Wearable Seizure Detection

BMEN 3151 *Medical Device Practicum*

Team members: Alex Seplak, Cole Helland, Enrico Podesta, Sam Jacob
Advisor: Professor Steven Saliterman

Clinical Problem

A seizure is a burst of uncontrolled electrical activity in the brain.[1] This uncontrolled brain activity can then potentially result in abnormal uncontrolled muscle movements, abnormal behavior, and/or abnormal sensations or awareness.[1] A seizure is a single one time event, while epilepsy is a reoccurring condtion.[1] Epilepsy/seizures pose many risks to patients diagnosed with this condition. A seizure can occur at any point, and this spontaneity poses a safety risk to patients. Seizures can result in serious injuries to patients, specially with trauma to the head. If no bystanders are present, one can be seriously injured by a seizure. Because of this we want to design a seizure detection/monitor device. This can be used to alert emergency contacts, and thus improve the safety of the patient.

Needs Statement

A system to monitor and detect an incoming seizure and provide real time data and alerts.

Market Analysis

Over 3.4 million people are diagnosed with epilepsy in the United States. [2] Current seizure monitors tend to be expensive, making it out of reach for significant portions of the US population. Current monitors can cost thousands of dollars. There is also very few solutions currently on the market. There is only one FDA cleared device; however, this device requires a monthly subscription payment in order to receive real time alearts[3].

Medical Device Solution

A solution we designed was a simple device powered and processed by an Arduino Uno. The parameters of pulse and electrodermal activity were used to monitor seizure symptoms. In order to monitor heart rate the *PulseSensor* was used. The electrodermal activity was monitored by the *Grove GSR sensor* (galvanic skin response). The readings of the heart rate and electrodermal activity sensors were outputted via a Bluetooth module (AT-09 Serial Wireless Module). The user can then view the outputted sensor data via an IOS app. The device can currently report an accurate heart rate and skin resistance readings. For future iterations of our prototype, we need to obtain clinical data in order to write a detection algorithm. This algorithm can be compiled in MATLAB, where data inputs can be compared to a developed mathematical model. The technique of discriminant analysis would be used to detect a potential incoming seizure. Clinical data would be used in testing purposes in order to determine the accuracy of our device. We would also want to add an absolute orientation sensor with an accelerometer to our device in the future, as that proved the most difficult sensor to integrate due to its sensitivity.

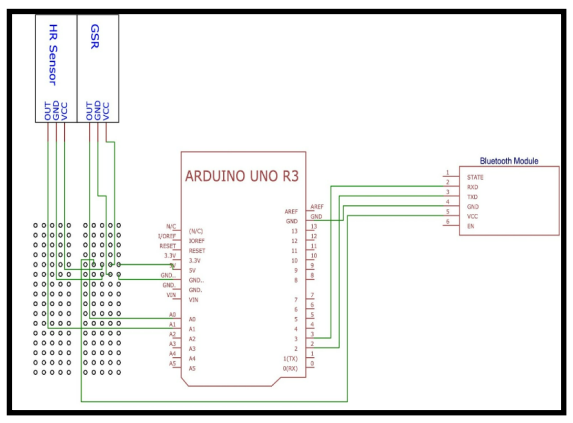

Figure 1: Current Iteration Circuit Diagram

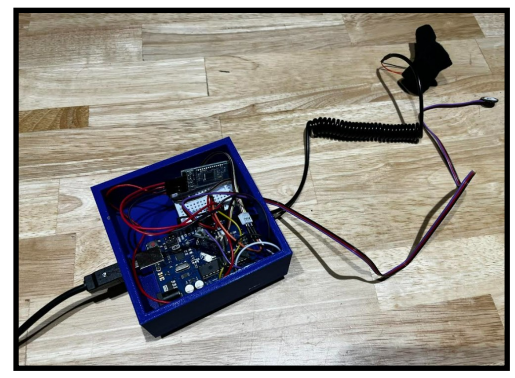

Figure 2: Current Iteration of Physical Prototype

Team Photo

Sources

1. *Types of Seizures*. 8 Aug. 2021, https://www.hopkinsmedicine.org/health/conditions-and-diseases/epilepsy/types-of-seizures.

2. *Epilepsy Fast Facts | CDC*. 30 Sept. 2020, https://www.cdc.gov/epilepsy/about/fast-facts.htm.

3. "Embrace2 Seizure Monitoring | Smarter Epilepsy Management | Embrace Watch." *Empatica*, https://www.empatica.com/embrace2. Accessed 12 Dec. 2022.