Lab 1 - Seizsmart Description
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CS 411
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(Date)
Version 1

1. Introduction

Introduce SeizSmart and the approach to demonstrating its characteristics through prototyping (essentially an abstract). This section should

- *be approximately one page in length.*
- *summarize the societal problem with some reference/date support.*
- *outline problem and needed solution characteristics.*
- *introduce your product by name as the solution.*
- Background
    - What challenges do seizure patients face?
    - What solutions already exist? [1] [2] [3] [4]
- What parts of the initial problem are left unsolved?
    - Accuracy of detection
    - Inaccessible due to cost and/or requirement of specialized hardware
    - Existing solutions detect based on body motion only, not a combination of both [5]
    - Require a relay device[5], [6]
    - Does not make the detection process unique for each individual user
- How does Seizsmart fill the gap?
    - Accuracy
    - Pricing
    - Smartwatch application will run independently of a smartphone
    - The detection process is unique for each individual user

Figures: slide 6, 7, 9

2. SeizSmart Description

Provide a top-level description of SeizSmart for the average reader. Provide a summary of the solution –- and its goals and objectives. This section should be one paragraph minimum.

- Explain the data collection and processing goals (high-level)
    - Detecting based on a combination of heart rate and body movements
    - Does not require a relay device
    - Trained neural network to make the detection process unique for each end-user
    - Emergency contacts notified directly from the smartwatch
    - Data required for optimal seizure detection (accelerometer, motion, heart rate)
    - Processing - once detected, how do we alert contacts?
    - Configurability - do caregivers want to lean towards false positives or false negatives; how does this improve the lifestyle of the patient?
- Explain the role of smartwatch application
    - Collect data
    - Receive false positive feedback
    - Perform direct notification over cellular comms
- Explain the role of the smartphone application

- View data collected from the smartwatch
- Configure account (edit emergency contacts)
- Receive false negative feedback (Hey I had a slight tremor at 10:30 and the app didn't detect it!')

Figures: slide 12,

2.1. Key Product Features and Capabilities

What does it do? What is significant/unique/innovative about it? What does it accomplish? Describe how this solves the problem.

Figures: slide 12,

- Detection algorithm
- Recording algorithm
- Reporting algorithm

2.2. Major Components

Provide an overview of the hardware needed to support the solution. Describe how it is structured based on CS 410 MFCD. Define and describe the software to be developed.

Figure: slide 21 (Prototype presentation), 22

> *2.2.1. Mobile Application*

> *2.2.2. Smartwatch Application and Smartwatch Database*

> *2.2.3. Cloud Server and Server-Side Database*

> *2.2.4. Seizure Detection Algorithm*

2.3. Identification of Case Study

For whom is this product being developed? Why? Who else might use this in the future?

- End users
  - Individuals with epilepsy
- Customers
  - caregivers

Figures: slide 13,

3. SeizSmart Prototype Description

Provide a top-level description of the SeizSmart prototype as it relates to the end product from CS 410 (i.e., the goal). Are capabilities reduced or eliminated? Simulated – modeled?> Include a table of comparison between RWP and Prototype either in section 4, 4.1 or 4.2

3.1 Prototype Functional Goals and Objectives

4.1.1 Simulate real-world data

4.1.2 Detect potential seizure based on threshold

3.2. Prototype Architecture (Hardware/Software)

How will the prototype be structured to demonstrate the key features of the CS 410 product?. Provide describe the Prototype MFCD.

- Describe watch data collection
- Describe Server receive/send watch data (training inputs + outputs)
- Describe watch seizure detection flow
- Describe the alert process
- Describe caretaker phone alert display and smartwatch false-positive UI

Figures: slide 22,

3.3. Prototype Features and Capabilities

What does the prototype demonstrate? Why is that significant in showing how the problem is solved? How you have demonstrated success? How does the prototype address the CS 410 project risk mitigation? Describe the functional goals and objectives.

- Monitor body movement and heart rate behavior
- Alert emergency contacts when the user does not respond
- Collect data about the environment at the onset of a seizure
- Fully functional without dependence of a smartphone or external device

Figures: Slide 19, slide 51

3.4. Prototype Development Challenges

Describe the expected challenges to be encountered while completing the prototype – e.g., knowledge missing, capability missing, supporting technology issues.

- Learning Watch, Phone, and Tensorflow APIs will take an unknown amount of time
- Sensitivity and precision of watch hardware (accelerometer, rotation) is unknown, but suspected to be good enough for seizure detection; this may make it difficult to detect slight tremors similar to shivering.

- The 411silver server is behind a firewall and to test in a realistic environment the team will need to set up a VPN client or SSH-tunneled access to use the server effectively.

4. Glossary

Alphabetical list of terms and abbreviations.

Absence Seizure: *A generalized onset seizure that lasts only a few seconds, causing the patient to suffer lapses in awareness. Formerly known as a petit mal seizure.*

Atonic Seizure: *Also known as drop attacks. In this kind of seizure, some or all of the patient's muscles suddenly become limp.*

Complex Partial Seizure: *A brief seizure that starts in one side of the brain, also referred to as a focal (onset) impaired awareness seizure. During this kind of seizure, the patient loses awareness of their surroundings.*

Clonic Seizure: *A seizure characterized by sustained, rhythmic jerking of the patient's body.*

Emergency Contact: *Anyone who cares for a patient; usually family members.*

Epilepsy: *A neurological disorder characterized by multiple unpredictable seizures.*

Myoclonic seizure: *A seizure characterized by brief jerking or twitching of muscles.*

Patient: *An individual who experiences generalized seizures. May also be referred to as the end-user.*

Seizure: *A disturbance in the brain caused by a sudden surge in neuroelectric activity.*

Seizure Profile: *Personalized for each patient, describes information regarding the individual's typical seizure, such as physical indicators, or their average threshold for specific biometrics during a seizure. The seizure profile is used to provide more accurate seizure detection. Technically; a matrix of weights computed from training data used to classify new inputs as seizure or non-seizure related.*

Simple Partial Seizure: *A brief seizure that starts in one side of the brain, also referred to as a focal onset aware seizure. During this kind of seizure, the patient does not lose awareness of their surroundings.*

Tonic Seizure: *A seizure in which the patient's body, arms, or legs suddenly stiffen.*

Tonic-Clonic Seizure: *What most people think of when they hear the word "Seizure." It combines the characteristics of tonic and clonic seizures.*

5. References

[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].

[5] "Website." [Online]. Available: Velez, Mariel, et al. "Tracking Generalized Tonic-Clonic Seizures with a Wrist Accelerometer Linked to an Online Database." Seizure, U.S. National Library of Medicine, July 2016, www.ncbi.nlm.nih.gov/pubmed/27205871. [Accessed: 11-Sep-2019].

[6] "Website." [Online]. Available: Borujeny, Golshan Taheri, et al. "Detection of Epileptic Seizure Using Wireless Sensor Networks." Journal of Medical Signals and Sensors, Medknow Publications & Media Pvt Ltd, 2013, www.ncbi.nlm.nih.gov/pmc/articles/PMC3788195/. [Accessed: 11-Sep-2019].

[7] February;25(2):28-29, N. R., Publish date: December 6, 2., & Publish date: December 18, 2. (2019, January 07). Mobile Devices May Provide Accurate Seizure Detection and Help Prevent SUDEP. Retrieved from https://www.mdedge.com/neurology/epilepsyresourcecenter/article/130162/epilepsy-seizures/mobile-devices-may-provide

[8] van Elmpt, Wouter J C, et al. "A Model of Heart Rate Changes to Detect Seizures in Severe Epilepsy." Seizure, U.S. National Library of Medicine, Sept. 2006, www.ncbi.nlm.nih.gov/pubmed/16828317.

[9] Borujeny, Golshan Taheri, et al. "Detection of Epileptic Seizure Using Wireless Sensor Networks." Medical Signals and Sensors, Medknow Publications & Media Pvt Ltd, 2013, www.ncbi.nlm.nih.gov/pmc/articles/PMC3788195/.

[10] Velez, Mariel, et al. "Tracking Generalized Tonic-Clonic Seizures with a Wrist Accelerometer Linked to an Online Database." Seizure, U.S. National Library of Medicine, July 2016, www.ncbi.nlm.nih.gov/pubmed/27205871.

[11] Kołodziej, M., Majkowski, A., Rak, R. J., Świderski, B., & Rysz, A. (2017, September). System for automatic heart rate calculation in epileptic seizures. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/28523469

[12] Nei, M. (2019). Cardiac Effects of Seizures. American Epilepsy Society.

[13] Zijlmans, Maeike, et al. "Heart Rate Changes and ECG Abnormalities during Epileptic Seizures: Prevalence and Definition of an Objective Clinical Sign." www.ncbi.nlm.nih.gov/pubmed/12181003.

[14] "Demystifying Epilepsy and Increasing Awareness." and Research, Mayo Clinic, Mayo Foundation for Medical Education https://newsnetwork.mayoclinic.org/discussion/epilepsy-demystify-disease-and-increase-awareness/.

[15] "Epilepsy Foundation." Epilepsy Foundation, 13 Mar. 2019, www.epilepsy.com/.

[16] "About SmartWatch Inspyre™ by Smart Monitor – Smart-Monitor." Smart, smart-monitor.com/about-smartwatch-inspyre-by-smart-monitor/.

[17] "Embrace2 Seizure Monitoring | Smarter Epilepsy Management | Embrace Watch." www.empatica.com/embrace2/.

[18] "SeizAlarm Epilepsy Seizure Detection." SeizAlarm Epilepsy Seizure Detection, seizalarm.com/.

[19] "Epilepsy Journal App | OllyTree Applications." Epilepsy Journal, www.epilepsy-journal.com/.

[20] "Health Storylines™." Health Storylines™, www.healthstorylines.com/.

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