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PROPOSED SYSTEM FOR DETECTION OF ALZHEIMER'S DISEASE

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Abstract: Alzheimer's disease is a neurological disorder in which the death of brain cells causes memory loss and cognitive decline. It is a type of dementia that gradually destroys brain cells, affecting a person's memory. It is an irreversible, progressive brain disorder that slowly destroys memory, thinking skills and the ability to carry out the simplest tasks. Alzheimer's disease is the most common cause of dementia among older adults. Pre-detection is crucial for such a disease as drugs will be most effective if administered early in the course of the disease. If not done on time, it can lead to irreversible brain damage. Therefore, it is very important to utilize automated techniques for pre-detection of Alzheimer's symptoms from such data. The system uses an experimental approach to evaluate the best pre-detection method of Alzheimer's disease. The study consists of two parts. First is obtaining the Alzheimer's disease Neuroimaging Initiative (ADNI) dataset and performing Image Processing on it which will be used to train the system. Next is using a Deep Learning algorithm to detect the disease from this neuroimaging data.

Keywords: ADNI, Alzheimer's Disease, Convolution Neural Networks, Deep Learning, Image Processing

I. INTRODUCTION

Alzheimer's disease is a "progressive" disease. Its symptoms usually start slowly and are mild. In the later stages of the disease, a person who has Alzheimer's is no longer able to communicate and depends entirely on his/her family or friends. A person having Alzheimer's disease can experience health complications such as Depression, Unreported pain, Pneumonia, Dehydration or Malnutrition [1]. Though there isn't any cure for the disease, an early detection with effective medication can help keep the brain cells active, thus making a person's life a little better. The aim of this project therefore is to develop a system for detecting Alzheimer's disease in its early stage. It will be using a deep learning model for classification of patients into different categories.

As a part of the literature survey, a few papers on the existing systems were read. A comparison was made to understand the advantages and disadvantages of using different algorithms. The conclusion was that Convolution Neural Network is the best algorithm as it gives the highest accuracy. Different designs were made to understand the flow of this project. Preprocessing of images was successfully completed. Training of the system model is currently being worked on. The dataset which has been used provides brain MRI scans of a large population suffering from Alzheimer's disease, few of them suffering from a stage lower. Data preprocessing was needed as the images contain unnecessary labels and noise. Next step is training CNN model with these preprocessed images and the last step is classification.

II. LITERATURE SURVEY

Some of the existing systems were studied while reading different papers on systems used to Detect Alzheimer's Disease from MRI scans.

First was Watershed Algorithm. Watershed Algorithm performs transformation on grayscale images. In [2], the study focused only on the hippocampus region of the brain. The watershed algorithm was used to identify the hippocampus from MRI scan of the brain. This algorithm, which is a segmentation technique, is used when the areas of interest in an image are very close to each other. The algorithm helped obtain an accuracy of 87%. The grayscale images that were used for the study were blur and hence, their system could not achieve a higher success rate.

A two-stage learning method was used in the study by [3]. In this, Sparse filtering was done in the first stage to learn the features of all MRI scans of the brain which were obtained from ADNI dataset. Sparse filtering was used to optimize a simple cost function instead of constructing a model for data distribution. The system involved conversion of 3D MRI into 2D and then creating patches from the three physical planes of imaging. These patches were then fed to the proposed network. SoftMax regression was applied to the then learned features in the second stage. This was used to normalize the input values into a vector of values. The SoftMax layer has four output classes and achieved an accuracy of 98.7%.

Convolutional Neural Networks (CNNs) is a category of deep neural network which has proven very effective in areas such as image recognition and classification. Also, it is a type of feed-forward Artificial Neural Network which learns image features on its own with the help of a convolutional layer. In [4], a convolution layer was used to handle image filtration. A pooling layer was then used for reducing sample size and controlling overfitting. ADNI and OASIS dataset was used for this study and achieved 90% accuracy.

III. PROPOSED SYSTEM

The aim is to develop a system that will take in the Brain MRI scan of a person and detect the presence of Alzheimer's Disease. Few terminologies were taken into consideration. First was CN (Cognitively Normal) which describes the brain of a person who is completely free of the disease. MCI (Mild Cognitive Impairment) is the initial stage which causes a decline in the brain cells, leading to AD (Alzheimer's Disease). AD is when the patient totally loses his/her ability to respond to the environment.

There is a minute difference between the brain MRI scans of MCI and AD patients. It is therefore difficult to visually distinguish between these scans and identify the presence of AD. This is only possible with the help of a computing system.

The system proposed is a deep learning model which will be trained using brain MRI scans belonging to the three categories explained above. The data being used to train the system will consist of processed brain MRI scans of patients of ages ranging from under 2 to over 85. The images used will be of DICOM format. DICOM gives individual slice from a single scan. As each scan has different number of slices, it is difficult to estimate the slice number for every patient. The system will therefore be using the middlemost slice of each scan where the features of the brain are more prominent.

The pre-processed images will be fed to the Convolution Neural Network model for training and classification. The Convolution Neural Network consists of a Convolution layer, Activation layer and a Pooling layer. The various filters will be applied to the input images in the Convolution layer. ReLU activation layer will be used to train the network faster without making a significant difference to the accuracy. Then a pooling layer will be applied to the outputs generated by the activation layer. The function of Pooling layer is to progressively reduce the spatial size of representation to reduce the number of parameters and computation in the network.

IV. DESIGN

Fig. 1 represents the flowchart of the training model. It starts with data pre-processing stage. The images used were in DICOM format. The feature vectors from these images were obtained. A feature vector is a vector that contains information describing an object's important characteristics. In image processing, features can take many forms. A simple feature representation of an image is the raw intensity value of each pixel. However, more complicated feature representations are also possible [4]. The classifier will be trained with the help of the feature vector.

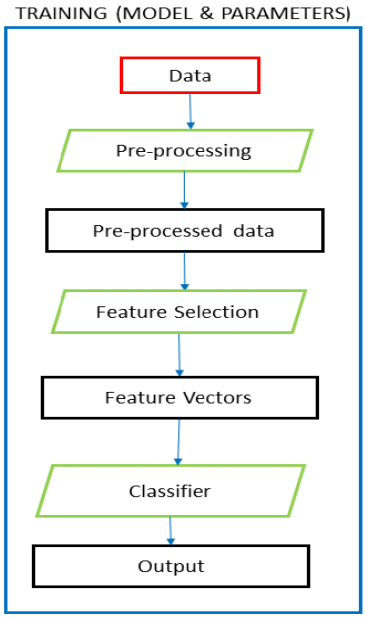

Fig. 1. Block Diagram for Training Model.

Fig. 2 represents the flowchart of the testing model. It begins with pre-processing of the testing dataset images which are in DICOM format. The next step is extracting feature vectors from these processed images which will be fed into the trained CNN model. The model will then classify the image based on comparison to the trained dataset.

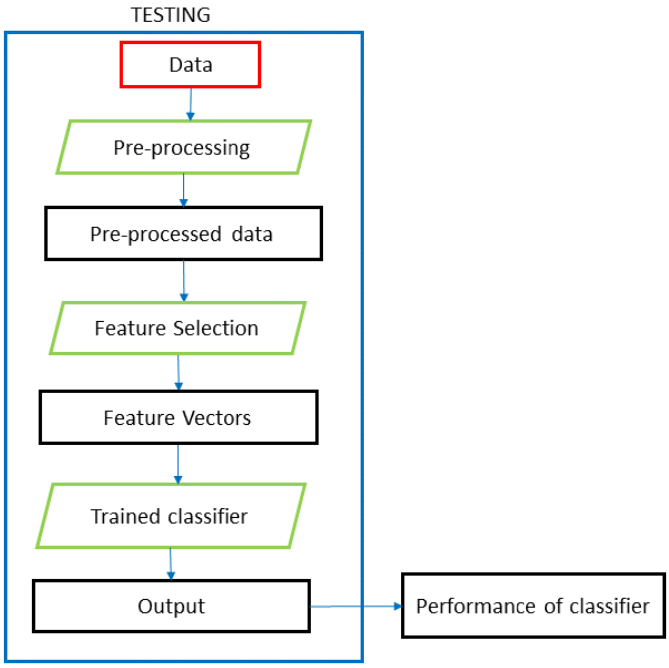

Fig. 2. Block Diagram for Testing Model.

V. ABOUT DATASET

The dataset being used is ADNI (Alzheimer's Disease Neuroimaging Initiative). ADNI is a globally designed clinical acquired website developed by the University of Southern California [6]. The dataset consists of images which are used in imaging genetic and biochemical biomarkers for the tracking of Alzheimer's disease (AD). The AD research enables sharing of data between researchers around the world.

ADNI helps in the study of detecting the earliest possible stage of the disease using biomarkers. It also advances in AD interventions, prevention and treatment through diagnostic methods and it also provides job security to the scientists in the world.

ADNI researchers collect many forms of knowledge from study volunteers throughout their participation within the study, employing a customary set of protocols and procedures to eliminate inconsistencies. This info is accessible at no cost to licensed investigators through the LONI Image and Data Archive (IDA).

The dataset is available in three views of the brain which are namely Axial, Coronal and Sagittal. The dataset provides various scans of a single patient in different views. Each scan consists of different slices of the brain. The dataset covers the age range of 2-85 years.

VI. IMAGE PROCESSING

Image pre-processing and feature extraction are very important when it comes to an image-based application. The quality of data being trained has a huge impact on the system accuracy. It was therefore necessary to process the brain MRI scans obtained from ADNI. The system began with removal of film-artifacts and labels from the DICOM images. Then, it moved on to skull stripping. Skull stripping refers to removing

skull outline from the brain MRI scan. Skull Stripping results in better segmentation of different brain regions. It therefore helps with accurate diagnosis of any brain-related disease. Next step was image smoothing. Image Smoothing helps with diminishing the noise and missing pixel values. Neighborhood averaging and edge - preservation smoothing techniques were used for blurring the background and focusing on the Region of Interest (ROI) [7].

Next was contrast enhancement using Histogram Equalization. Histogram Equalization was used to improve contrast in images. It involves stretching out the intensity range of the image.

After this, region-based mask extraction was performed. This was used to extract the Hippocampus region from the brain which is the feature that was decided to be used. The Hippocampus is situated in the temporal lobe of the brain. It plays a role in information processing and is one of the main features involved in Alzheimer's Disease. The Hippocampus can be seen clearly in the coronal plane of the brain as it is angled perpendicular to the long axis of the hippocampal body. Fig 3 is a sample of the images on which image processing was performed:

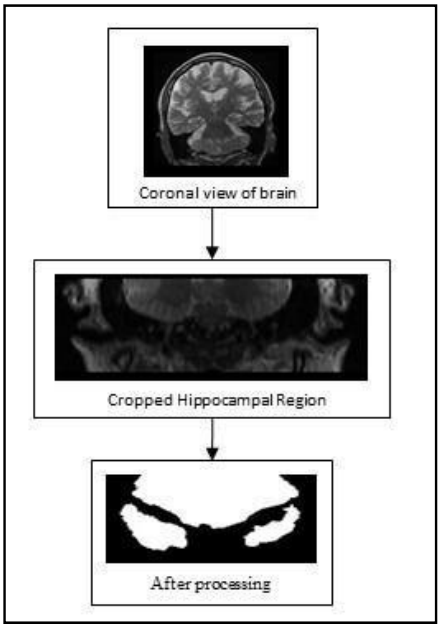

Fig. 3. Image Preprocessing Pipeline

VII. CONCLUSION

The cause and effect of Alzheimer's disease was hence studied. The treatments carried out by Doctors as well as the current systems for detection of the same were studied. Dataset for training the model was obtained and pre-processing techniques were performed on the images. These images can now be used to train the system using a Deep Learning algorithm. Image pre-processing techniques were thus implemented.

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