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| Proposal | |
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# Aim of the Project

The aim of the project is to make a device that can measure the pulse rate of the user and produce a trace that shows the user’s heart beat pattern. Thus, this will allow the device to detect if the user has heart problems such as arrhythmias without visiting a doctor.

# Background Information

Arrhythmias or heart rhythm problems are experienced by more than 2 million people a year in the UK [1]. An arrhythmia is defined as a breakage of the rhythm (of the heart beat) either in timing or shape (of the ECG trace). If the shape of the ECG trace is different to a normal ECG trace, it means that the electrical activation didn’t occur in the sequence it should have. The mechanical action will also be out of sequence thus the shape of the trace will be different. This is a cardiac arrhythmia.

One type of arrhythmia is called atrial fibrillation. This causes the heart rhythm to be irregular, in which case sometimes the electrical impulses are propagated to the ventricles and the ventricles beat. Other times the atrial contraction which are p-waves in the ECG trace, is not seen because there is a limited time in which the waves can be captured. Consequently, the beat to beat timing interval in atrial fibrillation is chaotic, with no regular pattern in timing.



Figure 1 - ECG Trace of Person with Atrial Fibrillation [2]

As an ECG will not be used in this project, the period can instead be used (i.e. the beat to beat interval) to detect arrhythmias using photoplethysmography. If the square of the standard deviation (i.e. σ2) of the timing interval is calculated, it will be seen that the variance of the interval is very large. This variance in the period for people with arrhythmias is much greater than normal heart rhythms.

Photoplatesmography (PPG) uses a light sensor with high precision, this calculates the volume of blood flow to understand the fluctuation in heart rate. PPG makes uses of low-intensity infrared green (IR) light. When light travels through biological tissues it is absorbed by bones, skin pigments and both venous and arterial blood. Since light is more strongly absorbed by blood than the surrounding tissues, the changes in blood flow can be detected by PPG sensors as changes in the intensity of light. The voltage signal from PPG is proportional to the quantity of blood flowing through the blood vessels. Even small changes in blood volume can be detected using this method, providing higher precision [3].

# Procedure

For this project, a pulse sensor (a PPG sensor) will be connected to an Arduino which will sample the pulse at a constant rate. For sampling, timer interrupt programming will be used on the Arduino. When the user will hold the sensor, their heart rate information will be sent to the Raspberry Pi which will convert the pulse rate into a graphical trace, replicating an ECG. As a Raspberry Pi is being used, the programming for the Pi will be coded in Python. Matlab may be needed to produce a trace. Other software is currently being considered. Using the trace, the period of the beat to beat interval will be calculated and the variation of the interval. The heart rate, average heart rate over a period of time, the variance and the square of the variance will be stored in a database using SQL. Thus, the user will be able to access how frequently they have experienced an arrhythmia and the length of time for which arrhythmia occurred.

# Components with Cost

Table 1 – Cost of Project Components

|  |  |
| --- | --- |
| Component | Approximate Cost |
| Breadboard | Already provided |
| Raspberry Pi 3 Kit | £55 |
| Keyboard for the Pi | Already provided |
| Mouse for the Pi | Already provided |
| Arduino Nano | Already provided |
| Pulse Sensor | £18.88 |
| Monitor | Already provided |
| Wires | Already provided |

# Next Steps

This is a rough outline of the plan for the project, with the estimated time in weeks. This will obviously change with time according to the situation and how quickly each sub-part of the project is resolved.

# Additional Comments

Thus, this project will only detect arrhythmias not distinguish the type of arrhythmia. However, if the project is completed with time to spare, additional features could be incorporated such as distinguishing the type of arrhythmia (i.e. atrial or ventricular) and other heart related problems may also be explained to user from the data received from the pulse sensor. This will be done using signal processing techniques.

References

[1] nhs.uk. (2018). *Arrhythmia*. [online] Available at: https://www.nhs.uk/conditions/arrhythmia/ [Accessed 8 Oct. 2018].

[2] Healio.com. (2018). *Atrial Fibrillation ECG Review - Criteria and Examples | LearntheHeart.com*. [online] Available at: https://www.healio.com/cardiology/learn-the-heart/ecg-review/ecg-topic-reviews-and-criteria/atrial-fibrillation-review# [Accessed 8 Oct. 2018].

[3] Soulfit Blog. (2018). *How Does PPG Technology Works? - SoulFitBlog*. [online] Available at: https://soulfit.io/blog/how-does-ppg-technology-works/ [Accessed 8 Oct. 2018].