Project plan + preliminary research - September 29

Basic overview: The creation of a system of devices to detect tonic seizures in epilepsy patients, aiming to be customizable, personizable, and cost efficient

- Early research completed, can be found throughout logbook

Proposed schedule

October: Start on prototyping, finalize all materials

November: Finalize design, work on building + creating

December + January: Wrap up building, complete testing and work on lab report

February: Complete and polish up lab report, potentially start on trifold

March: Finish up trifold and other necessities for CYSF.

- For list of all predicted materials, check background information

Background Information - October 13

What type of seizures are going to be detected?

- This device aims to detect tonic seizures, the most common type. Typically, tonic seizures are

characterized by a sudden stiffness in muscles, and sudden tachycardia (increased heart rate)

What materials are being used?

- 1 x EMG band (To place on arm muscle)
- 1 x ECG band (To place on chest)
- 2 x Dry electrode wires
- 2 x BioAmp EXG pills
- 1 x Arduino R4 minima control board (+ programming software).
- 1 x Piezoelectric buzzer
- 1 x HC-05 bluetooth module
- Jumper wiring (See "Connections" for deeper insight into wiring).
- 1 x Phone/Computer (To recieve results in message +app).
- 1 x Breadboard

What makes this project different than others of the same type?

- Comparing my seizure sensor to others of

a similar type, I believe mine is better as it will use 2 signals (Emg and ECG), and in the end, might also use a sleepwalking sensor as well.

↳ Also, this device is made of easily accesible materials and code, meaning customizability is evident.

What's next?

- Over the next few weeks, I expect to be working on understanding the physical aspects of my project

↳ This includes signal acquisition, using my bluetooth module for the first time, and getting multiple signals at the same time.

Signal Acquisition - October 15

- Today, using the "Chords" software by Upside Down Labs™, I acquired EMG signals for the first time!

↳ Next, my goal is to use my bluetooth module and make it work with my Arduino, with the final goal of being able to send my Emg (and later, ECG) signals

November 20th - Troubleshooting

- First of all, the month or so that I've been working on this project has been unsuccesful.
- With school workload increasing as we return from the strike, I haven't had much time to work on the project.
- Thus, the majority of time I worked on my project was regarding troubleshooting the design of my device, with minimal success
  - ↳ Currently, the issue I'm getting with EMG and ECG signals is that I'm getting too much excess noise, and I'm considering stripping away the usage of the Bioamp Exg pill entirely given its evident unreliability at this time.
  - ↳ Alongside this, I've been able to power my setup individually, but I'm still not able to detect signals reliably, wired or wirelessly.

What's Next?

- Since I have to submit the proposal form relatively soon, I don't expect any dramatic changes to the project, at least until I recieve advice.

December 20th - Changes

- As my concerns of the effectiveness of the EMG and ECG signal acquisition methods have been echoed by MR. Degelder, my school's science fair coordinator, I've decided to entirely remove them from the project

  ↳ Instead, I've decided to use MPU 6050 accele-rometers to detect movement, as they don't require the usage of an outside serial plotter to function & detect signals, though it does mean that cardiological (heart rate) changes can't be detected

  ↳ However, utilising multiple mpus will allow me to detect both sleepwalking and seizures simultane-ously, which I believe makes the usage of accelerometers outweigh the fact that heart rate and genuine EMG signals won't be used, in favour of the gyroscopic movement detection that the accelerometer provides.

- Alongside this, I've finalized the name of my proj-ect CLife-Band!, owing to the fact that I hope that the final project is a wearable, wristband-type device.

- Finally, some key changes in materials used in this project include the removal of all the emg & ecg signal acquisition devices (eg. Bioamp exg Pill, Electrodes) for the MPUs, and I swapped my Arduino R4 minima for an Arduino nano board and my breadboard for a smaller variant to minimize the amount of space my device takes up

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January 6- Formulas + Coding

- For getting the correct values or "thresholds" for seizure / sleepwalking detection, I need to understand the formulas that I can input in my code

Formulas

Notes: Throughout these formulas, force is always directly proportional to accelaration, as mass remains constant.

- The accelorometer measures Raw data in LSB (Least Significant Bit), a dimensionless unit that has a range of -32,768 → +32,767

↳ In standard form, an MPU-6050 has an LSB/G sensitivity of 16384, meaning that it has a range of measurement of ±2 gs (of gravitational force)

$$\frac{\text{(Raw Data)}}{16{,}384} = \#gs \text{ of force } (-2 \leq g \leq +2)$$

(Sensitivity scale Factor)

$$\#gs \text{ of force} \times 9.8\ m/s^2 = \text{Accelaration for 1 axis (X, Y, or Z)}$$

(9.8 m/s² = Earth's gravity)

$$(-19.6\ m/s^2 \leq a \leq +19.6\ m/s^2)$$

For total magnitude

When x, y, and z are measured in m/s^2

$$\sqrt{x^2 + y^2 + z^2} = M_{Total}$$

- Generally, a "jerk" associated with a seizure has an approximate magnitude of 22 m/s^2, while a firm step is about 12.

↳ Thus, I can create if statements that if magnitude exceeds one of these thresholds for a certain period of time, the buzzer can sound and an alert message can be sent to the serial monitor.

January 16 - Working Prototype

- While the hardware for the band still needs to be finished, our final code and first working prototype has been created.

↳ In this design, 8 "jerks" of magnitude of 22 + m/s^2 each, and/or consistent "walking" movement is detected for 5 seconds, a buzzer will turn on to a high or low tone, and a message stating "Prolonged walking" or "SEIZURE ALERT" will be sent to the serial monitor.

- Just as a quick reminder, this device is not intended for any usage on actual patients, and even the final product is not to be used commercially, to prevent ethical concerns.

January 20 - Additions

- As of today, the preliminary design (both software & hardware) is nearly complete!

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↳ Some minor modifications I've completed since my previous update include the addition of a MAX 30102 Heart Rate and Blood Oxygen (SpO2) has been added to my completed band design

- Thus, I hope to take my video this Thursday or Friday, with my only other goal before I take my video to create a simple application on MIT App Inventor, to display my recieved data in a tangible manner.

January 23 - Video recording & Logbook Submission

- With my app, hardware, and code all fully completed, this will be my last update before I submit my logbook & project to the school.

↳ On the basis of my video, recording is expected to happen today, with the video either being submitted later today or early tomorrow (Saturday)

February 3 - Project approval & Materials

- As of today, my project has been approved to progress to the CYSF! With a 93, I'm quite happy but there's still work to be done.

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↳ One key piece of feedback which I received for both my video and logbook was the addition of a dedicated list of all materials used in my fi-nal design which are shown below.

Materials

- 1 × Nano ATmega 328P Board (Microprocessor)
- 2 × MPU 6050 Accelerometers
- 1 × HC-05 Bluetooth Module
- 1 × Max 30102 Heart Rate & Blood Oxygen Sensor
- 2 × Elegoo Mini Breadboard
- 1 × DURACELL 9V Battery
- 1 × Piezoelectric Buzzer (Compatible w/ Arduino)
- 2 × Tupperware Containers w/ Lids
- 2 × Adjustable Velcro Straps
- 1 × Vacuum Hose (Conduit for wires)
- 1 × Phone & Computer (For app and arduino code)
- Jumper Wires