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Development of Heart Rate Analysis Device for Human Body Stress Level Indication

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Abstract

The COVID-19 pandemic has affected people's lives worldwide, and Malaysia also has a hard time facing the pandemic. The pandemic has caused many businesses such as hotel and tourism industries to shut down their operation and reduce costs by dismissing their workers. Losing a job can cause a feeling stress issue. Heart Rate is one of the famous investigative tools to identify stress levels for the past decades with various measuring methods. Therefore, these projects present a suitable method of measuring the Heart Rate using heart rate sensors. An AD8232 ECG sensor was used as a heart rate sensor which connected to Arduino MEGA to send the data for further analysis in a computer. In the computer, PyCharm software has been used to analyze the data using a Heart Rate measurement method to determine the Heart Rate. Then, the Heart Rate was chosen to determine the user stress level based on the Firstbeat baseline. A test consisting of six test subjects consisting of males and females. As a result, all of the test subject result indicates a normal stress level under resting conditions. The result was displayed in the designed PyCharm with some additional features such as ECG recording and save data function, which stores all the users' results in Microsoft Excel format..

1. Introduction

Since 2019, COVID-19 has affected peoples' lives all over the world. According to Worldometer website, as of December 21, 2023, over 699.9 million confirmed infections had been recorded, and over 6.9 million people have passed away because of the infection [1]. Furthermore, this epidemic has harmed individuals through infections and mental illness issues, such as stress, worry, depression, sorrow, fear, disgust, or anxiety. Even in Malaysia, the COVID-19 virus existed too. The movement control order (MCO) is in place, and cases continue to increase every day. Spending more time at home can be extremely stressful if the person already lives in a toxic environment. Since the MCO went into effect on March 18, 2020, there has been a rise in physical and emotional violence cases, according to The Star newspaper [2]. Many businesses have reduced their costs due to lack of funds, such as the hotel and tourism industries since then. Moreover, in 2023, this virus has spread again but the economy is increasing and the grocery prices getting more expensive. This situation has caused the increasing of poor people.

Heart Rate Variability (HRV) has become famous as a clinical and investigative tool for various applications such as disease analysis, identifying stress levels, and early recognition indicators for autonomic nervous system

dysfunction [3]. Stress is a feeling of emotional or physical tension that can come from any consequence or perception that makes someone feel frustrated, angry or nervous [4]. It can be detected by examining biological effects on human bodies, which researchers prove [5]. The stress level varies according to the variability of the heart rate change.

By proceeding this project, Heart Rate, we can compute the stress level of person. It is detection of the person either their body is in state of rest or state of stress. Therefore, this project proposes of developing a device of heart rate to determine body stress level to guide the users to self-assess their body stress level at any period of time.

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This project's objectives are to develop a device to detect heart rate by using ECG sensor and Arduino hardware and compute heart rate data measurement into body stress level indication via PyCharm. Due to the device being needed, the functionality of the prototype is needed to test.

2. Materials and Methods

The material and method of this project are based on previous studies that corresponds to the components needed. Based on the objective of this project is to develop a device to detect heart rate by using ECG sensor and Arduino hardware to compute heart rate data measurement into body stress level indication via PyCharm.

2.1 Materials

The min electronic components that are used in this project are Arduino MEGA 2560 and AD8232 ECG sensor. The rest are listed below in Table 1.

Table 1 *List of Components*

List of Components
Arduino MEGA 2560
ECG Sensor
Jumper Wire

2.2 Procedure

2.2.1 Project Planning

In this project, a flowchart model is used to demonstrate the project planning scheme. This is due to the flowchart model is one of the visual aids for displaying the flow of project planning, where it offers clear pictures of the overall project process. Furthermore, a visual diagram provides aid for understanding a complex system or structure. This helps the reader easily understand the structure of this project and help writers with monitoring progress.

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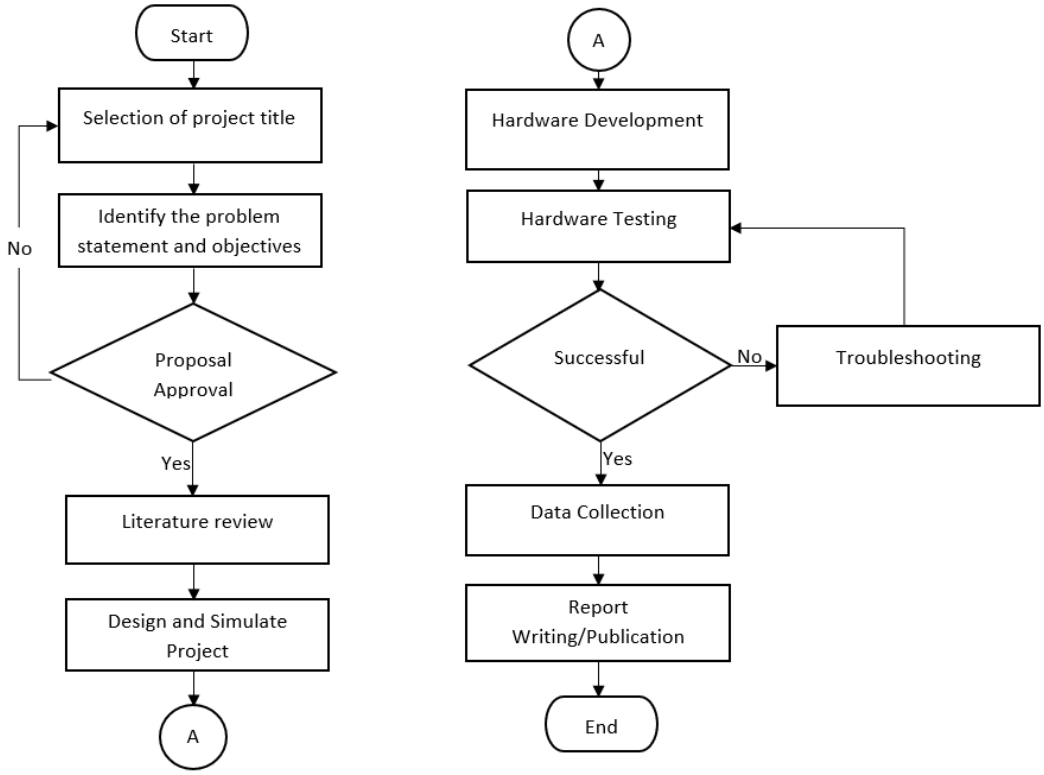

Fig. 1 *Project Planning Flowchart*

The project planning flowchart consists of several steps that need to be followed as guidance to get the project's expected result. The first stage in project planning is to come up with a good project title based on the knowledge gained from a specific research and to figure out what the study's issue statement is. The next step is to determine the project goal that must be met by the conclusion of the project and to write a project proposal to present to the supervisor. If the project proposal is approved, it may move on to the next phase; if not, it need to be rewritten in terms of title, problem statement, and project purpose. Following the approval of the project proposal, a literature study is required to discover and gather data based on existing research and data. A literature review aids in the selection of a solution and hardware for the project. After doing a thorough literature research, the project can begin by designing and simulating the circuit diagram in a program such as Proteus to obtain preliminary results before moving on to the real hardware configuration. The hardware configuration for the project may then be designed and tested. If there is an issue, a troubleshooting method should be adopted to identify it and address it. Finally, after receiving the results from the hardware setup and confirming that the project goal has been met, report authoring has been completed.

2.2.2 General Block Diagram

Figure 2 shows this project's general block diagram in a simple version, which help the reader understand the overall project system's functionality easily.

Fig. 2 *Block Diagram*

Figure 2 shows the project's general block diagram, the Arduino MEGA is used to power supply the ECG sensor and, at the same time to receive the signal from the ECG sensor for the electrode attachment. Then ECG sensor's electrode must be attached correctly to the patient's body. If one of the electrodes is detached, the device not be functioning correctly and the Heart Rate measurement is not displayed. Then, Arduino MEGA is used to receive the signal from ECG sensor and a computer with PyCharm software receives it for further analysis. Next, in the PyCharm software, the extracted data was analyzed using a time-domain method to determine the value of Heart Rate. With the value of the Heart Rate, the system is able to determine the user's

stress level based on their age and display the result on PyCharm. All the display data in PyCharm can be printed into a text document that is recorded. Other than that, the systems can also record raw ECG signals measured from the AD8232 ECG sensor and save them in CSV file format, which can be used for other clinical applications.

3. Results and Discussion

The Measuring Device of Heart Rate to Determine Body Stress Level is successfully developed. All the hardware and material are entirely built up and working well. The device can be powered using type A-B cable to laptops or computers. Figure 3 shows the view of the device.

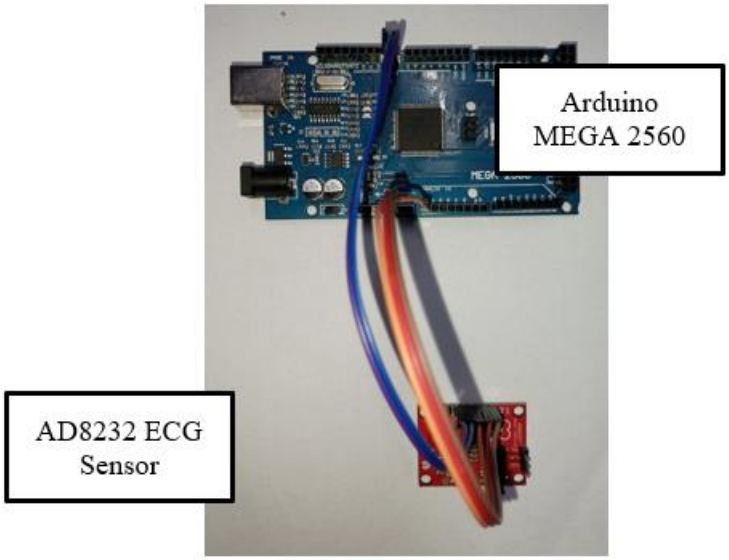

Fig. 3 *Block Diagram*

3.1 Electrode Placement

In this project, the electrode of the ECG sensor must be attached to the subject's body. If one of the electrodes is not attached, the sensor could not get the actual reading of the heartbeat.

A few UTHM students who volunteer to be the test subject to this experimental setup consist of males and females with a range of age from 20 to 25 years old and deemed to be in good physical and mental health also have no history of any chronic diseases. The experiment was done in which the test subject did not perform any exercise or caffeine. The session started with a short brief on the disposable ECG electrode placement and a reminder to minimize body movement during the experiment to avoid unwanted noise on the ECG signal. Then the subject while attaches the disposable ECG electrode to their body. There are three electrodes that need to attach to the subject body: two on the left (yellow) and right chest (red), and the other one is placed on the lower right abdomen (green), as shown in Figure 4.

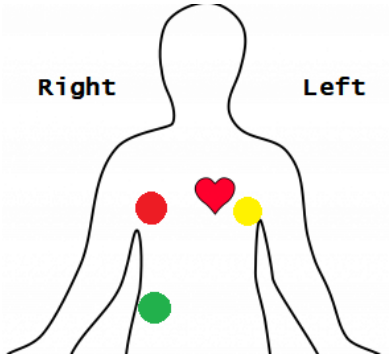

Fig. 4 *Electrode Placement on Subject's Body*

3.2 Heart Rate Result

Heart rate was used to determine the stress level of six test subjects which in resting conditions. Table 2 shows the summarized results of all the test subjects.

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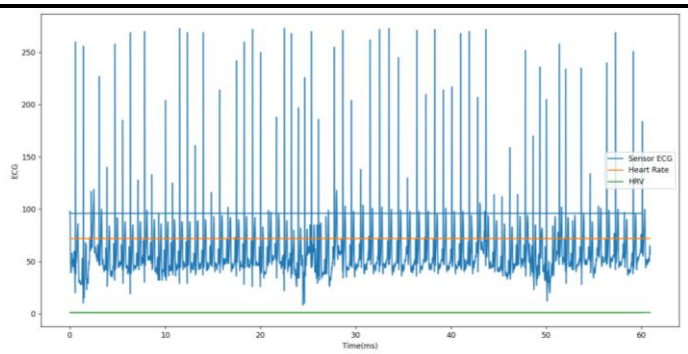
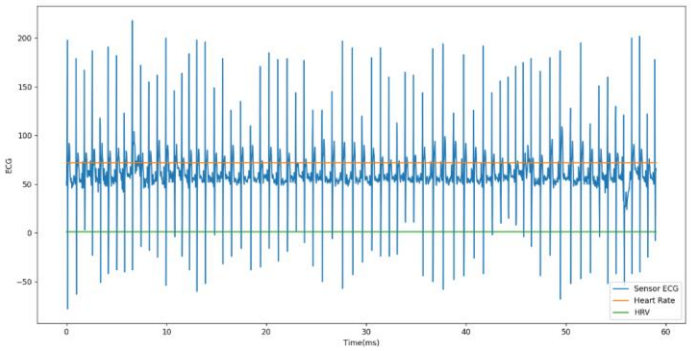
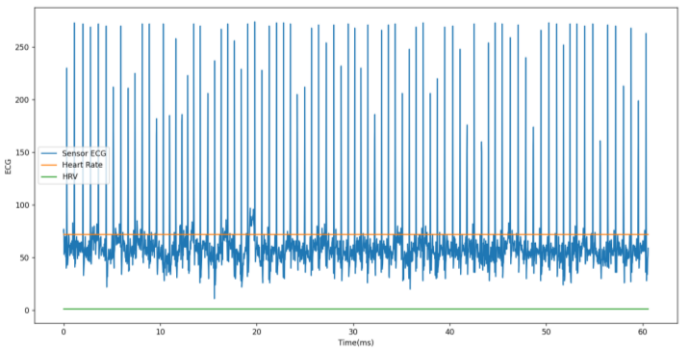
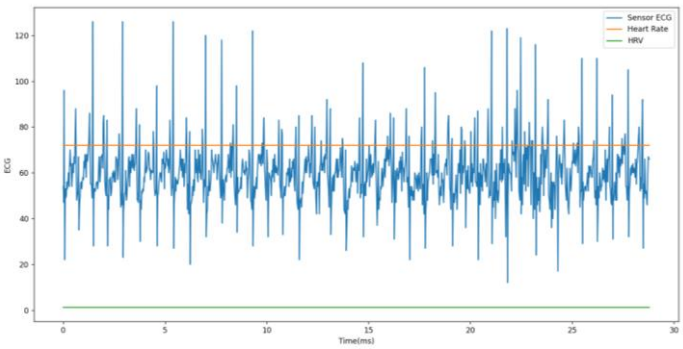
Table 1 *An example of a table*

Test Subject	Heart Rate Result
1	
2	
3	
4	

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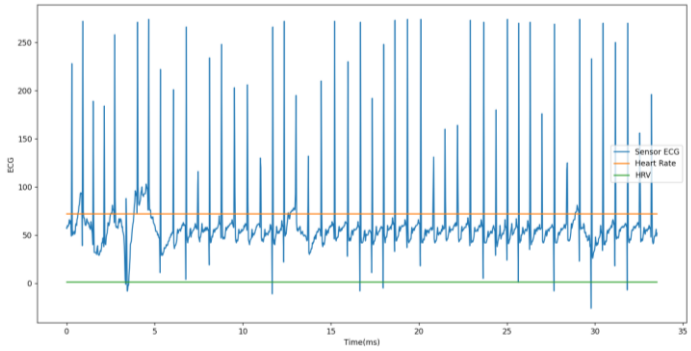

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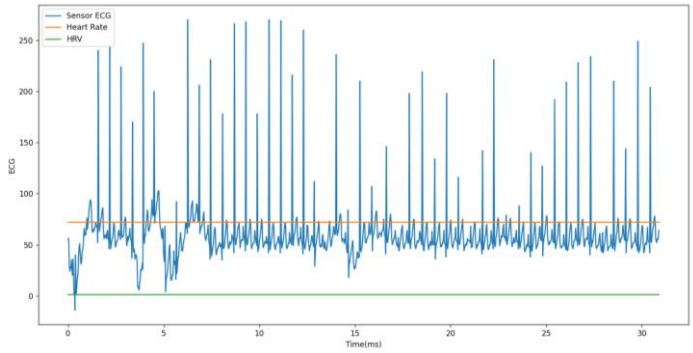

3.3 Summarized Result of Stress Level

Table 3 shows a table that summarizes the Heart Rate of all the test subjects. From the result, the heart rate of all the subjects is in the range 60-100 BPM indicating that the results are valid. The stress score shows that all the subjects are in normal stress conditions.

Table 3 *Summarized Result of Test Subjects*

Test Subject	Gender	Heart Rate (BPM)	Stress Score
1	Male	72	Normal
2	Male	72	Normal
3	Male	72	Normal
4	Female	72	Normal
5	Female	72	Normal
6	Female	72	Normal

The displayed heart rate graph shows different noise levels due to the contact of the skin surface. But the noise does not affect the heart rate result. In conclusion, the short-term measurement of heart rate is reliable for determining user's stress level in resting condition. Furthermore, although the test subject has the same heart rate, the heart rate graph is still different due to various effects such as disease and genetics. But all of the test subjects still have a normal heart rate range of healthy heart.

4. Conclusion

In conclusion, all the objectives of the Measuring Device of Heart Rate to Determine Body Stress Level is achieved. AD8232 ECG sensor has been chosen as the heart rate sensor of this project to measure the heart rate of the different test subjects due to its low cost, small and easy to bring anywhere. The sensor also filters the minuscule signal noise and amplifies the input signal which makes it easier to use.

Based on the objectives stated in Chapter 1, a device to detect heart rate by using an ECG sensor and Arduino hardware has been developed successfully. The device is functioning well and the heart rate can be detected. Next, this project is to study the heart rate signal quality in terms of noise and accuracy. The test was carried out in a quiet place and after the students took a rest for 5 minutes. For the last objective of this project, the data of heart rate measurement were computed into body stress level via PyCharm. From the analysis, if the heart rate of the user is above the normal range, the user is in a stress condition and vice versa. The result of the user can be saved in Microsoft Excel for further reference

Acknowledgement

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