EXPANDING THE TEMPORAL EVOLUTION OF ALZHEIMER'S DISEASE THROUGH MULTI-MODAL DATA

Keywords: Alzheimer's Disease, Structural MRI (sMRI), Functional MRI (fMRI), Mild Cognitive Impairment (MCI), GPU computing

Summary: I propose to use multiple imaging systems, such as structural and functional MRI imaging to provide a temporal evolution of Alzheimer's disease (AD) with multi-modal data. It will include patients that show no symptoms and patients that have MCI. This temporal evolution will show how different regions of the brain changes and how AD evolves. The hippocampus region will be a main region of interest, but other regions like the temporal lobe will be examined [2,3]. In addition with the imaging system, looking at the cerebrospinal fluid will provide great insight to how AD affects the body [1]. I will also incorporate GPU computing to make it efficient.

Motivation: AD is ranked as one of the leading diseases in increasing deaths. AD plans to increase among the world, which will have an effect on the economy. It is proposed that the expected cost of AD will rise to $1.2 trillion by 2050 [2]. Some methods have shown how some patients who have MCI evolve into AD [4]. If AD is not detected early, it will lead the patients to be in the latter stages of AD. The latter stages, such as stage 5 create severe cognitive decline and require the AD patient to need assistance in performing routine tasks [2]. Thus, detecting AD early is very crucial.

Hypothesis: Detecting AD in the early stages could be very beneficial to future patients, but has been a challenge. One group has said that validating imaging biomarkers for AD has brought controversial findings [5]. Now, using multi-modal data, such as fMRI, sMRI, and other imaging systems, could capture how AD progresses through time. With seeing different areas of the brain and CSF, it could provide insight to how AD evolves with patients that show no symptoms and patients that have MCI.

Research Strategy: To develop an extensive model of what makes AD develop between patients that show no symptoms at all and patients that have MCI.

Objective 1: Identify the critical parts/aspects that could lead to Alzheimer's developing.
Objective 2: Examine the different imaging systems that have been used to look for AD, such as fMRI, sMRI, PET, and etc.
Objective 3: Extract the regions from the different imaging systems that show where AD could develop and run pattern recognition methods to classify which are likely to develop.
Objective 4: Identify which interconnections between regions to show how the disease progresses.

Research Methodology: This research methodology is based on several pattern recognition approach. Other people have used different image processing techniques to extract regions of

interest that show where Alzheimer's could develop and use pattern recognition to classify the regions. Overall, biomedical image processing and pattern recognition will be the foundation in developing more information about detecting AD in the early stages.

Anticipated Results: The anticipated result will show how different areas of the brain can show how Alzheimer's progresses throughout the patient's age. It will also show evolution between patients with no previous symptoms and patients with MCI. Plus, I plan to incorporate GPU computing so the data could be computed faster because some of the imaging systems, such as fMRI is computationally expensive and extensive [1]. The research that is conducted will be submitted to a journal paper. A journal publication could be sent to IEEE Transactions or Computer Vision and Pattern Recognition.

Institution: Dr. Alan C. Bovik from University of Texas at Austin is a great professor to conduct research for this project. One of his research areas is biomedical engineering. His work has done detection and diagnosis of breast cancer. The Laboratory for Image and Video Engineering would be a great place to conduct research for this project.

Intellectual Merit and Broader Impacts: This research could be valuable to the medical field. It would help multiple people in trying to understand more about AD. The major problem with AD is trying to diagnose it earlier in the beginning stages because there people could prepare. When AD is detected at the latter stages, the damage is done and the patients diagnosed with AD will need to be cared for the rest of their life. If a new patient is experiencing common trends compared to a previous patient where it showed the patient's temporal evolution, then the temporal evolution can provide a model to show if a new patient with similar patterns will develop AD.

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