Disease modelling

Alzheimer's Disease modelling.

"It began as a family argument and ended in tragedy -- a teenage girl stabbed to death by her elderly grandfather in a case that shocked a nation. This elderly man with Alzheimer's killed his granddaughter. He says he doesn't remember". By Heather Chen and Yuki Kurihara, CNN

Link: https://edition.cnn.com/2022/06/11/asia/japan-man-grandfather-alzheimers-murder-crime-intl-hnk/index.html

This was a recent article posted by Cable News Network. In court his lawyers argued that he should not be criminally responsible because of his illness. However, he was sentenced to 4 and a half year of prison. The news shocked the whole of Japan. This was the start that motivated us to work on the project study on the disease Alzheimer's.

Alzheimer's disease is a type of brain disease, the neurons damaged first are those in parts of the brain responsible for memory, language and thinking. As a result, the first symptoms of Alzheimer's disease tend to be memory, language and thinking problems.

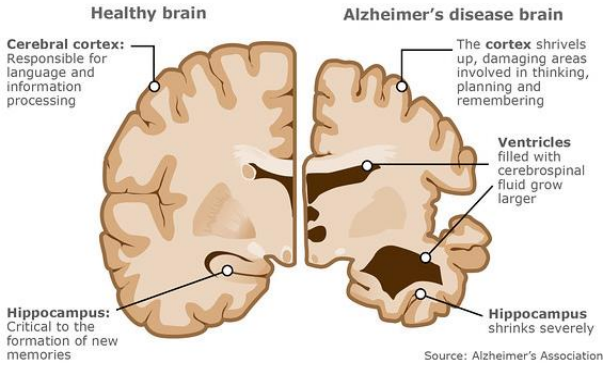
Age and genetics are the greatest of the risk factors. The percentage of people with Alzheimer's dementia increases dramatically with age: 5.0% of people age 65 to 74, 13.1% of people age 75 to 84 and 33.2% of people age 85 or older have Alzheimer's dementia. A small percentage of Alzheimer's cases (an estimated 1% or less)91 develop as a result of mutations to any of the three specific gene.

Further on studying about the disease world health organization states the following about the rate of disease.

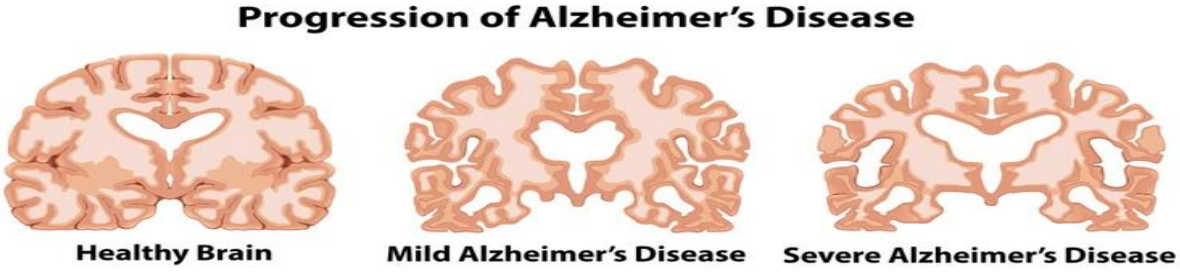
"Worldwide, around 55 million people have dementia, with over 60% living in low- and middle-income countries. As the proportion of older people in the population is increasing in nearly every country, this number is expected to rise to 78 million in 2030 and 139 million in 2050"

Link: https://www.who.int/news-room/fact-sheets/detail/dementia

WHO also states that it is seventh leading cause of death and currently no treatment is available to cure the disease. It is estimated that 1 in 3 seniors dies with Alzheimer's.



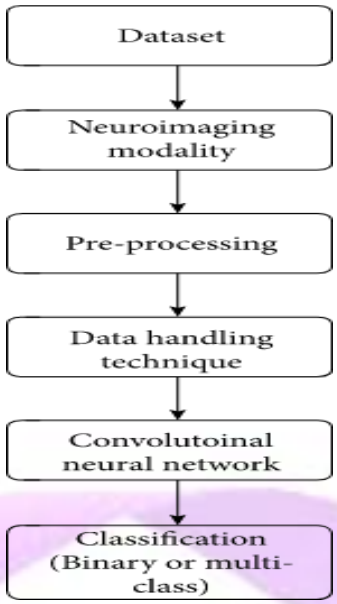
There are different stages of the disease. The hippocampus and cerebral cortex reduce and the cerebral ventricles to enlarge. The intensity of all these disruptions depends on the stage of the disease. Early patients with Alzheimer's are referred to as having Mild Cognitive Impairment.



The detection of the disease can be made at the mild stage such that the disease can be further prevented using medication or treatment. The changes in the brain can be understood by neuroimaging which gives us an image of organ tissue and changes related to blood flow.

In this project we use CNN architecture to model the disease, which helps us to extract low level to complex level features of the image. The CNN network trains filters that activate only when it sees some specific features at some particular location in the input.

Before analysis, the neuroimaging modalities undergo a series of pre-processing steps that are required to improve and prepare the data for further usage. And this is one of the mandatory steps, as the complete triumph of an automatic diagnostic system relies emphatically upon how effectively the pre-processing steps are considered.The data is then passed on to the CNN model when series of tuning is performed to overcome the overfitting and obtain more efficiency.



Flow Chart

Alzheimer's is most widely recognized as an irreversible degenerative disorder and leads to neuronal cell death. The effects of the disease can be stopped when the detection is done in the early stage as we know prevention is better than cure. Hence by the end of the project we would be able to model the MRI data to classify if the person has Alzheimer's.

LITERATURE SURVEY:

[1] Alexander Selvikvåg Lundervoldab, Arvid Lundervold, ***"An overview of deep learning in medical imaging focusing on MRI"***

This paper describes about the how deep learning can be applied to the MRI processing chain, i.e., from acquisition to image retrieval and from segmentation to disease prediction. The paper also shares a detailed explanation about CNN and also shows applications with MIRs of different human organs, like kidney, prostate, spine and brain.

November 2018.Medizinische Physik, Journal of Medical Physics.

[2] Monika Sethi, Sachin Ahuja, ***"Alzheimer's Disease Classification Based on Convolutional Neural Network"***

This paper proposes an efficient Convolution neural network architecture that relies on neuroimaging (MRI) scans of the brain. This paper also describes methods adopted for Alzheimer's classification, pre-processing methods used and the sort of data inputted to the CNN model. Patch and ROI data handling methods are much more efficient as compared to slice- and voxel-based techniques. 3D CNN is being employed to gain spatial correlations of 3D MRI images, and they provide better performance in comparison to the 2D CNN

December 2021. BioMed Research International.

[3] Guilherme Folego, Marina Weiler, ***"Alzheimer's Disease Detection Through Whole-Brain 3D-CNN MRI"***

This paper focuses on the methodology proposed for an end-to-end deep 3D CNN for the multiclass AD biomarker identification task, using the whole image volume as input. Here the method did not use any domain-specific knowledge from Alzheimer's with accuracy around 53% and the model being considerably fast.

October 2020.Front Bioeng Biotechnol, National Library of Medicine.