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Design of Home-Based Heart Monitoring System Using Electrocardiogram (ECG)

Thamendaran Gunaratnam[1], Nur Ilyani Ramli[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA.

*Corresponding Author Designation

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Abstract: Rapid development of technology in current era has been very important in achieving balance in healthy lifestyle. With the constant evolution on technological development the possibilities in having the advanced, affordable, and accessible medical devices are easier than usual. This development provides challenges and opportunity to healthcare providers to manage patient remotely. In this project, a heart rate monitoring system using a Nodemcu microcontroller and an AD8232 sensor is developed and connected to the IoT platform of Ubidots. The AD8232 sensor is used to detect the electrical activity of the heart and convert it into a readable analog signal. The Nodemcu is then used to read this signal and send it to the Ubidots IoT platform, where the data can be visualized and analyzed in real-time. The system allows for remote monitoring of heart rate and can be useful in various applications such as monitoring the health of patients with cardiac conditions. The aim is to create system for monitoring the heart signal and activities to identify how healthy the heart is. The project is done by testing volunteers who have different health rate and tested with the activities done before taking the reading on the ECG. The results visualize the ECG reading of the subject to the IoT platform and the condition of the heart can be interpreted by specialist.

Keywords: Ubidots, ECG Signal, Real Time Monitoring

1. Introduction

The past two decades, the numbers of heart disease remain to be the main cause of death among Malaysians This statement is supported strongly by the Ministry of Health, that Malaysia is not a healthy country based on the public awareness of the health aspects, which is still at a low level while the heart disease and obesity rates are relatively high [1]. Ischemia is a condition of in which blood flow is partially blocked or restricted from being flowed. Cardiac ischemia is the name for decreased blood flow and oxygen to the heart muscle [2]. The heart arteries are narrowed thus this makes the flow of usual amount of blood and oxygen harder thus subsequently the heart muscles do not function in the normal rate The rate of death differs based on sex, race and even stratum that has been dominated by ischemic heart diseases.

*Corresponding author: ilyani@uthm.edu.my

This project is important and could save a patient's life with early detection from any fatality [3]. Inspecting patients on a regular basis is vital for their safety. Compared to the physical inspection, wireless monitoring offers continuous observation, reduced costs, and increased security. The aim of the project is mainly to create a working prototype to trace the activities of the heart and process the output to display in mobile phone. This project has high objectives to design and develop heart monitoring system with suitable sensing, processing, and displaying unit. This home-based heart monitoring system is designed for a specific group of people who suffer from cardiac problems and, more critically, for patients who have a history of heart problems. This prototype should be quite effective. It may function alone in a household setting. As a result, this device can truly benefit patients by allowing them to receive appropriate care in the comfort of their own homes.

2. Materials and Methods

In this section, there are two stages that leads to the project's completion by understanding each software and hardware function. In this project to achieve the proposed objective to design a heart monitoring system that mainly focuses different weight category subjects. To design a method of system in sensing, processing, and displaying unit should work well simultaneously. The heart electrical activities sensor output is digital, and it can be integrated with any of the digital pin from the Nodemcu. This provides the communication from sensor to Nodemcu. Ubidots software is used to communicate with Nodemcu as it sends the data to phone so that the patient can keep track of the data. The ESP8266 board has certain selected pin for transmission and receive data for the Ubidots communication.

2.1 Block Diagram

The main criteria in most of the projects are inputs, control unit and outputs. The input of this project is ECG AD8232 sensor, control unit is Wi-Fi module ESP8266, and output is data from the microcontroller unit that is processed as a display on the phone. Figure 1 shows the block diagram of the project.

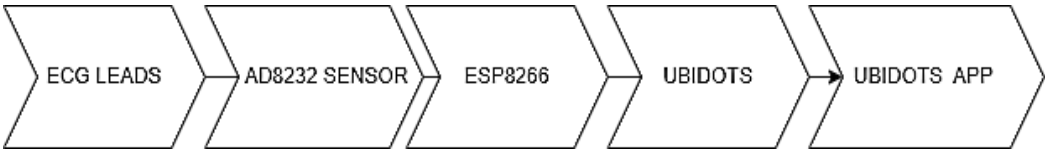

Figure 1: Block Diagram of Project

2.2 Methods

The objective of this project is to design a heart monitoring system that mainly focuses different weight category subjects. The design system in sensing, processing, and displaying unit should work well simultaneously. The heart electrical activities sensor output is digital so that it can be directly integrated with any of the digital pin from the Nodemcu. This provides the communication from sensor to Nodemcu. Ubidots software is used to communicate with Nodemcu as it sends the data to phone so that the patient can keep track of the data. The ESP8266 board has certain selected pin for transmission and receive data for the Ubidots communication. Figure 2 shows the process flow of the system development.

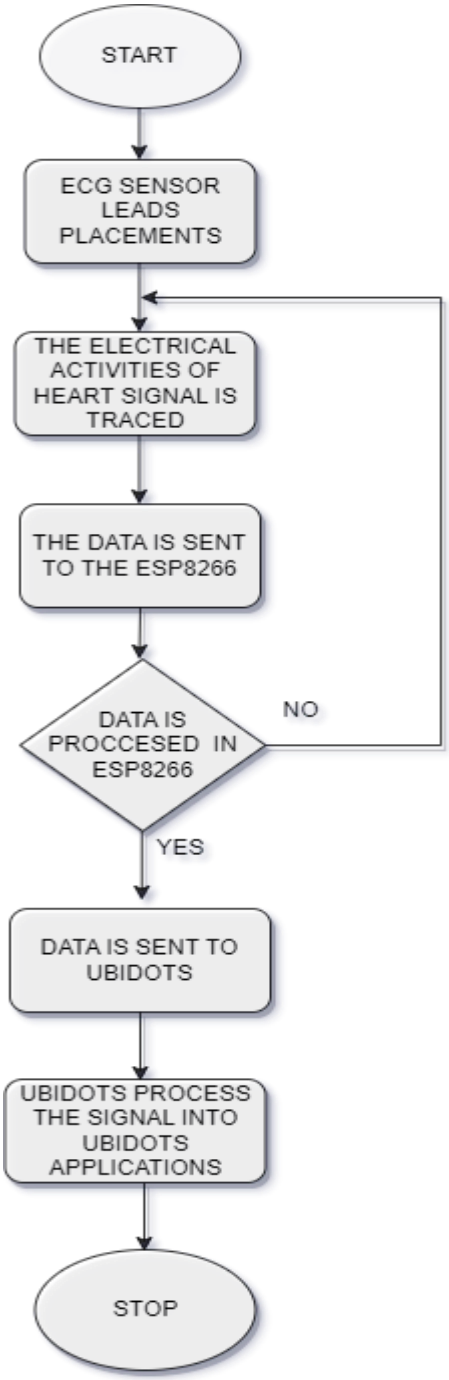

Figure 2: The Process Flow

3. Results and Discussion

The results derive on how the project is designed and provides the results of the output from AD8232 sensor and ECG signal analysis that is sent to the IoT platform. The data is sent to the IoT platform to make sure the patient or subject can get their heart rate checked at home and the data is sent to an IoT platform so that the doctors can also have an assessment on the persons heart rate. This also shows the initial circuit connection of the project.

3.1 Results

The AD8232 sensor has nine connections from the IC that can solder pins, wires or other connectors to the input of LO+, LO-, OUTPUT, SDN 3.3V and GND. These are the essential pins in operating this

monitor with the Nodemcu ESP8266 microcontroller in transmitting and receiving the data. There are 5 general pins that needs to be connected to the microcontroller. The output is connected to analog A0 of Nodemcu while the LO= AND LO+ PIN is connected to pin D6 and D5, respectively. The supply is connected to 3.3v to VCC and grounded each other. Figure 3 shows the prototype of the project.

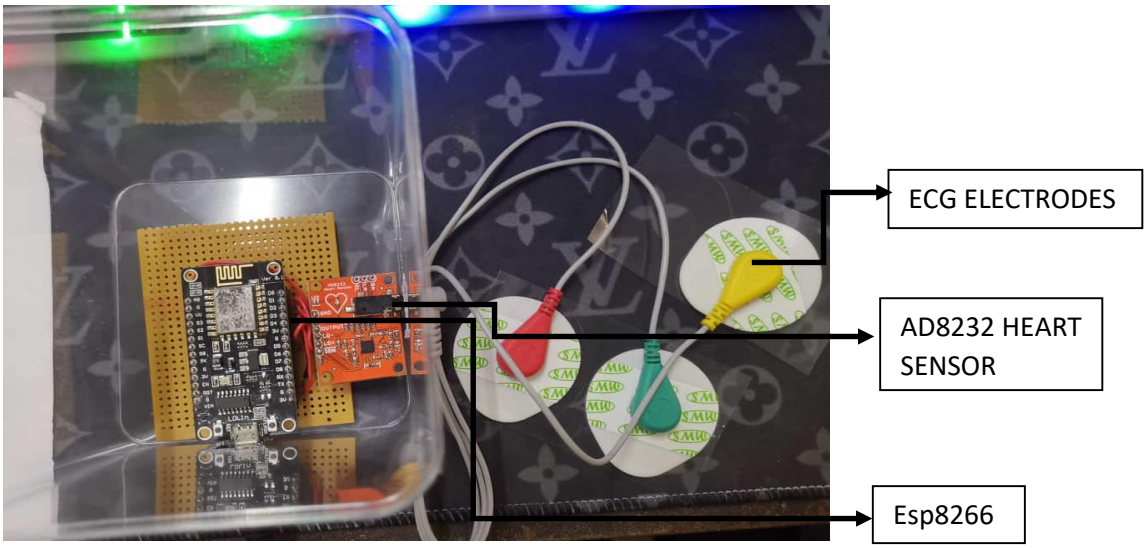

Figure 3: Prototype of Project

As shown in Figure 4, the data is published into the Ubidots, and it is viewed in serial monitor once the MQTT connection is secured and connects successfully.

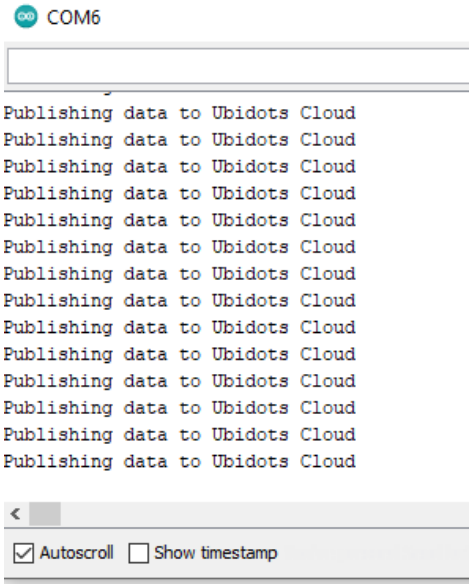

Figure 4: The publishing of data into Ubidots

Here the R-peak is identified as the peak of each cycle in ECG signal, as shown in Figure 5. The wave of QRS complex range can be determined from the first trigger point before the R-peak until the next trigger point after the R-peak locates the T wave and S wave are located at the peaks prior and after the QRS complex.

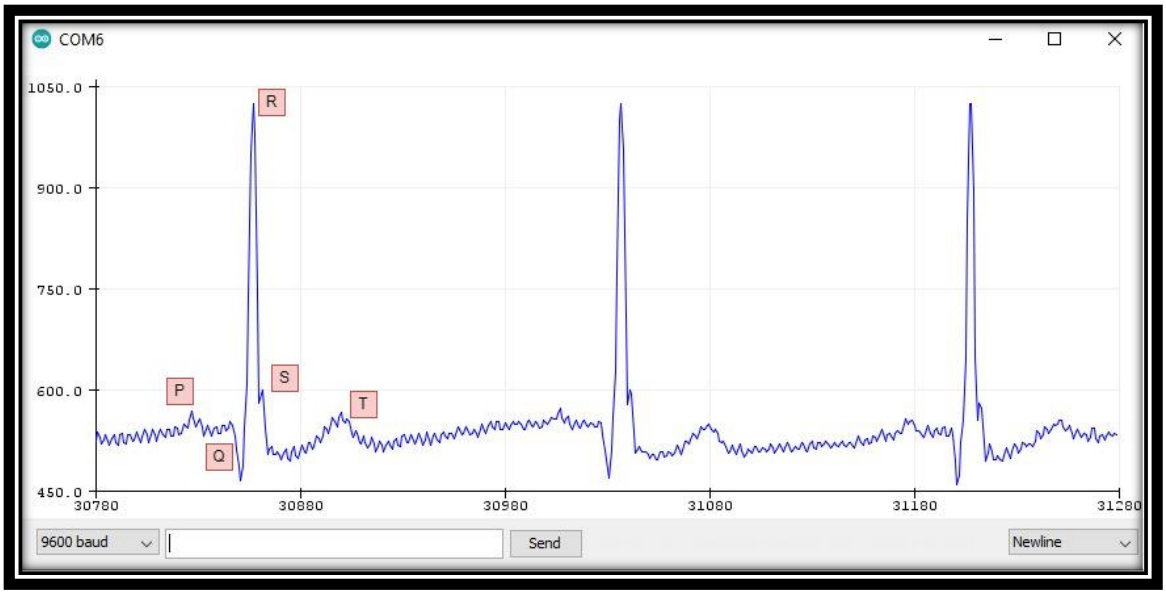

Figure 5: The signal in serial monitor

Real-time data refers to information that is received, processed, and presented to the user in a way that allows them to respond to it immediately. In other words, the data is updated and displayed as soon as it becomes available, rather than being delayed or presented in batch form. The information taken after reading the heart signals can be seen in the dashboard of ubidots as shown in Figure 6. The data taken from the sensor is transmitted to Ubidots and data can also be extracted in Excel. The dashboard of Ubidots helps to show the signals created from subject 1 heart signal as shown in Figure 6 and the waves of P, Q, R, S and T in normal steady state position.

Figure 6: Dashboard of Ubidots

Interpreting the data is important that it involves looking at the different waves of P, Q, R, S and T on the ECG tracing and understanding what they represent. It can also show if the heart is beating to slow or, too fast or irregularly. The data is analyzed between three different subjects which represents a healthy person who often exercises and maintains a healthy lifestyle, while the second subject represents an obesity person who seldom exercises and has an unbalanced diet. The third subject represents the lifestyle of a chain-smoker and does not maintain a balanced diet. The data is recorded in 1 minute span and read the average R value. The experiment is repeated for 3 times to get the best

average reading for the R peak values. The reading of the ECG signals is validated with a pulse oximeter to show the readings are interconnected to the ECG signal readings. The R peak value works in sync as it raises or drops thus the BPM value also shows the reading differs. The unit measured from the device tends to be in hertz as it reads the electrical signals of the heart. Table 1 shows the comparison of data from 3 different subjects.

Table 1: The comparison of data from 3 different subjects with the value of average R peak signal and the beats per minute

Subject	Weight	Resting Mode	BPM	Exercising Mode	BPM
1	77.5 KG	653	55	730	126
2	131.51 KG	766	85	874	153
3	68.6 KG	631	79	822	147

The graph shows the reading of ECG signal in a 1-minute span of subject 1 during resting mode. Figure 7 shows the recorded data is interpret in a graph form for better understanding and the get the R peak value. The graph demonstrates the resting ECG of the subject, and the highest peak value is at 653. The y axis of the graph the value of the ECG signals in hertz while the x axis interprets the time taken in milliseconds.

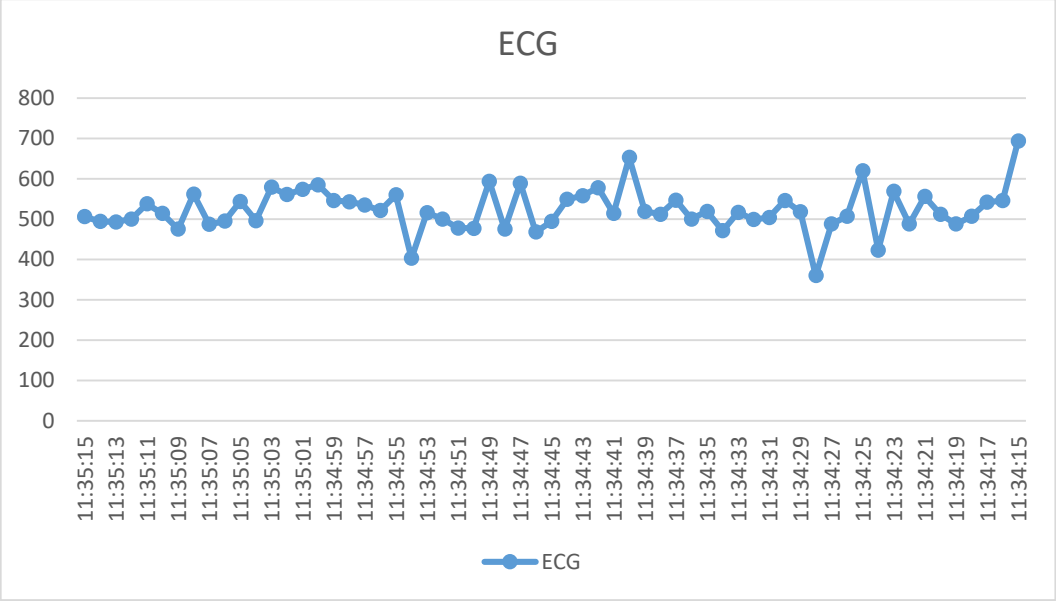

Figure 7: reading of subject 1 during resting

4. Conclusion

As a conclusion of the project, the implementation of the heart sensor and Nodemcu works efficiently based on the objective of the project. At the end of this project, a system design can be done for monitoring the electrical system of the heart using the AD8232 heart sensor. The data that has been collected from the results shows the existence of heart signals of the subject during resting mode and exercise mode by the wave of P, Q, R, S and T wave. On the other hand, the processing unit is developed successfully by collecting and processing the data of the heart signal activities. The data is successfully collected and sent to the microcontroller of ESP8266. It is also then sent to the IoT platform to keep track of the data plus has options to work on the real time monitoring. The prototype works by the sensing unit of ECG leads and heart sensor of AD8232 is then sent to microcontroller to conduct the processing method. The processed data is then sent to the IoT platform so that patient could monitor

the electrical activities in real time. The subject characteristics plays a main role in determining the ECG signals. A healthy subject reflects a normal reading based on the activities done.

Acknowledgement

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