3 Specific Requirements

Section 3 encompasses the requirements to be met for the production version of SeizSmart. Requirements are grouped by functional areas and further subgrouped by product features and capabilities. A line containing the information that denotes who the Originating and Modifying authors are will follow after each requirement. The format is shown below:

(O: Last Name, M1: Last Name, M2: Last Name, ..., MN: Last Name)

O represents the Originating author and M represents the Modifying Author.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this section are to be interpreted as described in RFC 2119.

3.1 Functional Requirements

3.1.1 Posting data to server from smartwatch.

3.1.1.1 Introduction/Purpose of Feature

The data stored in the local sqlite database on the smartwatch must be sent to the external mysql database for training by the machine learning algorithm.

3.1.1.2 Stimulus/Response Sequence:

N/A

3.1.1.3 Associated Functional Requirements

3.1.1.3.1 The smartwatch must be able to store all biometric data to its local database. (O: Din Gabisi)

3.1.1.3.2 The smartwatch must be able to establish a connection to the server. (O: Din Gabisi)

3.1.1.3.3 The smartwatch must be able to send an HTTP POST request to add biometric data to the server. (O: Din Gabisi, M1: Weldaregay)

3.1.2 Adding emergency contact to server

3.1.2.2 Stimulus/Response Sequence:

N/A

3.1.2.3 Introduction/Purpose of Feature

Upon starting the application, users will have the ability to add emergency contacts to whom notifications will be sent if a seizure is detected.

3.1.2.3 Associated Functional Requirements

3.1.2.3.1 The smartphone must be able to establish a connection to the server. (O: Din Gabisi)

3.1.2.3.2 The smartphone must be able to send an HTTP POST request to add new emergency contacts to server. (O: Din Gabisi, M1: Hamberry, M2: Weldaregay)

3.1.3 Users must be able to manually log seizures.

3.1.3.1 Introduction/Purpose of Feature

Users must have the ability to manually log previous seizures, using the smartphone.

3.1.3.2 Stimulus/Response Sequence:

N/A

3.1.3.3 Associated Functional Requirements

3.1.3.3.1 The smartphone must be able to establish a connection to the server. (O: Din Gabisi)

3.1.3.3.2 The smartphone must query the MySQL database if the data from the period surrounding the reported time if not already available. (O: Din Gabisi/Scheible)

3.1.3.3.3 The smartphone must set the seizure tag of the reported time as true. (O: Schieble, M1: Din Gabisi, M2: Weldaregay)

3.1.3.3.4 The user must be able to manually input a start time and an end time for when the seizure occurred. (O:Scheible M1: Weldaregay, M2: Sokol, M3: Hamberry)

3.1.3.3.5 The smartphone must be able to send an HTTP POST to log new seizures to the server.

(O: Din Gabisi, M1: Schieble, M2: Weldaregay, M3: Sokol, M4: Hamberry)

3.1.4 Smartwatch Database

3.1.4.1 Introduction/Purpose of Feature

After data is collected from the smartwatch sensors, that data must be logged into the local database for later use by the machine learning algorithm.

3.1.4.2 Stimulus/Response Sequence:

N/A

3.1.4.3 Associated Functional Requirements

3.1.4.3.1 The smartwatch must be able to get accelerometer, gyroscope and heart rate data. (O: Din Gabisi)

3.1.4.3.2 The smartwatch must be able to get ambient air temperature, illuminance, ambient air pressure, and ambient relative humidity data. (O: Luckraft)

3.1.4.3.3 The smartwatch must be able to store biometric data into local database. (O: Din Gabisi)

3.1.4.3.4 The smartwatch must have a local sqlite database. (O: Din Gabisi, M1: Luckraft)

3.1.5 Notifying Emergency Contacts.

3.1.5.1 Introduction/Purpose of Feature

Notifying emergency contacts means that when a seizure is detected, the patient (end-user) will be given 30 seconds to respond to the displayed alert on the smart watch. if the patient does not respond, the patient's emergency contact(s) must receive a text message stating that the patient is having a seizure.

Stimulus / Response Sequence:

Stimulus: The patient does not respond to an alert indicating a seizure is detected in 30 seconds.

Response: A text message is sent to the patient's emergency contact(s) indicating the patient is having a seizure.

3.1.5.2 Associated Functional Requirements

3.1.5.2.1 The patient's emergency contact must receive the alert indicating the patient is having a seizure as an sms text message. (O: Abel Weldaregay, M1: Scheible, M2: Hamberry)

3.1.6 Seizsmart Non-SMS Alert.

3.1.6.1 Introduction/Purpose of Feature

Seizsmart-server provides a non-sms alert capability for watches to alert to phones which are in poor signal service areas. the phones have usernames associated with them and the watches will

have a list of usernames to which they report. the only user interaction with this process is to clear an alert, creation is handled by the watch.

3.1.6.2.2 Stimulus/Response Sequence:

N/A

3.1.6.3 Associated Functional Requirements

3.1.6.3.1 Seizsmart-server must provide the capability for phones to listen on a websocket for alerts. (O: McAteer, M1: Weldaregay)

3.1.6.3.2 Phones must identify their associated username when connecting to the websocket. (O: McAteer, M1: Weldaregay)

3.1.6.3.3 Phones must reconnect if a websocket connection is closed due to network errors. (O: McAteer, M1: Weldaregay)

3.1.6.3.4 Watches should include a list of usernames to be alerted in the /notify api request.

(O: McAteer, M1: Weldaregay)

3.1.7 Alert Payload

3.1.7.1 Introduction/Purpose of Feature

The alert to the emergency contact must contain meaningful information pertinent to helping the emergency contact aid the patient. this information includes the following specific requirements.

3.7.7.2 Stimulus/Response Sequence:

N/A

3.1.7.3 Associated Functional Requirements

3.1.7.3.1 The name of the patient having the seizure must be present in an alert message. (O: Weldaregay M1: McAteer, M2: Hamberry, M3: Weldaregay)

3.1.7.3.2 The heart rate reading at the onset of the seizure must be present in an alert message. (O: Weldaregay M1: McAteer, M2: Hamberry, M3: Weldaregay)

3.1.7.3.3 The accelerometer and gyroscope reading at the onset of the seizure must be present in an alert message. (O: Weldaregay M1: McAteer, M3: Hamberry, M4: Weldaregay)

3.1.7.3.4 Every emergency contact associated with the patient must receive the text message. (O: Weldaregay, M1: Hamberry)

3.1.7.3.5 The smartphone application must provide the capability for the patient to enable/disable emergency contact(s). (O: Weldaregay, M1: Scheible, M2: Hamberry)

3.1.7.3.6 The smartphone application must provide the capability for the patient to add emergency contacts. (O: Weldaregay, M1: McAteer, M2: Hamberry, M3: Scheible)

3.1.8 Adjusting Detection Parameters.

3.1.8.1 Introduction/Purpose of Feature

The smartwatch must be able to adjust the detection threshold values based on the output of the machine learning algorithm. the patient must also have the ability to adjust the detection parameters.

3.1.8.2 Stimulus/Response Sequence:

N/A

3.1.8.3 Associated Functional Requirements

3.1.8.3.1 Users must be able to adjust seizure detection values using smartphone. (O: Weldaregay)

3.1.8.3.2 New detection values must be sent to the external database from the output of the machine learning algorithm. (O: Weldaregay)

3.1.8.3.3 The smartwatch must be read new detection parameters from the external database. (O: Weldaregay)

3.1.8.3.4 The smartwatch must be able to determine the onset of a seizure based on the current detection parameters for the patient. (O: Weldaregay)

3.1.9 User Modifiable Error-Sensitivity.

3.1.9.1 Introduction/Purpose of Feature

Seizsmart implements a neural network to calculate a seizure probability between 0.0 and 1.0 for a given time frame. seizsmart must allow the user to indicate the error-sensitivity of the final action taken by the detection algorithm.

3.1.9.2 Stimulus/Response Sequence:

N/A

3.1.9.3 Associated Functional Requirements

3.1.9.3.1 The smartwatch must store a value to indicate error-sensitivity of the final action made by the detection algorithm. (O: Luckraft)

3.1.9.3.2 The threshold value should be between 0.0 and 1.0. (O: Luckraft)

3.1.9.3.3 The smartphone application must provide the capability to modify the threshold value. (O: Luckraft)

3.1.9.3.4 The threshold value should be set during initial setup and modifiable any time thereafter. (O: Luckraft)

3.1.9.3.5 When the threshold value is modified, the smartphone must update the threshold value on the watch. (O: Luckraft)

3.1.10 Seizure Detection

3.1.10.1 Description / Introduction to Feature:

SeizSmart must be able to recognize when the user is potentially having a seizure through the combined use of heart-rate monitoring and motion monitoring

3.1.10.2 Stimulus/Response Sequence:

N/A

3.1.10.3 Associated Functional Requirements:

3.1.10.3.1: SeizSmart must recognize input from host watch's heart rate monitor (O:Atkinson)

3.1.10.3.2: SeizSmart must recognize input from host watch's accelerometer (O:Atkinson)

3.1.10.3.3: SeizSmart must recognize input from host watch's gyroscope (O:Atkinson)

3.1.10.3.4: SeizSmart must be able to compare the above information to the user's currently set seizure profile.(O:Atkinson)

3.1.10.3.5: SeizSmart must register the result of this comparison as a flag to determine if a potential seizure episode is occuring (O:Atkinson)

3.2 Performance Requirements

3.2.1 Seizsmart Notification Delay.

Notification time measured from the time the smartwatch issues a /notify post request until the time when the user's phone displays a text should not exceed 25 seconds. (O: McAteer)

3.2.2 Seizsmart Biometric Log Size.

To reduce wear + tear on a user's smartwatch flash storage, seizsmart should not store more than 256mb of biometric data at any time. if the smartwatch has more than 256mb of biometric data it should make immediate attempts to upload this to the server and remove the old biometric data from the smartwatch. (O: McAteer)

3.2.3 Seizsmart Training Time.

To ensure a useful set of trained biometric weights is available and up-to-date, server training time measured from the time the server gets biometrics posted to /biometrics to the time a new set of weights is available from a get request to /trained-algo should not exceed 1 hour. to measure this, the server must log training beginning and end times, printing total training duration when the end of training is reached. (O: McAteer)

3.3 Assumptions and Constraints

Condition	Type	Effect on Requirements
An android smartwatch is available for the prototype	Dependency	The smartwatch must be simulated on a PC if a physical one is not available
An android smartphone is available for the prototype	Dependency	The phone must be simulated on a PC if a physical one is not available
A programmable server is available for the prototype	Dependency	The server must be simulated on a server if a physical one is not available
Only one patient will be using the SeizSmart prototype	Assumption	This allows us to skip authentication entirely, greatly simplifying the prototype and focusing the work on the seizure detection and notification pieces.
Seizures only induce motion on a 3-axis geometry	Constraint	By limiting the math needed to a 3-dimensional system we reduce the risk that trained data will actually detect on an unrelated event, such as the passage of time in a 4th dimension.
Caregivers only use mobile providers listed here	Constraint	Bounds the amount of guesswork required to correctly identify a phone number's SMS gateway address.

3.4 Non-Functional Requirements

3.4.1 Seizsmart Code Changes Should be Inspectable to Provide Maintainability.

When a code change occurs the reason for the change should be documented and the exact change should be recorded. this will allow future engineers to learn why design decisions were made and if a design decision does not work in the real world it can be easily removed from the codebase. (O: McAteer)

3.4.2 The Seizsmart Prototype Must be Delivered as an Android Package Kit (apk).

The seizsmart mobile and smartwatch application must be delivered as a .apk package that can be installed in any android device that meets the sensor and api requirements. (O: Weldaregay)

3.4.3 Security.

The data collected about the patient will be encrypted using sqlcipher. this sqlite extension will be used to encrypt data stored on the internal sqlite database running on the smartwatch and smartphone. (O: Weldaregay)

3.4.4 Reliability.

The smartwatch's seizure detection functionality must be available at all times while the device is in use. both the smartwatch and smartphone applications' connection to the server must be maintained at a high enough rate so that the internal databases do not run out of space. (O: Sokol, M1: Weldaregay)

4. Appendix

Required Equipment:

- Android 28+ Smartphone
- Android 28+ Smartwatch
- 1x Linux Server

Required Software:

- Java 8+ JDK
- MySQL
- Gradle
- Git
- Android Studio

Link to Project Repositories:

- Server: https://git-community.cs.odu.edu/fall2019-411-silver/SeizSmart-Server
- Smartphone: https://git-community.cs.odu.edu/fall2019-411-silver/seizsmart-android
- Smartwatch: https://git-community.cs.odu.edu/fall2019-411-silver/seizsmart-watch
- Project Website: https://git-community.cs.odu.edu/fall2019-411-silver/410silver-website