall process for this project, including a block diagram and flow chart. All the material and components' characteristics will be explained in this section.

2.1 Block Diagram

Figure 1 shows the block diagram of the device. It explains the working principle and the operation of this system. This device is using max30100 sensor as input which can integrate sensor solutions for pulse oximeters and heart rate monitors [3]. For the process, this device is using NodeMCU ESP8266 Wi-Fi & Bluetooth as a microcontroller and processor to access all the Wi-Fi & Bluetooth networking [4].

Finally, there are four outputs in this bracelet. First is the OLED screen, which can display the measurements from the max30100 sensor [5], the second is monitoring the oxygen level and a notification will be received by the third user who owns an application on any smartphone or device [6]. Third, the red LED will turn on and off if the oxygen level drops to 95%. Lastly, the output of this bracelet is GPS. GPS is a detection device that can also detect the missing victim's body while it is drowning.

Figure 1: Block Diagram Project.

2.2 System Flowchart

Figure 2 shows the flowchart of the bracelet. A process is represented by a rectangle, a diamond represents a decision, and a parallelogram represents an I/O process [7]. The flowchart shows that this project started the process by wearing an automatic pulse oximeter and heart rate monitor.

While wearing the bracelet, a notification will always be sent to the health monitoring applications about the person wearing the bracelet. The health monitoring applications will keep sending a message of the live latitude and longitude of the victim or swimmers. This will help the rescue team locate the victims of drowning bodies who are missing by using a GPS tracking bracelet. Lastly, if the OLED screen displays the body's oxygen level such as normal 100% - 98% or active 97% to 95% the bracelet will keep monitoring the oxygen level in our body [2].

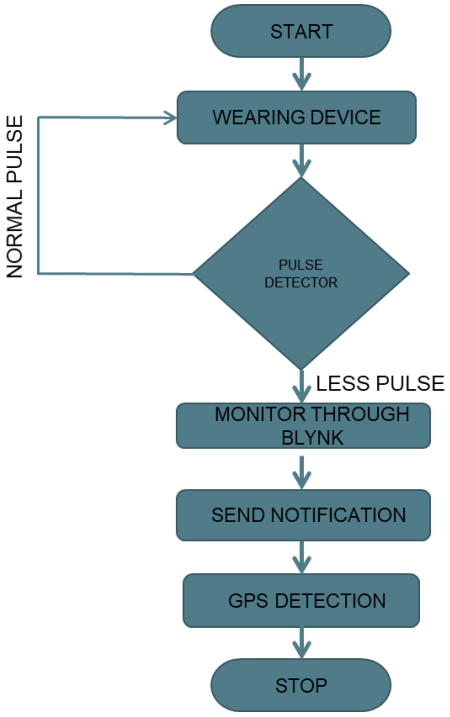


Figure 2: Flowchart Project

2.3 Circuit Diagram

Figure 3 shows the circuit diagram of the Swimming Health Monitoring System. It depicts the connection of the component parts in the device. First of all, the battery is connected to the ESP8266 Wi-Fi & Bluetooth to power up the circuit. Next, the MAX30100 sensor is connected to the OLED screen. Meanwhile, the OLED screen is connected to the ESP8266 Wi-Fi & Bluetooth. After that, the GPS module is connected to ESP8266 Wi-Fi & Bluetooth.

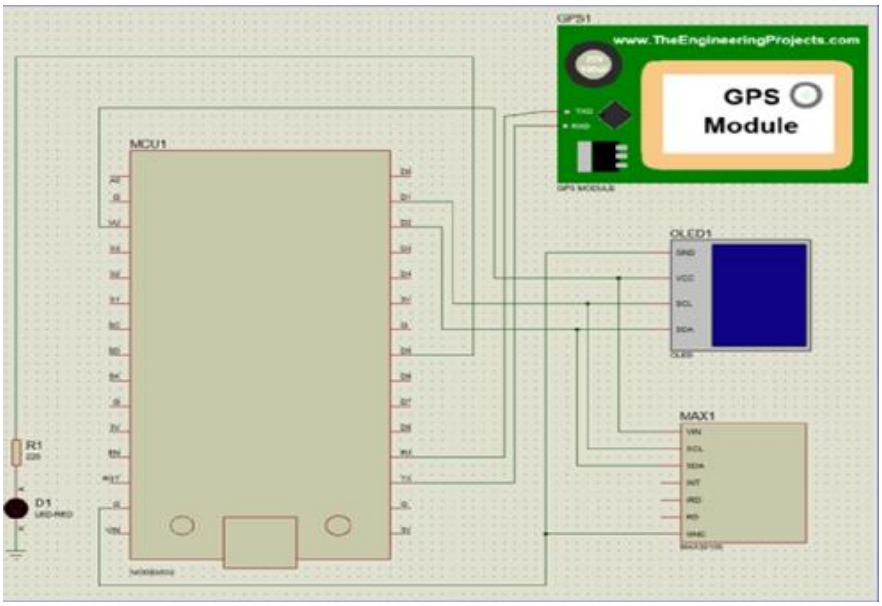


Figure 3: Schematic Circuit

2.4 Product Sketch

Figures 4,5,6 and 7 show the product sketch of the Swimming Health Monitoring System with Heartbeat and Oxygen Sensor. This design will illustrate how the casing will look to be used for the system. This drawing has been drawn in the SolidWorks software. From the front view, it will be fulfilled with an OLED screen, and from the side view, the red LED and charging port will be placed. On the back view, there is a MAX30100 sensor for detection function.

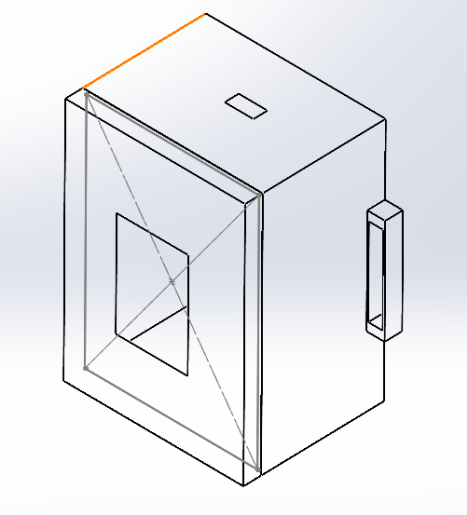


Figure 4: 3D view of the product

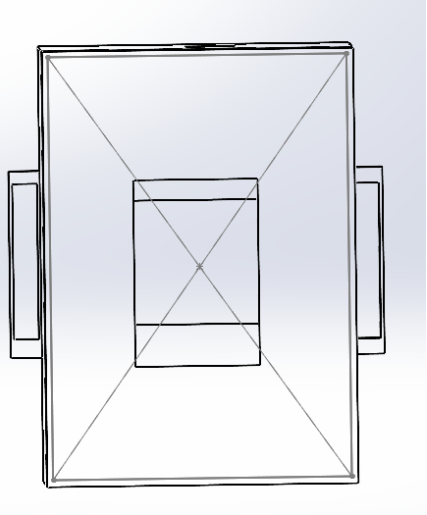


Figure 5: Front View

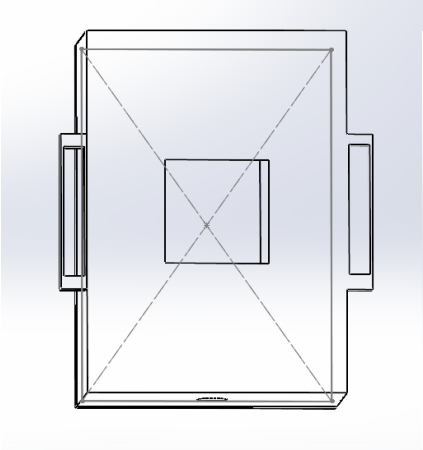


Figure 6: Back View

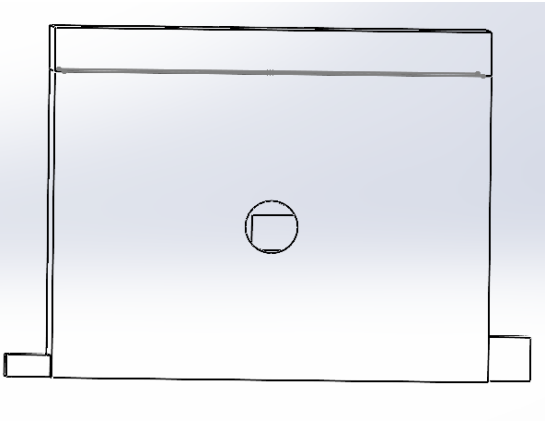


Figure 7: Side View

3. Results and Discussion

This section shows the result gained from this project. The results are then analyzed for the project's efficacy evaluation purpose. The project is tested in the laboratory to make sure that the system functions as expected for the overall process.

3.1 System Operation

Figure 8 is the basic representation of the Swimming Health Monitoring System, which is used to measure the heartbeat and oxygen levels of the human body. This bracelet also can monitor the user's device position with a GPS bracelet detector. For this purpose, this circuit uses a MAX30100 heart rate sensor, ESP8266 development board, NEO-6M GPS Module, and OLED display.

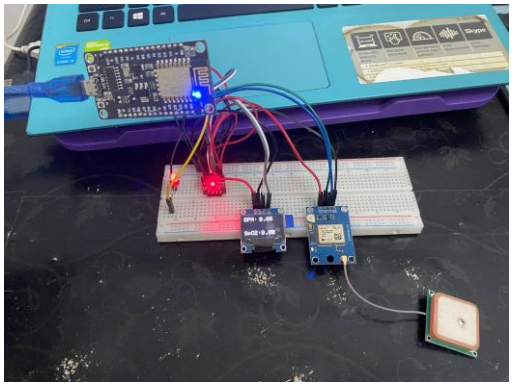


Figure 8: The basic representation of the circuit

3.2 Analysis Oxygen Level of Swimming Health Monitoring System

Referring Table 1, shows the comparison between the developed device and Fingertip Pulse Oximeter. The pulse oximeter is often worn on a fingertip. It calculates the pulse rate and blood oxygen saturation using laser beams. The amount of oxygen carried by the blood is revealed by oxygen saturation. Without taking a blood sample, the pulse oximeter can determine the amount of oxygen in the blood. The data was collected based on a different person and the same time taken to achieve the accuracy of the reading.

Table 1: Comparison of the system and Fingertip Pulse Oximeter.

	Oxygen Level Saturation			**Heartbeat**		
Dataset	**MAX30100**	**Fingertip Pulse Oximeter**	**Discrepancy Oxygen Level**	**MAX30100**	**Fingertip Pulse Oximeter**	**Discrepancy Heartbeat**
1	97	98	99.0	65.4	75	87.2
2	96	97	99.0	70.6	70	100.9
3	96	98	98.0	74.0	74	99.9
4	96	99	97.0	76.3	75	101.7
5	97	99	98.0	73.1	72	101.5
6	97	99	98.0	72.2	77	93.8
7	97	96	101.0	74.7	75	99.6
8	97	98	99.0	73.3	71	103.3
9	97	97	100.0	73.0	74	98.6
10	98	99	99.0	71.2	72	98.9
11	97	97	100.0	70.4	72	97.7
12	97	98	99.0	73.0	73	100.0
13	96	98	98.0	78.1	67	116.6
14	97	98	99.0	73.5	72	102.1
15	97	97	100.0	70.7	73	96.9

Table 1: Comparison of the system and Fingertip Pulse Oximeter (continued)

16	97	99	98.0	74.1	75	98.7
17	98	99	99.0	70.3	72	97.6
18	97	99	98.0	71.3	73	97.6
19	97	97	100.0	73.2	75	97.6
20	97	98	99.0	71.9	75	95.8
Average	**96.9**	**98**	**98.9**	**72.5**	**73.1**	**99.3**

From this comparison, it could be concluded that the Swimming Health Monitoring System is slightly accurate to the Fingertip Pulse Oximeter system as the commercial that has been available in the market for quite some time. The overall Discrepancy of Oxygen Level is 98.9% which means it stays at the same level throughout the Dataset value. The overall Discrepancy of Heart Beat is 99.3% which means it remains stable for the heartbeat. The graph in Figure 9 shows the Oxygen Level versus the Dataset that demonstrates that the reading value of MAX30100 from the system have fluctuation with the Fingertip Pulse Oximeter. The graph in Figure 10 is the Heart Beat versus Dataset that displays the reading value of MAX30100 from the system that is in agreement with the Fingertip Pulse Oximeter.

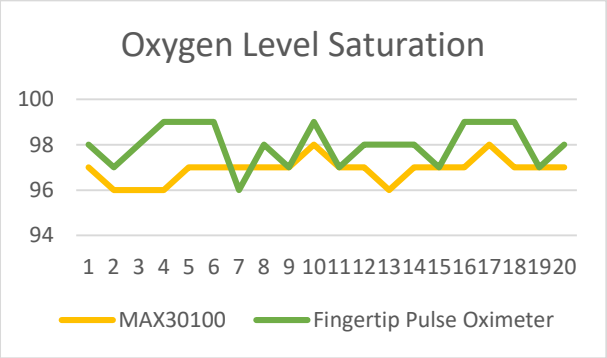


Figure 9: Oxygen Level versus Dataset

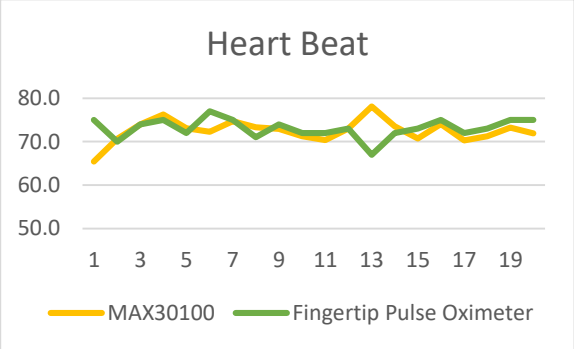
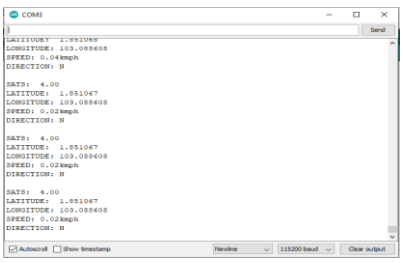
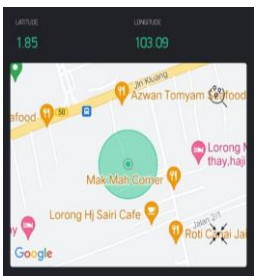


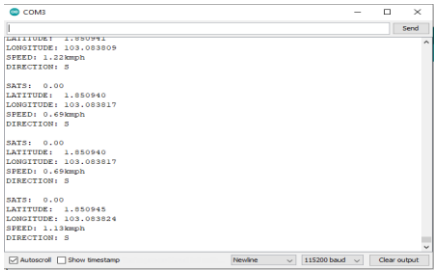
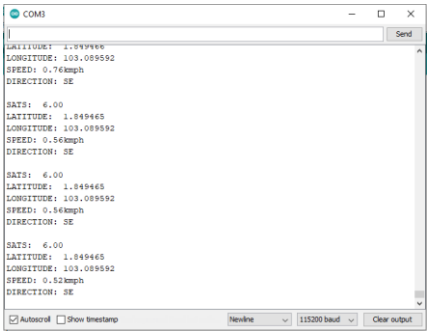
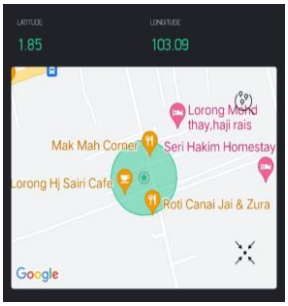
Figure 10: Heart Beat versus Dataset

3.2 Analysis GPS Tracking of Swimming Health Monitoring System

Referring to Table 2, the location of GPS will appear as the live latitude and longitude when the device was near the health monitoring applications. The GPS location will always appear as long as it is close to the Wi-Fi connection.

Table 2: Coordinate of Live Latitude and Longitude

Distance of location from checkpoint	Coordinate of Location shown in Serial Monitor	Coordinate Display at Blynk Application
Parit Haji Rais 0 m		

Parit Jelutong 850 m		
Parit Haji Abdul Kadir 1 Km		

3.3 Analysis Blynk Application of Swimming Health Monitoring System

Referring to Figure 11, this system displays the overall reading from heartbeat (BPM) and Oxygen Level (SPO2) in the Gauge feature and also in Value Display. While for the GPS, it will always show the live latitude and longitude in Value Display and MAPS feature. The device; is named Pulse Oximeter layout as shown in the system.

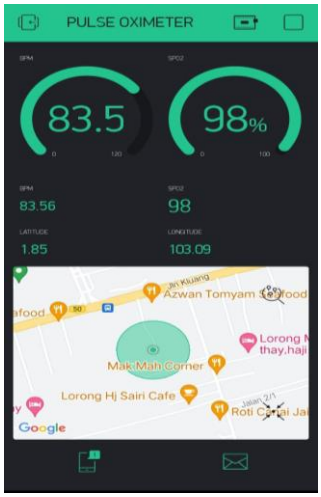


Figure 11: Monitoring the value from Blynk Application.

3.4 Overall Swimming Health Monitoring System

Figures 12 and 13 show the overall system of Swimming Health Monitoring System connect to Blynk Application. The reading of oxygen level, heartbeat, and GPS Navigation will be shown on the Blynk Apps

Figure 12: Overall system

Figure 13: System connect to Blynk Apps

4. Conclusion

As a conclusion, this project is focused on developing the Early Stage Drowning Detection Device in order to increase the user's sense of security and comfort when interacting with these devices. This device can be upgraded to include a buzzer function, allowing other people in close proximity to the victim to hear the sound. Second, redesign the shape of the prototype of the device to resemble a watch and can give notifications through social media such as Twitter, and Email.

Acknowledgement

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References

[1] Maxim Integrated, "Pulse Oximeter and Heart-Rate Sensor IC for Wearable Health/MAX30100," Electronic Components Datasheet Search, Dec. 2010 [Revised April.2022].

[2] Medicine Net, "Hemoglobin: Norma, High, Low Level and Causes," Hemoglobin Centre, Charles Patrick Davis MD, PHD. July 2019. [Online]. Available: https://www.medicinenet.com/hemoglobin/article.htm [Accessed: August. 12,2020].

[3] WHO, "Drowning," Newsroom Website, April 27, 2021. [Online], Available: https://www.who.int/news-room/fact-sheets/detail/drowning. [Accessed April. 8, 2022].

[4] Component 101, "NodeMCU ESP8266," Components Datasheet Search, April. 2019 [Revised August 2020].

[5] Vishay, "128 x 64 Graphic OLED." Components Datasheet Search. Dec 2016 [Revised August 2020].

[6] Vishay, "128 x 64 Graphic OLED." Components Datasheet Search. Dec 2016 [Revised August 2020].

[7] Lucidchart, "What is a Flowchart," lucidchart.com, [Online]. https://www.lucidchart.com/what-is-a-flowchart-tutorial. [Accessed October. 3, 2020].