Lab 2 - SeizSmart Descriptive Paper

Dakotah Atkinson

CS 411W

Professor Thomas J. Kennedy

November/10/2019

Version 2

Table of Contents

List of Figures

1. Introduction

Seizures, the silent reaper that sits on the shoulder of millions at this very moment, capable of snuffing out a life with few warnings to those around and even fewer options to those in the midst of an attack. Epilepsy has been on the rise in recent years becoming the fourth most common neurological disease worldwide and is projected to only continue growing well into the future. See Figure 1.

Despite the growing prevalence there are still many social misconceptions and stigmas about epilepsy, seizures, and how best to treat those suffering. There is a silent battle that those with the condition fight knowing that if they have an attack while alone they could end up losing their life. Even if the stigma is lifted and misconceptions cleared there still remains a larger problem, what to do if a seizure strikes while someone is left alone? Trouble speaking, erratic body convulsions and loss of consciousness make it difficult for one to reach out to others for help which becomes a far bigger issue when the span of time available to save a life is so short. See Figure 2.

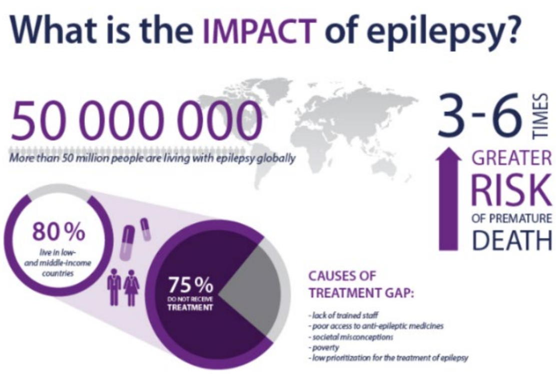

Figure 1: Background of Epilepsy

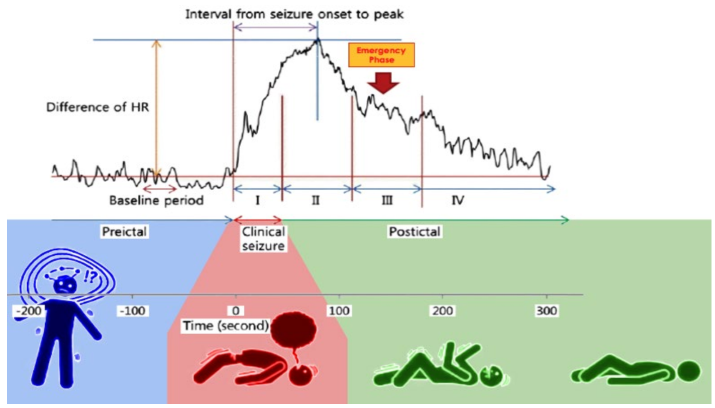

Figure 2: Interval from seizure onset to peak

The most common solution of the modern era has been to create an accessory that monitors a user's heartrate or their body movement for a paid subscription, and if the accessory notices anything that appears off a signal is sent off to a relay that calls help for the patient. [1][2][3][4] But these come at the cost of being tethered to a relay at all times hindering a person's social and/or professional obligations. Not to mention the possibility that the connection to the relay could be severed due to any number of possible reasons. More so seizures come in many flavors and will not always affect the same person the same way every time, making it difficult for traditional monitors to catch every seizure.

That is where plans for SeizSmart have taken root, intended as an iOS and Android smartwatch app that monitors both the user's heartrate and movements, creates a customized seizure profile for its user for easier detection, uses the watch's in built call functions to issue emergency requests without need for a relay, and is planned to be available free of charge with no prescription required.

1.1. Purpose

SeizSmart will be a combination smartphone/smartwatch app designed to aid patients suffering from generalized seizures rest at ease knowing that help is never out of reach in case of emergency. Making use of native smartwatch inbuilt gyroscope, accelerometer, and heart rate monitor it seeks to have the most accurate possible readings for detecting the onset of a seizure, combined with machine learning and a customized user profile to better recognize false positives. Upon the detection of a seizure, multiple user configurable alerts will be displayed, and if not responded to will immediately contact appointed care givers to the attack via messaging systems. This allows for patients to have a larger degree of freedom in their lives by not needing to be constantly monitored by a second party, while also still keeping their safety in mind. While SeizSmart seeks to detect seizures as soon as they occur, it will not in any way be able to predict their oncoming.

1.2. Scope

The overall goal of SeizSmart is to provide seizure patients with the freedom to live their lives without being restricted by the fear of an oncoming attack or being hampered by the financial obligation often found in other seizure detection services. Furthermore, SeizSmart seeks to deliver the most accurate possible readings in seizure detection using multiple detection parameters combined with a machine learning assisted personal profile.

For the primary prototype the main focus will be on initial Seizure detection through artificial erratic movement. No heartrate features will be included at this time. Through the detection of the simulated seizure the prototype will further highlight the patient alerts, care giver reports, and message delivery features. Further information of the overall workflow plan can be seen in Figure 3.

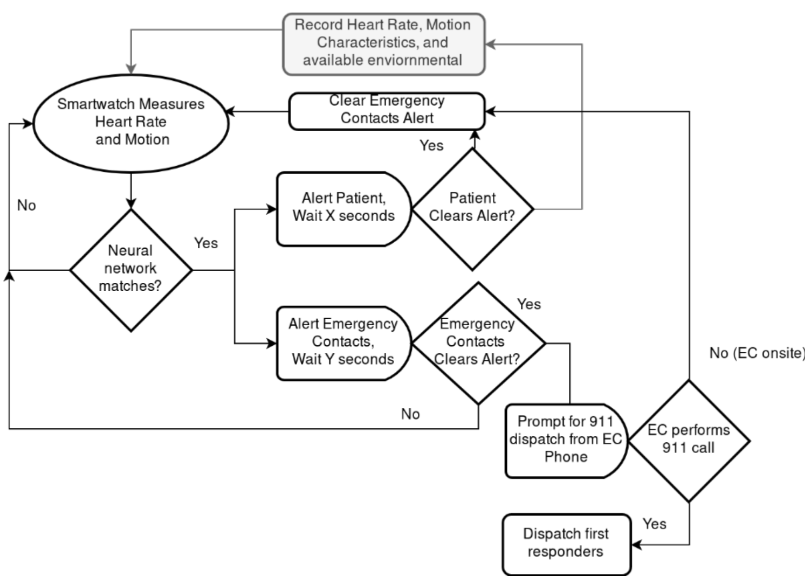

Figure 3 SeizSmart Workflow

1.3. Definition, Acronyms, and Abbreviations

Accelerometer: *Tool used for measuring the acceleration of an object.*

Caregiver: *End-user providing care to the patient using SeizSmart for monitoring purposes. May include friends, relatives, or professional healthcare providers.*

Emergency Contact: *See "Caregiver".*

Gyroscope: *Tool for measuring the orientation of an object.*

Heart-rate Monitor: *Tool for measuring the heart rate of an individual.*

Patient: *End-user prone to seizures using SeizSmart for personal seizure detection.*

Seizure: *A sudden boost in electrical activity of the brain leading to involuntary movements*

Seizure Profile: *A patient's personal profile for seizure confidence, a set of numbers corresponding to expected biometric data in the patient.*

Training Server: *The server containing the machine learning algorithms responsible for building and growing a patient's seizure profile.*

[This space intentionally left blank]

1.4. References

[0] Team Silver., "Lab 1 - SeizSmart Product Description", ODU, 2019.

[1] "Website." [Online]. Available: Tzallas, A. T., Tsipouras, M. G., Tsalikakis, D. G., Karvounis, E. C., Astrakas, L., Konitsiotis, S., & Tzaphlidou, M. (2012, February 29). Automated Epileptic Seizure Detection Methods: A Review Study. Retrieved from https://www.intechopen.com/books/epilepsy-histological-electroencephalographic-and-psychological-aspects/automated-epileptic-seizure-detection-methods-a-review-study. [Accessed: 11-Sep-2019].

[2] "Website." [Online]. Available: Giannakakis, G., Sakkalis, V., Pediaditis, M., & Tsiknakis, M. (1970, January 01). Methods for Seizure Detection and Prediction: An Overview. Retrieved from https://link.springer.com/protocol/10.1007/7657_2014_68. [Accessed: 11-Sep-2019].

[3] "Website." [Online]. Available: Devices & Technology. (n.d.). Retrieved from https://www.dannydid.org/epilepsy-sudep/devices-technology/. [Accessed: 11-Sep-2019].

[4] "About SmartWatch Inspyre™ by Smart Monitor – smart-monitor." [Online]. Available: https://smart-monitor.com/about-smartwatch-inspyre-by-smart-monitor/. [Accessed: 11-Sep-2019].

[This space intentionally left blank]

1.5. Overview

This SeizSmart prototype makes use of an android compatible smartwatch with inbuilt accelerometer, gyroscope, and heart rate monitor. In terms of software, development is being conducted with Java, Android studios, SQLite, Gradle, Git, Gitlab, JUnit, HTML5/CSS/JS, and MySQL.

[This space intentionally left blank]

2. General Description

The SeizSmart prototype is to be a proof of concept that such a device and system are feasibly possible.

2.1. Prototype Architecture Description

The SeizSmart prototype consists of two major front facing components, the smartwatch and smartphone applications, both used by the patient. The watch application will serve as the main patient information relay recording biometric data, keeping watch for any irregularities, and presenting the initial alerts to users in the midst of a believed attack. The smartphone application serves as the hub for the patient to set up their account, list emergency contacts, and alter their user profile. On the back end there is a single test/training server which stores a patient's emergency contact info and seizure biometrics and signatures.

2.2. Prototype Function Description

Functionally the SeizSmart prototype is expected to be able to recognize a simulated seizure through sudden erratic movement of the smartwatch. The watch should then prompt the user to identify if this is in fact a seizure, should the user respond the watch will return to a standby observation mode. However, in the case that the user does not respond the prototype should push an SMS message to any listed emergency contacts that a seizure event is taking place. Should the above conditions be met, then the prototype can be considered a complete proof of concept. See Figure 4.

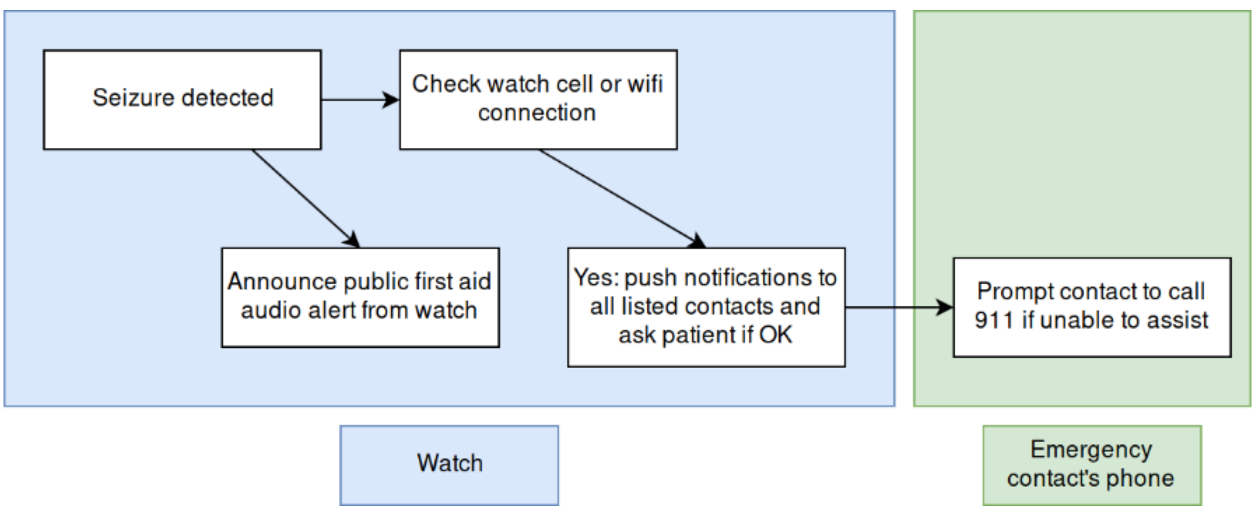

Figure 4 Expected Final Reporting Flow

2.3. External Interfaces

The prototype currently relies on a virtual server provided Old Dominion University's Computer Science "Root" System's Group which will communicate with both the phone and watch apps.

2.3.1. Hardware Interfaces

Hardware used in the prototype will consist of a smartwatch and a smartphone both running an Android 28+ operating system with WiFi and/or cellular network access. The watch requires a built-in gyroscope, accelerometer, and heat-rate monitor. Further it is necessary to have a physical and accessible server to run the virtual server mentioned in section 2.3.

2.3.2. Software Interfaces

The training server will run a MySQL database containing patient data (name, e-mail, user id, password, current detection parameters, emergency contact list, first responder) as their recorded seizure history as gathered by the smartwatch biometrics.

2.3.3. User Interfaces

Both the smartwatch and the smartphone will require touch screens of minimum 256x256 RGB pixels to display the UI as pictured in figures 5 and 6.

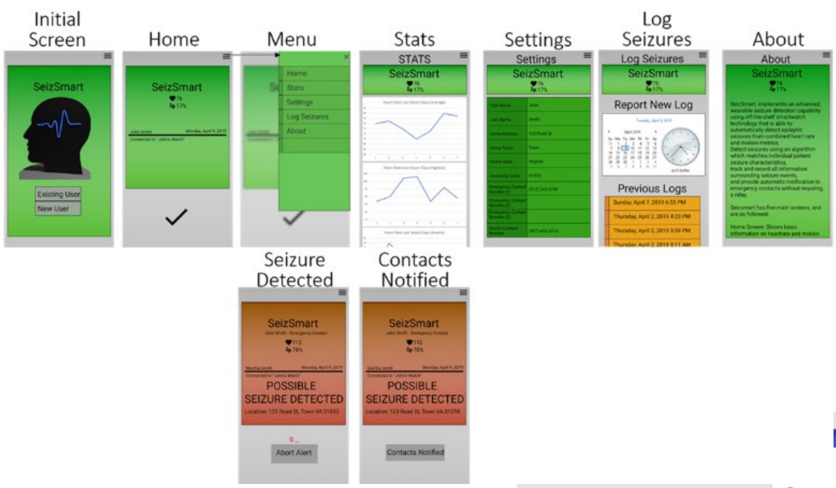

Figure 5 Smart Phone GUI

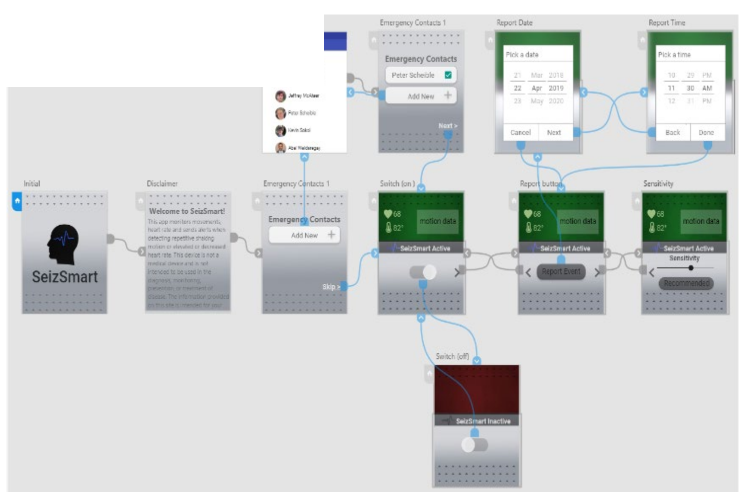

Figure 6 Smart Watch GUI

2.3.4. Communications Protocols and Interfaces

To communicate effectively between the server, watch, and phone the following protocols will be implemented:

- TCP Kernel API
- MySQL Unix Socket Connection
- HTTP runtime API

3. Specific Requirements

[Section omitted, please see separate document]

[This space intentionally left blank]

4. Appendix

4.1. Materials

- 1+ Android 28+ Smart Phone
- 1 Android 28+ Smart Watch
- 1 Virtual Server

4.2. Repositories

- https://git-community.cs.odu.edu/fall2019-411-silver/seizsmart-watch
- https://git-community.cs.odu.edu/fall2019-411-silver/seizsmart-android
- https://git-community.cs.odu.edu/fall2019-411-silver/SeizSmart-Server