CZ-1 – DL Alzheimer's

Software Requirements Specification (SRS)

CS 4850 - Sections 02 & 04 - Fall 2025
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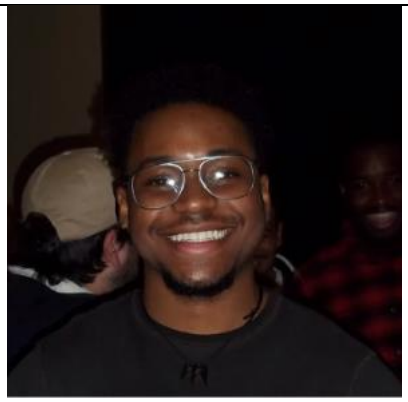
 Julia Johnson Developer	 Jordan Rainford Developer

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Table of Contents

1.0 Introduction

1.1 Overview

Alzheimer's disease (AD) is a common disorder that presents many challenges for early diagnosis. Our project aims to improve AD staging prediction by integrating deep learning models with MRI images to make better AD staging predictions. We will perform comprehensive preprocessing of MRI images and electronic health record data to develop a deep learning model with improved predictive accuracy for diagnosing AD.

1.2 Project Goals

Our goal is to gain a deeper understanding of AD progression and contribute to the development of more advanced diagnostic and prognostic tools for the disease, as well as advance clinical outcomes for people suffering from AD. In more narrow language, our main goal is to utilize machine learning techniques to improve predictive accuracy for AD.

1.3 Definitions and Acronyms

AD : Alzheimers Disease

Progressive brain disorder that destroys memory and thinking skills, causing the inability to carry out simple tasks

Spm12 : Statistical Parametric Mapping (version 12)

Widely used, free, and open-source tool for the analysis of brain imaging data such as fMRI, PET, and EEG

Cat12 : Computational Anatomy Toolbox

Software package for analyzing structural MRI data using techniques like voxel-based morphometry and surface-based morphometry

DPABI : Data Processing & Analysis of Brain Imaging

Open-source MATLAB-based toolbox for processing and analyzing brain imaging data, particularly resting-state functional MRI (R-fMRI) data

MRI : Magnetic Resonance Imaging

Non-invasive medical imaging procedure that uses powerful magnets and radio waves to create detailed pictures of organs, soft tissues, bones, and other internal body structures

AAL3v2 : Automated Anatomical Labeling (version 3 iteration 2)

Digital map of the human brain used in neuroimaging research. The atlas divides a normalized single-subject brain into 171 distinct anatomical regions

1.4 Assumptions

This project is dependent on many external aspects, including but not limited to the following:

1. AD presents in a way that is recognizable to a Deep Learning Model
2. Data scans from all data sources are sufficiently standardized
3. Availability of several sufficiently large datasets, with data sufficient for training, testing, and validating the model
4. Ability of a Deep Learning model to generalize across patient demographics
5. Quality of MRI images will allow for clear and consistent segmentation of each image

These assumptions are largely addressed by the preliminary steps we are taking to prime data for ingestion into a deep learning model. We are confident in our ability to control the above factors to provide the most accurate and useful data to train on.

2.0 Design Constraints

2.1 Environment

This project's needs are bound to the resources given to us by the CSSE Research department, as well as those allotted to us by Dr. Chen.

Environmental Constraints for this project will mostly concern themselves with the power constraints involved with inefficient deep learning models. Most deep learning models draw significant amounts of power and require significant amounts of time to train. These are the external resources we must be the wariest of during the design and development phases of this project.

2.2 User Experience Characteristics

This project is bound by a large set of constraints based on the intended users of the end program, as well as the necessity for the output data to be easily understood.

UX Constraints will be that the output data must be organized in a way conducive to human readability and optimized for understanding within a research context. The system must respond quickly with easily understandable prompts when ingesting data, as well as when exporting data. The system must also contain an extensive error handling and error notification segment, which ensures that the user or developer knows exactly what's going wrong within the system.

Again, our main goal is not to create a consumer product with this project, but to create a research aid to scientists. Therefore, the perspective of a research scientist will be what guides us to make UX decisions within this program.

2.3 System

Since we're utilizing machine learning to accomplish the predictive aspect of this project, we are constrained to utilizing Python as the language has the most widely used and developed frameworks for software development. We are also constrained to utilizing the CSSE Lab

equipment, which provides us with an NVIDIA GeForce RTX 4090 to run our model on for processing of the MRI Images.

3.0 Functional Requirements

The system(s) must allow for the following:

- Ensure MRI images are correctly processed, segmented, and primed for ingestion
- Ensure EHR health data is correctly processed and primed for ingestion
- Generate a predicted AD Stage and attach said stage to the patient scans and data
- Adjust from previous training sessions to increase accuracy over time

4.0 Non-Functional Requirements

4.1 Security

- System must require permissions to access generated data
- System must not allow for unauthorized access of any EHR data

4.2 Capacity

- System must generate prediction result within a specified time frame
- System must maintain an uptime of at least 80% once developed
- System must manage multiple parallel processes when ingesting data
- System must perform consistently and accurately across multiple test cases

4.3 Usability

- System must be usable with any MRI image data
- System must be accurate with new, unseen data