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Monitoring Heart Condition of the Patient with ECG Sensor

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Abstract: This work is about heart rate monitoring system which can give immediate response to patient suffer for heart disease in their own house and have time for them to refer their disease in a hospital. Mostly, that there is no early detection for heart disease patients that could save their lives if normal heartbeat and an abnormal heartbeat can be compared. An abnormal ECG can signal a medical emergency, such as a myocardial infarction heart attack or a dangerous arrhythmia. Next, the heart patients cannot go to the hospital on their own. In most cases, the symptom will begin slowly, however sometimes the symptoms can be sudden and intense. Electrocardiogram is a famous heart rate monitoring machine in many public or private hospital with its ability to measure and record vital sign of heart patient clearly and continuous. The system is about self-monitoring and using an AD8232 sensor to monitor electrocardiography (ECG) signals. ECG is a non-invasive method of measuring the electrical activity of the heart and is widely used in medical settings for diagnosis and treatment of cardiovascular diseases. The AD8232 is a low-cost, single-lead ECG sensor that can be easily integrated into wearable or portable devices for continuous monitoring of ECG signals. With the help of Ad8232 sensor and Arduino UNO, it can measure heart rate and Electrocardiogram and analyze it with help of Excel data streamer and MATLAB. The sensor data display the result in ECG graph and in beats per minute (BPM) and display it to the TFT LCD. The recorded ECG signals are analyzed using standard techniques such as filtering, peak detection, and heart rate calculation. The results demonstrate the feasibility of using an AD8232 sensor for continuous, real-time monitoring of ECG signals, and highlight the potential of this approach for applications in telemedicine and remote healthcare.

Keywords: Electrocardiography Sensor, Healthcare, Arduino Board

1. Introduction

Our heart is the most vital organ in the human body since it pumps continuously from the moment when people are born and continues to beat even when the body are at resting time. In fact, during our

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lives, our hearts pump roughly a million barrels of blood. As a result, the heart functions as the human body's engine. If something goes wrong with the heart, it will affect all the other organs as well.

In Malaysia, the prevalence of heart disease is on the rise. What used to be a senior citizen's sickness is now being noticed much earlier. Heart attacks are becoming more common among Malaysians in their 20s and 30s. In Malaysia, heart disease is still the leading cause of death. Almost one out of every four deaths have fewer options for choosing the most efficient and reliable methods [1]. Therefore, the current problem in Malaysia is the need for appropriate and practical strategies. ECG (electrocardiography) is a method of collecting electrical signals generated by the heart. An ECG is a paper or digital recording of the electrical signals in the heart. It is also called an electrocardiogram or an EKG. The ECG is used to determine heart rate, heart rhythm, and other information regarding the heart's condition [2]. It is used to diagnose a variety of heart conditions and can detect abnormal heart rhythms (arrhythmias), damage to the heart from a previous heart attack (myocardial infarction), and other problems with the heart. The test is usually performed by attaching electrodes to the chest, arms, and legs and then measuring the electrical signals produced by the heart as it beats. The results are usually interpreted by a healthcare provider or a specialist in cardiology.

2. Methodology

The phases included in this study are the input sensor, the processor, and the output. Basically, the input of this system is ECG sensor (AD8323), the control unit is Arduino UNO, and the output is MATLAB, Excel, and LCD OLED display. The waveform was analyzed and collected in real time data for an Electrocardiogram of the patient. Figure 1 shows the block diagram of the system.

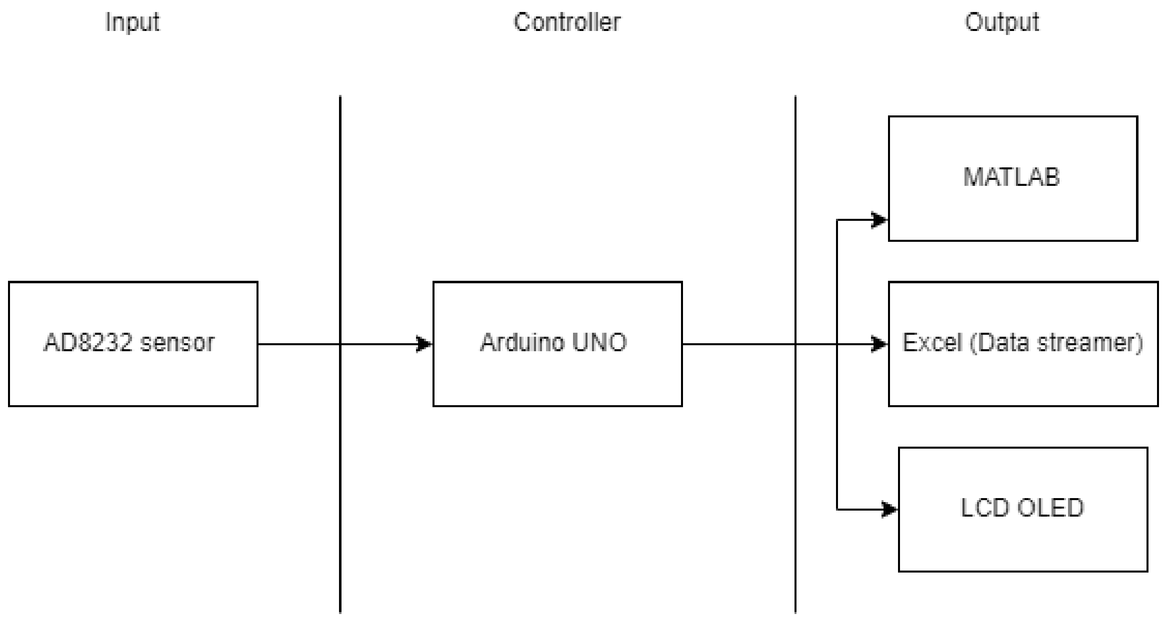

Figure 1: The Block diagram for the proposed system

Firstly, from the block diagram show a subject paired with a pin from ECG cable to their chest to measure a subject heartrate. The hardware that been choose is 3 pin ECG cable and ECG sensor that shown in a Figure 2. From that the ECG waveform transfer to the Arduino IDE. Arduino IDE reads an ECG waveform and stores it to the data streamer in excel in real time data. The ECG waveform filter and R-R peak will be analyzed to find a person heartrate. The normal heartrate for a normal person is 60-100 bpm. Lastly the data been shown, and the person can know their heartrate whether normal or not.

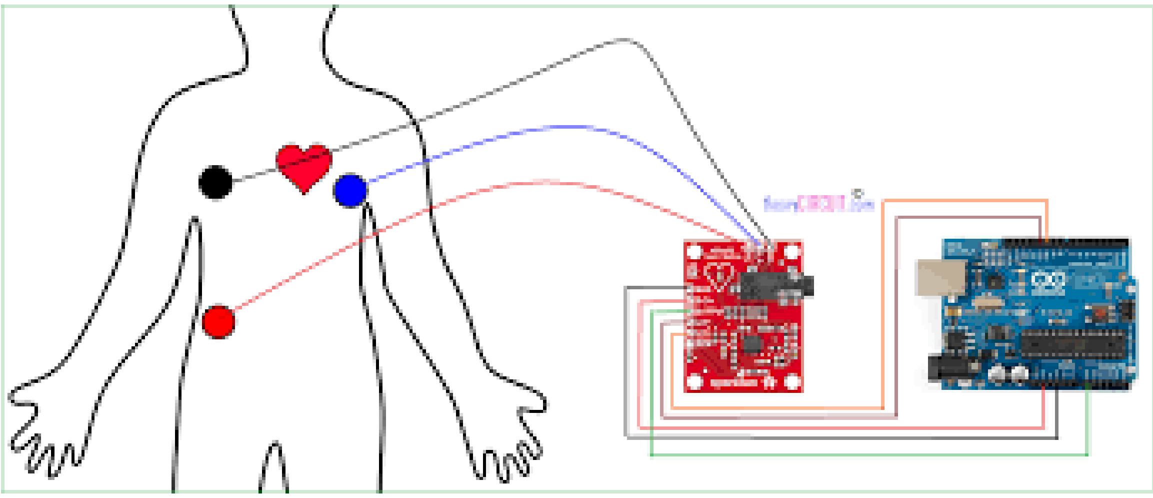

Figure 2: AD8232 lead placed at the body.

2.1 Application of software

In this work, the data collected in a data streamer is in Excel software. In Microsoft Excel, a data streamer is a type of data connection that allows you to retrieve and update data in real-time from an external data source. Data streamers in Excel are to connect to a variety of data sources, including databases, web services, and other data feeds. The other software that has been used is MATLAB software to differentiate a normal ECG with an abnormal ECG. The data obtained for an abnormal ECG was found on a Physionet website. Physio Net is a resource for accessing and analyzing physiological data, including electrocardiography (ECG) signals, blood pressure measurements, and other types of physiological data.

2.2 Hardware Design

This study aims to evaluate the performance of design monitoring systems using the software. The effectiveness of the implementation of this device was analyzed and proven using the Arduino IDE software, Excel, and MATLAB software. The system receives the input and then transmits the data to the main processing unit. The obtained data is subsequently analyzed by the Arduino UNO and displayed data streamer in EXCEL. The Arduino IDE software is widely used in monitoring systems for an Arduino UNO board. The applications were generally user-friendly, comprehensive, and open-source software. The researchers then display the data using the Data streamer and the ECG waveform will be analyzed.

2.3 Flowchart of the system

A thorough review of the literature was conducted to identify the elements, types of parameters used, platforms used, and system design by other researchers This algorithm is to show the proposed detection system runs and working. The algorithm starts with initialization which is to diagnostic tests are run and the operating system is loaded. Then, it will continue with ECG sensor analyze the ECG waveform from the subject. Next, it will go through Processing data. The data will process in an Arduino IDE software. Next the data will go to data streamer to be analyzed and store.

The workflow of the system is illustrated in Figure 3. Installing the hardware is the first step. Then, the device system must establish a connection with the Data streamer application to commence operating to analyze the ECG data. After the testing method had been completed successfully, the Excel and MATLAB platform had to be configured to ensure that all parameter data would be shown in the form. After recognizing the ECG data in MATLAB and Excel platform the ECG machine will read a heart rate for a patient and the heart rate must be at average 50 to 100 for a healthy heart. Figure 4 shows a schematic diagram for a sensor to work. In this unit consists of Arduino UNO as a Microcontroller, ECG sensor as a transducer and 3 pins ECG cable to attach at a human chest and lastly TFT LCD to monitor an ECG and BPM of heart failure patient. These components function to detect a human Electrocardiogram waveform. First, the Arduino UNO is to process the data from the sensor. Then the ECG sensor will detect the ECG waveform from a human heart

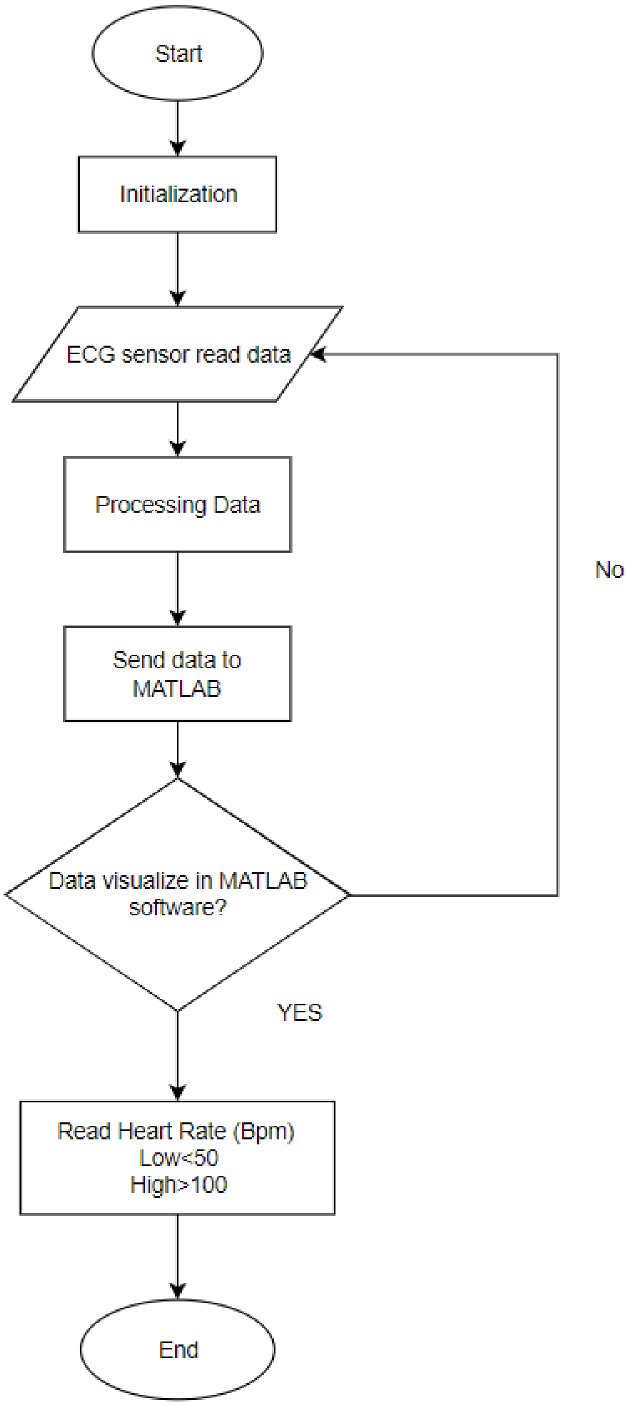

Figure 3: The workflow of the system

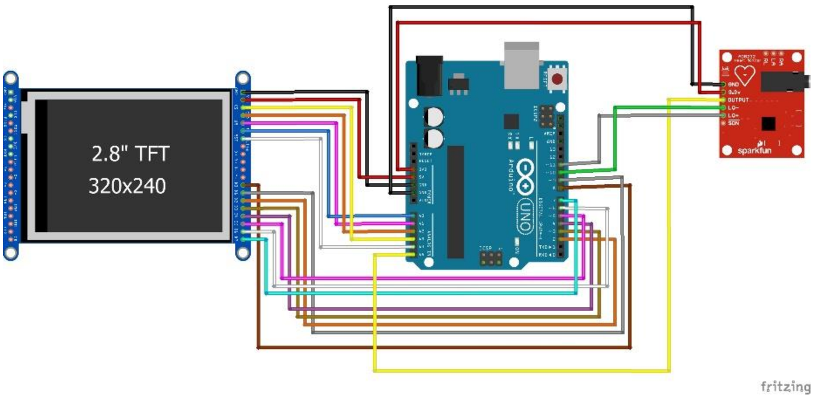

Figure 4: Schematic diagram

3. Results and Discussion

The data obtained by monitoring the heart condition of a healthy boy with a height 170 and weight 78 to do a resting state and running condition. Basically, the stress test is testing for an ECG. A stress test ECG [3], also known as an exercise stress test or treadmill test, is a diagnostic test that assesses how well the heart functions during physical activity. The test is typically performed on a treadmill or stationary bike, and the patient's heart rate, blood pressure, and ECG are monitored while they exercise. The test is used to diagnose and evaluate cardiovascular conditions such as coronary artery disease, heart failure, and arrhythmias, and to determine a safe level of exercise for patients with known heart problems.

The wearable prototype is developed as shown in Figure 5. This prototype is used to monitor an Electrocardiogram and pulse rate of a subject during rest and exercise. Figure 6 shows a subject that has been testing their heartbeat. One hundred data are collected for each subject for both rest and exercise condition. This reading is recorded in the data streamer to be analyzed.

Figure 5: Wearable prototype

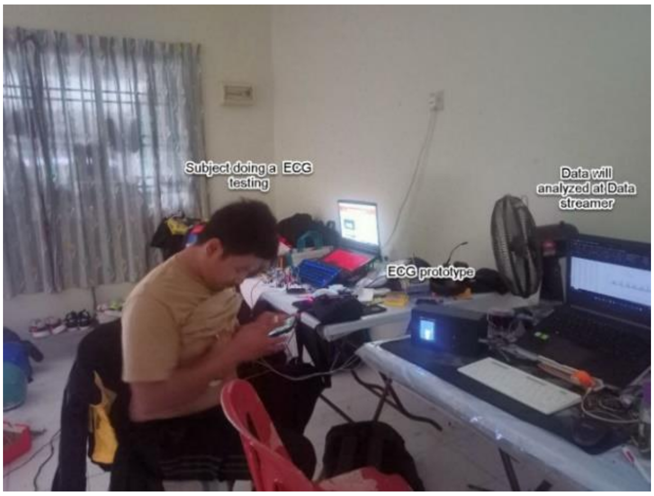

Figure 6: Subject test for a prototype

A normal ECG for a healthy individual typically shows a consistent and regular rhythm, with the P wave preceding each QRS complex and the T wave following. The P wave represents the electrical activity of the atria, the QRS complex represents the electrical activity of the ventricles, and the T wave represents the ventricular repolarization. The duration of each of these waves, as well as the intervals between them, should be within normal ranges. The normal heart rate for an adult at rest is 60-100 beats per minute[4]. Figure 7 shows an ECG resting condition of a heartbeat.

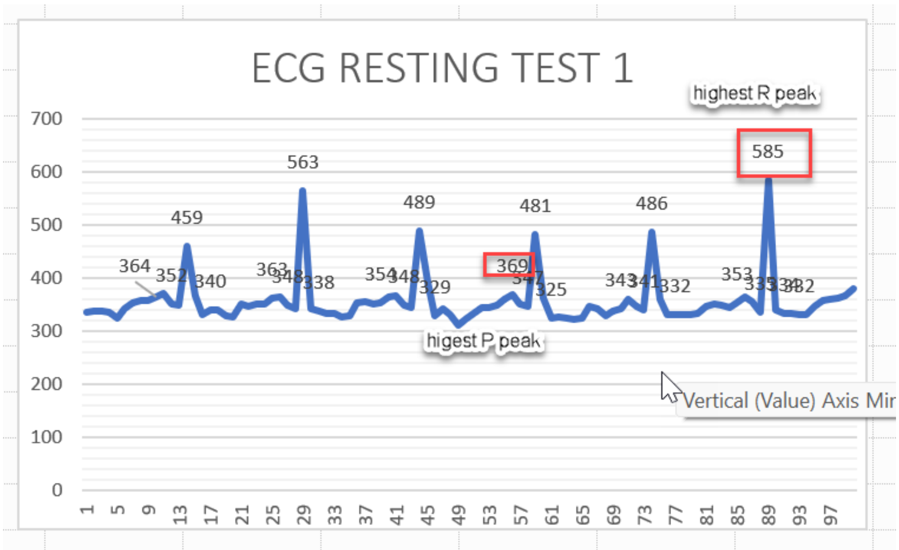

Figure 7: ECG resting condition

During running, the ECG of a healthy individual may show a slight increase in heart rate, as the body demands more oxygen and blood to be delivered to the muscles. The QRS complex and T wave may also appear slightly different than they do at rest, as the increased blood flow and demand on the heart can affect the electrical activity of the ventricles [5]. Figure 8 shows a running condition of a heartbeat.

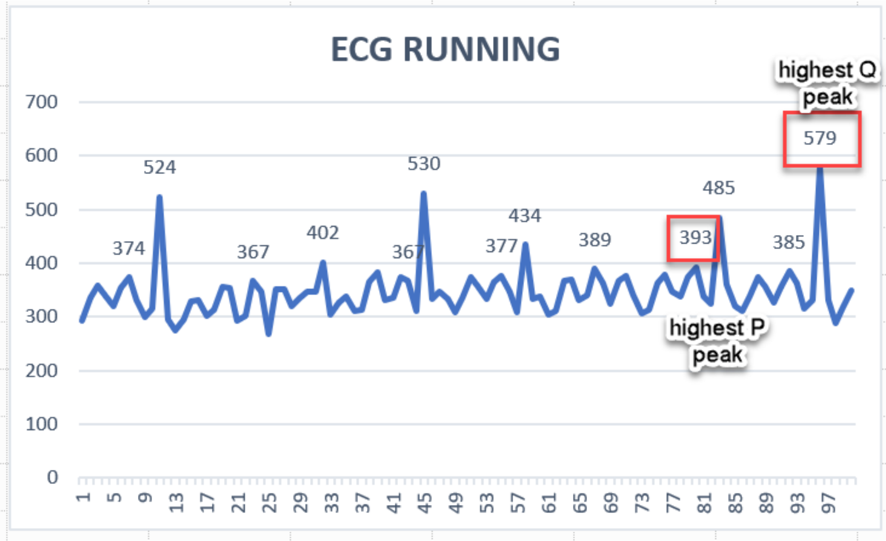

Figure 8: The running condition

Figure 9 shows a comparison between a resting and running condition for a healthy ECG. An ECG at rest in a healthy individual should show a consistent and regular rhythm with a heart rate of 60-100 beats per minute, normal duration and intervals between waves, normal axis and voltage. An ECG during running in a healthy individual may show an increase in heart rate and slight changes in the QRS and T waves due to increased blood flow and demand on the heart, but the P-Q and P-R intervals should remain consistent and there should be no significant ST-segment or T-wave changes or arrhythmias. It's important to note that individual factors such as training status, age, and medical history can affect the results, and a cardiologist should always evaluate the results in the context of a patient's overall health and any known cardiovascular conditions.

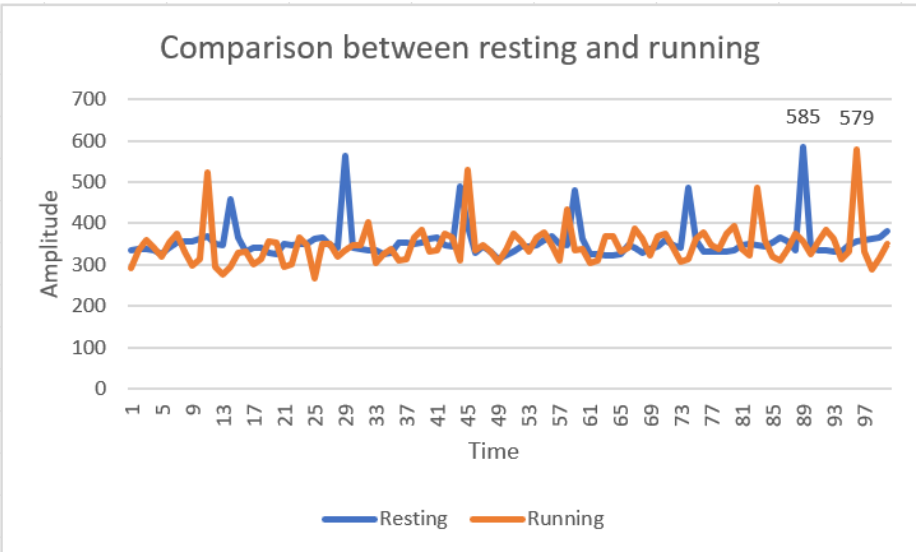

Figure 9: The comparison between resting and running

Figure 10 shows a comparison of Normal ECG versus Abnormal ECG. The orange graph represents a abnormal graph of ECG that has been analyzed by a physionet website and the blue graph is a normal ECG graph that been collected from ECG prototype. From the figure shown a abnormal data are shows a amplitude of ECG at too low and too high. It is because In heart failure, the heart's ability to pump blood is decreased, which can cause changes in the electrical activity of the heart and affect the amplitude of the ECG reading

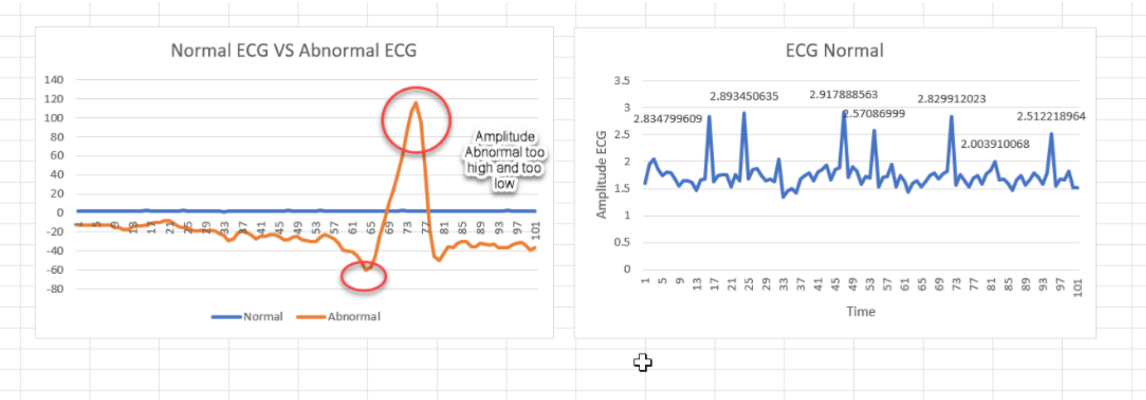

Figure 10: Graph comparing of abnormal ECG and normal ECG

The developed system that uses an AD8232 sensor and Arduino for real-time data collection is an interesting application of technology in the healthcare industry. The AD8232 sensor is a single lead ECG sensor that can measure heart rate and rhythm with high accuracy. The basic idea behind this work is to use the AD8232 sensor to collect ECG data from a patient, which is then transmitted to an Arduino microcontroller for processing. The Arduino microcontroller is connected to a computer, where an Excel spreadsheet is used to collect and analyze the ECG data in real-time. One of the main advantages of using Arduino is its ease of use and affordability. Arduino is a user-friendly platform that can be easily programmed to collect and process ECG data from the AD8232 sensor. Additionally, the open-source nature of Arduino allows for easy customization and modification of the work to meet specific needs. Overall, the ECG that uses an AD8232 sensor and Arduino for real-time data collection is a great example of how technology can be used to improve healthcare. With the ability to collect and analyze ECG data in real-time, medical professionals can quickly and accurately diagnose and treat various heart conditions.

4. Conclusion

Monitoring ECG with the AD8232 is a simple and cost-effective way to measure and monitor the electrical activity of the heart. The device is small and portable, making it easy to use in a variety of settings. It is also relatively inexpensive compared to other ECG monitoring devices. The AD8232 can be used to detect and monitor various cardiac conditions, including arrhythmias, myocardial infarction, and hypertension. It can also be used as a tool for evaluating the effectiveness of treatments for these conditions. Overall, the AD8232 is a reliable and accurate device for monitoring ECG.

Acknowledgement

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