**SAN JOSE STATE UNIVERSITY**

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**SOFTWARE ENGINEERING - FALL 2014**

**ENTERPRISE SOFTWARE PLATFORMS (272-03)**

**SEIZURE PREDICTOR**

**SOFTWARE REQUIREMENT SPECIFICATIONS**

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1. **INTRODUCTION**

Epilepsy affects on average 5 to 8.4 of every 1000 people in the United States. It is the fourth most common neurological problem; with 1 out of every 26 US citizens will develop epilepsy at sometime in their life. Due to the common prevalence of epilepsy within our society, it is important to help prevent the negative side effects that come with the neurological condition.

A person is usually diagnosed with epilepsy after he or she experiences two seizures that were not caused by a known medical condition. Any person who experiences two or more unprovoked seizures separated by 24 hours is said to have epilepsy.

As seizures are the characteristic of epilepsy, it is crucial we help prevent the risks which come along with seizure episodes. Although many seizures end on their own and cause minimal concern, there are times during some seizures where patients can cause self-injury or create life-threatening emergencies. This can range from injuring the head while collapsing to causing a major car accident while experiencing an episode when driving.

* 1. **PURPOSE**

In an effort to help prevent devastating events while experiencing an epileptic episode, the Seizure Predictor has been developed. As the name suggests, the intent of the product is to warn those diagnosed with epilepsy during the first indicator of the onset of a seizure. This document describes the design and architecture of the Seizure Predictor in detail, intended to be read by epileptic patients interested in using the software and doctors intending to recommend the software to patients.

* 1. **DEFINITIONS**

The Seizure Predictor will be available for any patient with an Internet connection and a web browser. The product expects a series of inputs recording the Intracranial EEG using an ambulatory monitoring system. The EEG must be sampled while using 16 electrodes at 5000 Hz. The Seizure Predictor expects that the user already has his or her own monitoring device either internally or externally set up for recording brain activity. Once the client has the necessary body device to generate the needed input, the Seizure Predictor will analyze the data. By calculating the slope and comparing current slopes to past slopes, the product is able to warn users if there is an onset of a seizure. Unfortunately, the software will not be able to prevent seizures but instead help give sign to epileptic patients when a seizure is about to take place. Having the ability to warn patients when a seizure is about to occur, gives patients the possibility to stop what he or she is doing and give them a couple minutes to be able to prepare for the seizure to come. For example, if at home, the person can run to a safe spot to be in a relaxed position, or can have the chance to pull over to avoid the possibility of having a car accident.

* 1. **SYSTEM OVERVIEW**

Refer to Appendix A.

* 1. **REFERENCES**

Refer to Appendix B.

* 1. **OVERVIEW**

The remainder of this document explains all aspects related to the Seizure Predictor. This includes system requirements, the location of this product within the market of related physical equipment, product functionality, a more detailed description of intended users, inherent constraints, assumptions and dependencies, and finishes the document with a detailed description of all specified requirements of the product.

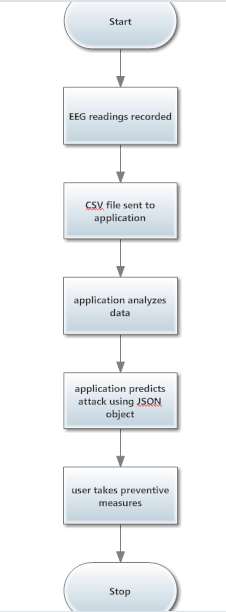
1. **OVERALL DESCRIPTION**

As epilepsy has become understood to be a common diagnosis to neurological problems, it is important products are produced to help those who carry out symptoms. As epilepsy is described by have more than one seizure within a minimum 24-hour period, being able to predict when someone is about to seize can be extremely beneficial to their overall health. Although it is not common, it is possible to greatly injure oneself or others while having an unexpected seizure. While monitoring brain activity in real time by a separate device which creates the needed EEG data can be sent to the Seizure Predictor in order to generate alerts if a seizure is about to happen. This can be very helpful if the patient is doing an activity that could otherwise threaten his or her safety if falling or becoming unconscious unexpectedly.

* 1. **PRODUCT PERSPECTIVE**

The flowchart below is a high-level overview of how the Seizure Predictor will interact with the data retrieval from the Electroencephalogram (the electrodes) and following the arrows to finish at the handheld device (which is our desktop), below is a description of how the entire seizure prediction system works:

1. Electroencephalogram attached (externally on the patient’s body) to the patient records neurological electrical activity.
2. A CSV output file is generated by the recorded data (this is done every 5 minutes), which is sent to the Seizure Predictor Service using SFTP.
3. The Seizure Predictor Service analyzes the data received to determine if unexpected activity is measured indicating a seizure to come.
4. The Seizure Predictor service generates a JSON object with the prediction.
5. SFTP is used to send the analysis output to the patient’s monitor displaying the Seizure Predictor online account.

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* + 1. **SYSTEM INTERFACES**

As shown by the diagram in Section 2.1, there will be 3 major components making up the system interfaces. The first is the CSV output file generated by the Electrode Recorder using HTTPS to send over to the Seizure Predictor Service. Once the Seizure Predictor Service analyzes the CSV file, it generates a JSON object file which is then interpreted by the browser connected to by any device. HTTPS is used again to send the resulting JSON document back.

* + 1. **USER INTERFACES**

In order for a patient to properly use the Seizure Predictor service, they must only be able to connect to the Internet using a browser. As long as the Electrode Recorder is properly sending data to the service, and the user has access to a browser and Internet, the user can freely log into the service by connecting to the proper URL in a browser, and begin viewing the results of the analyzed data. Once logging into his or her account, the user will immediately see three different methods of interpretations of the measured neurological data. An average user should be able to fully use and understand the service after reading the How To page and completing all the steps.

* + 1. **HARDWARE INTERFACES**

The service only uses HTTPS to pass necessary information between the service and the devices connecting to the service. Both input and output to the Seizure Predictor are text documents. Therefore, the only hardware interfaces necessary are standard network cards. It is expected that the user is able to connect to port 443, the standard HTTPS network port.

* + 1. **SOFTWARE INTERFACES**

The Seizure Predictor is intended to work with two separate devices:

* + - 1. Electroencephalogram
      2. Patient device connected to the service via a web browser

The Electrode Recorder is responsible for recording brain activity and writing all data points to a file in CSV format. Every 30 seconds (this is the default behavior of the Electrode Recorder) a call will be made to the Seizure Predictor service with the generated file as input. The Electrode Recorder will send this data to the Seizure Predictor over HTTPS. The Seizure Predictor will then generate a JSON document to a browser open on the client’s device opened to the service. This document will be sent over, again, using HTTPS.

* + 1. **COMMUNICATION INTERFACES**

The interface used here is the application, as the readings are taken directly from the user’s body and a graph is plotted, since we are using Ubuntu Server from a remote desktop/Putty. Presently this is a web application, so the interface is AWS.

* + 1. **MEMORY CONSTRAINTS**

Based on the patient’s recordings, the data used for analysis is a ten-minute recording of the electronic impulses of the patient’s brain. Since we have taken laboratory data (which is not real time), which is given for prediction of seizure challenge.

* + 1. **OPERATIONS**

The first operation is the user login, which is used to authenticate the user, as the hospital maintains the patient’s records with utmost privacy and security. Once the patient is able to login to the application, he will be able to extract a JSON file, which predicts the seizure prediction of the patient, based on the previous recordings maintained by the hospital. The user can also be able to view the graph of the EEG recordings, which shows the variations in the impulses.

The webpage provides a background color for the detection of seizure. For example, if the person has the onset of a seizure, the background will become red. Similarly, if the person has a warning for a seizure, the color will be yellow. For the safe zone, the color is green.

* + 1. **SITE ADAPTATION REQUIREMENTS**

The data used in our application is a csv file, which has a recording of the electronic impulses of the brain (i.e., the fluctuations that take place).

* 1. **PRODUCT FUNCTIONS**

The basic product function is to predict a seizure using the patient’s data. The data is not real time and is a sample data obtained online.

* 1. **USER CHARACTERISTICS**

The user has to be a patient, whose ID is given to him/her by the doctor. The ID has to be authenticated by the doctor beforehand.

* 1. **CONSTRAINTS, ASSUMPTIONS AND DEPENDENCIES**

The assumption in the application is that the prediction is 100% correct. The dependencies in the application are that the output is completely based on the previous recordings.

1. **SPECIFIC REQUIREMENTS**

Our application can be used through a web browser through a desktop computer or through a mobile device. We are working on Amazon Web Services Cloud Environment, Ubuntu Server, with Ipthyon Notebook installed on the server for development. The development platform is Python Language. The security technologies used are Firewall, SSH, Login for multiple users. The server is Ubuntu server 14.01 LTS.

* 1. **EXTERNAL INTERFACE REQUIREMENTS**

The main inputs received are the EEG readings, which are electronic pulses recorded from the brain. The readings demonstrate the frequency of the occurrence of an attack. The EEG reader is responsible for giving any and every reading of the brains activity. The EEG is ineffective over an average of 10% of the patients. Since the measurements are the frequency of occurrence of an attack, it usually is number of attacks in a specific time period. Since the application only predicts the future using the data already present, it is only analyzing the previous data and predicting the possibility of an epileptic attack in the patient.

* 1. **FUNCTIONAL REQUIREMENTS**

The system shall analyze the previous data, on the basis of frequency of attacks, intensity of the attack, duration of the attack, and the aftermath details as an input to add to the data and predict the possibility of an epileptic attack. The application records the patterns (electronic impulses in the brain) and draws a graph, which is our source of raw data.

The possible abnormalities in the application may be a server interrupt (many people logging in at once), or if the web browser of the user is not supported. Unavailability to access the data by the application is another situation which is an abnormality the user will be likely to face.

The various parameters are the frequency, intensity, duration, and aftermath conditions, for the data we are collecting.

The output is dependent on the inputs, that is, the previous data, the data received by the EEG reader, depending on the various parameters.

* 1. **PERFORMANCE REQUIREMENTS**

The number of EEG reader is variable for every patient. The number of users using our service is dependent on the maximum limit of the AWS users. The type of information handled here are the EEG readings (which are electronic impulses).

* 1. **LOGICAL DATABASE REQUIREMENTS**

The type of information used in the database is graphical readings of the EEG reader. The frequency of using our software depends on the condition of the patient (that is, the frequency of attacks). Any data that has been added to the database should be freely accessible (as each entry is important to predict an attack).

* 1. **DESIGN CONSTRAINTS**

There are a few limitations to this application: Firstly, the data which we have been using for prediction is not real time data, it is sample data. Secondly, the user has to have an internet connection at all times. Thirdly, the web browser which he is using should be operating at all times and should be open.

* + 1. **STANDARDS COMPLIANCE**

The application complies with all rules. The application is not created with real time data, so it complies with the rules.

* 1. **SOFTWARE SYSTEM ATTRIBUTES**

There are a few limitations to this application: Firstly, the data which we have been using for prediction is not real time data, it is sample data. Secondly, the user has to have an internet connection at all times. Thirdly, the web browser which he is using should be operating at all times and should be open.

* + 1. **RELIABILITY**

The application is developed using the AWS, it may not be available if the server has experienced technical difficulties. Also, the predictions are done on the basis of the data already available. It is quite possible that the prediction may be somewhat incorrect.

* + 1. **AVAILABILITY**

The application is available whenever the user switches on the application on in the browser, and accesses it accordingly.

* + 1. **SECURITY**

The application is secure as each user has an individual user ID and login credentials are unique.

* + 1. **MAINTAINABILITY**

Since this is the first increment of the software, whatever technical issues are observed and reported will be dealt with accordingly.

* + 1. **PORTABILITY**

Since the application is accessible online, the software will work as long as the browser supports it.

* 1. **ORGANIZING SPECIFIC REQUIREMENTS**
     1. **SYSTEM MODE**

The application can only work on normal mode, and is not able to run on any other mode (e.g., safe mode).

* + 1. **USER CLASS**

The user here is only the patient. He has a patient ID authenticated by the doctor and is using it by user name and password.

* + 1. **OBJECTS**

The object here is the EEG sensor, patient and doctor. The doctor is responsible for the authentication of the patient ID. The patient checks his EEG reports by the application, which uses the data provided by the EEG sensor.

* + 1. **FEATURE**

The feature of the application is to provide a graphical output of the data which has been entered by the EEG sensor into the application of the patient.

* + 1. **STIMULUS**

The response is recorded from the patient, by the application, which in turn, uses it to plot a graph.

* + 1. **RESPONSE**

The response to the patient using our application here is the graph obtained. It will show imminent threats to the patient.

* + 1. **FUNCTIONAL HIERARCHY**

The functional hierarchy of the application is producing the data on the basis of the inputs obtained from the EEG sensor.

* + 1. **ADDITIONAL COMMENTS**

For future development, the target to be achieved is to reach 99.99% accuracy of prediction of seizures, using real-time data. Also, we need to develop a mobile application, as in the real world, it is impossible to stay in front of a desktop computer all the time, even if it is a portable laptop.

1. **TESTING**
   1. **CODE TESTING**

We have used python scripts for our data analytics for the prediction of seizures in patients. We have validated and evaluated the python script code using the static code analysis. We have used Pylint tool to evaluate the errors in our code. The rating was 9 out of 10 for both the scripts.

This tool basically provides the information of unused variables, duplicate variables, indentation, spacing, etc…

* 1. **WEB APPLICATION TESTING**

Since we have deployed our application on AWS, it is always up and running, and the user does not see an error of a broken link. So, this ensures that our service is available at all times.

* 1. **WEB APPLICATION PERFORMANCE TESTING**

We have utilized an online web page test tool about how a webpage functions parallel with different users. The response time was unique, there was no delay in the display of the web page. It also supports parallel processing.

1. **SUPPORTING INFORMATION**

This section gives the table of contents and the appendices (references).

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   1. **APPENDICES**
      1. **APPENDIX A**
         1. EEG - Electroencephalography - recording of electrical activity in the brain measured by electrodes.
         2. Seizure - Sudden surge of electrical activity in the brain.
         3. Interictal - The state of being between seizures, or baseline.
         4. Preictal - The state prior to having a seizure.
         5. Ictal - The state of having a seizure.
         6. Postictal - The state after having a seizure.

# **APPENDIX B**

# "About Epilepsy: The Basics." *Epilepsy Foundation*. Epilepsy Foundation, n.d. Web. 23 Nov. 2014. <<http://www.epilepsy.com/learn/about-epilepsy-basics>>.

# "Epilepsy Statistics." *Epilepsy Foundation*. Epilepsy Foundation, n.d. Web. 24 Nov. 2014. <<http://www.epilepsy.com/learn/epilepsy-statistics>>.

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# "Predict Seizures in Intracranial EEG Recordings." *American Epilepsy Society Seizure Prediction Challenge*. Kaggle, n.d. Web. 10 Oct. 2014. <<https://www.kaggle.com/c/seizures-prediction>>.