Alzheimer's Stage Classification Using Image Processing

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ABSTRACT: Alzheimer's disease (AD) is most common type of dementia, is an incurable, progressive neurological brain disease beginning with mild memory loss, possibly leading to loss of the ability to carry on a conversation and respond to environments. It can severely affect the person's ability to carry out daily activities. Early detection of Alzheimer's disease can help with proper treatment and prevent brain tissue damage. Several statistical and machine learning models have been exploited for Alzheimer's disease diagnosis. Analyzing Magnetic Resonance Imaging (MRI) is a common practice for Alzheimer's disease diagnosis. It can clearly reflect the internal structure of a brain and plays an important role in Alzheimer's diagnosis of disease. Detection of Alzheimer's disease is exacting due to the similarity in Alzheimer's disease MRI data and standard healthy MRI data of older people. Advanced deep learning techniques have successfully demonstrated human level performance in numerous fields including medical image analysis. We have proposed a trained and predictive model using Deep Convolutional Neural Networks (CNN) for Alzheimer's disease diagnosis using brain MRI data analysis. While most of the existing approaches perform binary classification of disease, our model canidentify different stages of Alzheimer's disease and obtains superior performance for early- stage diagnosis.

***KeyWords*:** Image classification, oversampled, MRI image data, convolution neural network.

1. INTRODUCTION

Brain is the primary organ of the human body. The diseases that affect brain is very crucial tohandle since mostly once changes occur it is irreversible in extreme cases. Diagnosis of brain disease is considered one of the most challenging medical task to perform. Alzheimer's diseaseis a type of brain disease, just as coronary artery disease is a type of heart disease. It is also a degenerative disease, meaning that it becomes worse with time. Alzheimer's disease is the most common type of dementia. One in every 3 seconds a new person someone somewhere is affected by dementia. Alzheimer disease is caused by both genetic and environmental factors,those affects the brain of a person over time. The Cause of Alzheimer's Disease are some genetic component for early onset Alzheimer's and Late – onset Alzheimer's begin from complex series of brain change. The other causes are genetic environment Lifestyle, Health and Detecting changes in body fluid and changes in body fluid and changes in brain can detectAlzheimer's disease. Alzheimer's disease is thought to begin 20 years or more before symptoms arise with small changes in the brain that are unnoticeable to the person affected. Only after years of brain changes do individuals experience noticeable symptoms, such as memory loss and language problems. Symptoms occur because nerve cells (neurons) in parts of the brain involved in thinking, learning and memory (cognitive function) have been damaged or destroyed. Individuals typically live with Alzheimer's symptoms for years. Over time, symptoms tend to increase and start interfering with individual's ability to perform everyday activities. At this point, the individual is said to have dementia due to Alzheimer's disease or Alzheimer's dementia. As the disease progresses, neurons in other parts of the brain are damaged or destroyed. Activities that used to be core to the individual's identity, such as planning family events or participating in sports, may no longer be possible. Eventually, neurons in parts of the brain that enable a person to carry out basic bodily functions, such as walking and swallowing are affected. People in the final stages of Alzheimer's disease are bed-bound and require around the clock care. Alzheimer's disease is ultimately fatal.

Alzheimer's disease is a neurological condition in which the death of brain cells causes memory loss and cognitive decline Alzheimer's disease is a condition that affects the brain. The symptoms are mild at first and become more severe over time. There is no treatment to cure Alzheimer's disease. The diagnosis at MCI stage will help the person to focus on healthy approach of life, and good planning to take care of approach of life, and good planning to take care of. The objective of the AD Detect and prevent project is to develop an integrated and seamless solutionfor people with Alzheimer's disease.

2. LITERATURE SURYEY

I. Alzheimer Disease Prediction using Machine Learning Algorithms. Author: J.Neelaveni, M.S.Geetha Devasana. **Year**: 2020.

Alzheimer disease is challenging one because there is no treatment for the disease. Diagnosis Of the disease is done but that too at the later stage only. Thus if the disease is predicted earlier, the progression or the symptoms of the disease can be slow down. The author has used machine learning algorithms to predict the Alzheimer disease using psychological parameters like age, number of visit, Mini Mental State Examination (MMSE) and education.

II. Classification of Alzheimer's Disease in MRI based on Dictionary Learning and Heavy Tailed Modelling. Author: Perla Mayo, Robin Holmes, Alin Achim. **Year**: 2019.

Diagnosis of brain disease is considered as one of the challenging medical task to perform, even for medical experts who rely on high-resolution anatomical images to identify signs of abnormalities by visual inspection. In this author presents a model to aid in the task of classification of structural MRI scans.

The classification is done using a Support Vector Machine (SVM), whilst the features to analyze belong to a dictionary space. Such space was mainly built from a dictionary learning perspective, although a predefined one was also assessed. The results indicates that features learnt from the data of interest lead to improved classification performance.

III. Using Machine Learning Methods for Detecting Alzheimer's Disease through Hippocampal Volume Analysis. Author: Gokce UYSAL, Mahmut OZTURK. **Year:** 2019.

Alzheimer's disease is the most common cause of dementia and the incidence of the disease increases with age. The author presents accessing the utility of image processing on the MRI scans to estimate the probability of early diagnosis of dementia in Alzheimer's disease. The data is diagnosed by the Alzheimer's Disease Neuroimaging Initiative(ADNI) protocol. The dataset was formed based on age, gender, diagnosis, right and left hippocampal volume values. The diagnosis via hippocampal value information was made by machine learning techniques. By using this approach, conclusion is made that brain MRI's can be used to separate the patients with Alzheimer's Disease (AD), Mild Cognitive Impairment (MCI), and Cognitive Impairment (CN); while most researches were only be able to separate AD with CNN.

IV. Alzheimer's Disease And Dementia Detection From 3D Brain MRI data Using Deep Convolutional Neural Networks. Author: H.M.Tarek Ullah, Riashat Islam, Zishan Ahmed Onik, Dr.Dip nandi. **Year**: 2018.

As reported by the Alzheimer's Association, there are more than 5 million American's living with Alzheimer's today, with an anticipated 16 million by 2050. As of this authors research, detecting Alzheimer's is a difficult and time consuming task, but requires brain imaging report and human expertise. In this research Deep Learning represents the true bleeding edge of Machine Intelligence. Convolutional Neural Networks are biologically inspired Multilayer perceptron specially capable of image processing. This results a state of the art Deep Convolutional Neural Network to detect Alzheimer's disease and Dementia using 3D MRI image.

3. METHODOLOGY

The proposed system consists of the following 5 steps:

STAGE 1: INPUT IMAGE

Take as input, MRI scan of a patient. Generally input to CNN are image pixel values .CNN extracts the features in the input image and learns some weight over the epochs.

STAGE 2: GRAYSCALING

Convert the image to gray scale .The complete pixel turns to gray, no other color will be seen.

STAGE 3: CONVERT GRAY SCALING TO ARRAY

Here, Numpy is used to convert the gray scale image into array format.

STAGE 4: MODEL INPUT

Input the array values to the model as per requirement.

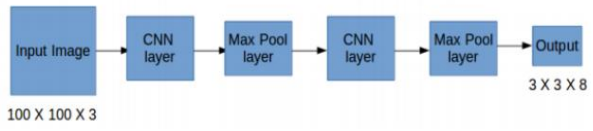


Fig 3.1 TRAINED MODEL

STAGE 5: PREDICT THE DATA

Use the trained classifier to predict the output for the patient's MRI scan. Given Data is checked here ,whether it is predicting properly or not.

Stages of disease

A) MODERATE DEMENTED

B) NON DEMENTED

C) VERY MILD DEMENTED

D) MILD DEMENTED

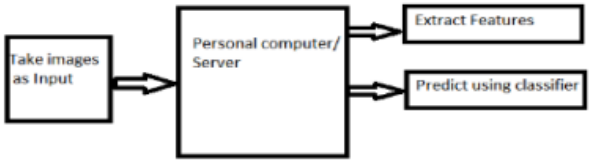


Figure 3.2 BLOCK DIAGRAM

The proposed approach is divided into two phases:

Training phase: A set of labeled MRI scans is preprocessed for ROI extraction and segmentation.

The training phase can be summarized as follows:

a) Extract features such as Texture, Shape and Area from the pre-processed MRI scans.

b) Train an ANN classifier using this feature set.

The output of the training phase is a trained classifier capable of predicting classification label based on features of MRI scan.

The performance of the trained classifier can be evaluated using measures like accuracy, sensitivity and specificity.

Classification: This phase can be summarized as follows:

a) Take as input, MRI scan of a patient.

b) Pre-process the MRI scan.

c) Extract the required features from the patient's MRI scan.

d) Use the trained classifier to predict the classification label for the patient's MRI scan

A. Dataset: An MRI based dataset is considered from the Open Access Series of Imaging Studies (OASIS): the project aimed at making MRI data sets of the brain freely available to the scientific community. The dataset consists of processed MR images. Additional information such as the patients age, gender, education, socio-economic status, Mini Mental State Examination (MMSE) score are also available with the scans.

B. ROI Extraction: The hippocampus is the first region in the brain that gets affected during the Alzheimer's disease.

Therefore, the proposed work focuses on the hippocampus region for detection of AD which will be extracted as the Region of Interest from the MRI scan. Masking based correlation technique will be used for extraction of ROI. In this technique, a mask with ROI extracted manually is run through the subject image and the hippocampus region from the subject image is extracted as ROI using maximum correlation value.

C. Feature Extraction: The Texture, Shape and Area features will be extracted from the Hippocampus region of the Brain for detection of AD. The Gray Level Co-occurrence Matrix will be used to extract the texture features and the Shape, Area features will be extracted using seven moment invariants. The features available with the dataset such as age, gender, education, socio-economic status, Mini-Mental Examination Score will also be extracted. These extracted features will then be used to generate the feature vector.

Classification phase: It has following steps.

1. Preprocess MRI scan for ROI extraction.

2. Extract texture, shape and area features of the hippocampus region (ROI).

3.Feed the feature vector to the trained CNN for classification.

4.Determine the appropriate label from the response of the CNN.

Algorithm used:

CNN Algorithm

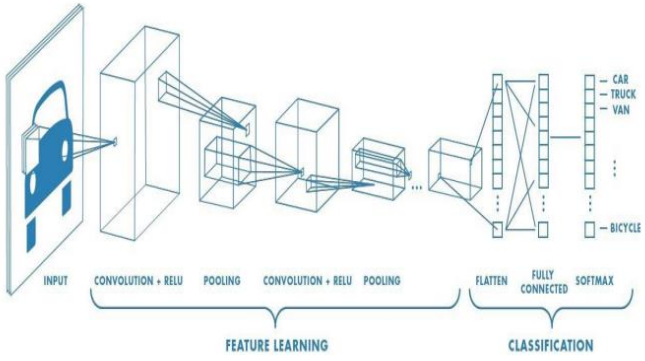


Figure3.3: External view of CNN

CNN works by extracting features from the images. Any CNN consists of the following:

1. The input layer which is a gray scale image

2. The Output layer which is a binary or multi-class labels

3. Hidden layers consisting of convolution layers, ReLU (rectified linear unit) layers, the pooling layers, and a fully connected Neural Network

It is very important to understand that ANN or Artificial Neural Networks, made up of multiple neurons is not capable of extracting features from the image. This is where a combination of convolution and pooling layers comes into the picture. Similarly, the convolution and pooling layers can't perform classification hence we need a fully Connected Neural Network.

The role of CNN is to reduce the images into a form that is easier to process, without losing features critical towards a good prediction. This is important when we need to make the algorithm scalable to massive datasets.

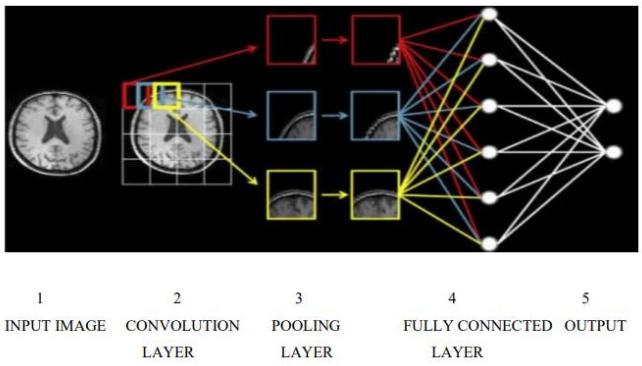


Figure 3.4: Functions of CNN

FUNCTIONS OF EACH LAYER CONVOLUTION LAYER: converts images into an array and converts negative numbers into zeros.

Figure 3.5: Convolution Layer

POOLING LAYER: Reduces the Image Size and Image segmentation takes place and perform operation on infected area.

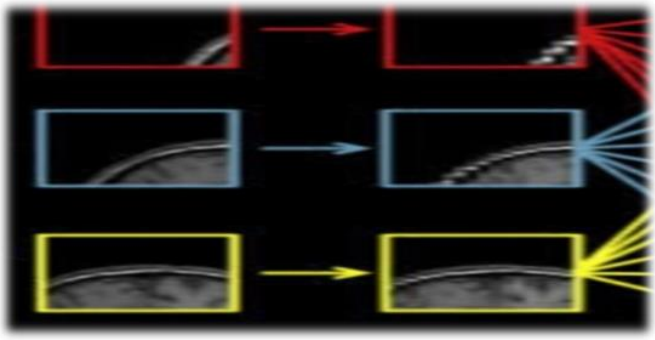


Figure 3.6: Pooling layer

FULLY CONNECTED LAYER: Combines the extracted features and represents a new model.

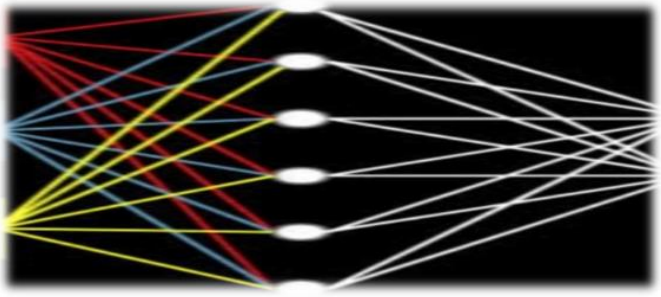


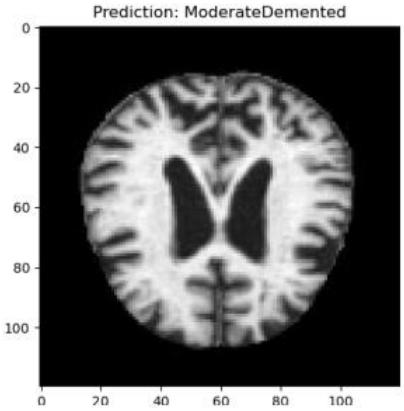
Figure 3.7: Fully connected layer

In short think of CNN algorithm that can take an input image, assign importance (learnable weights and biases) to various aspects/objects in the image, and be able to differentiate one from the other.

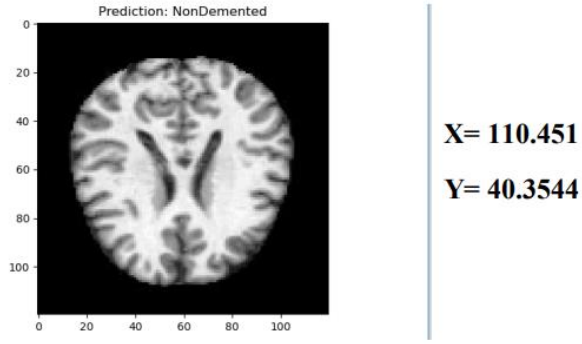
4. RESULTS

PREDICTION OF STAGES

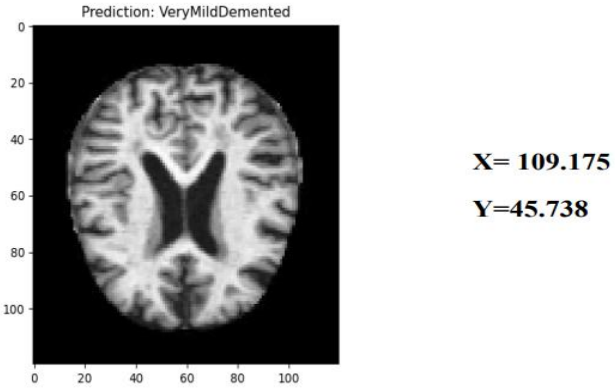
A) MODERATE DEMENTED



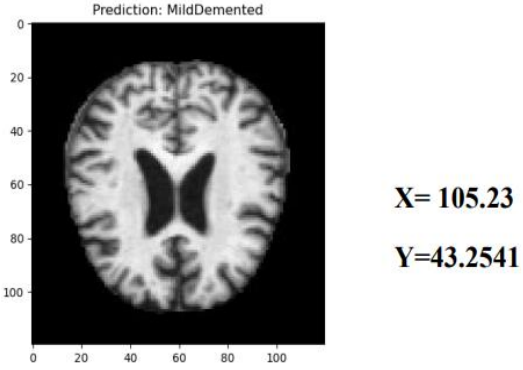
B) NON DEMENTED



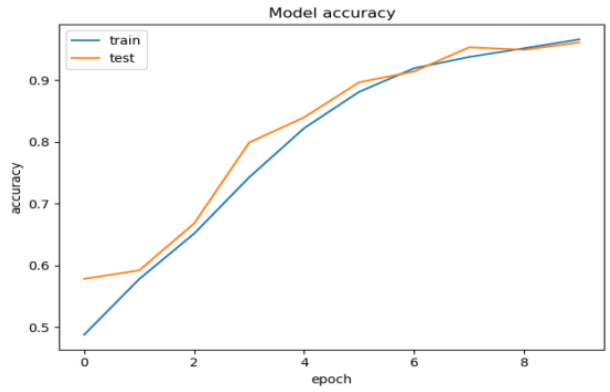
C) VERY MILD DEMENTED



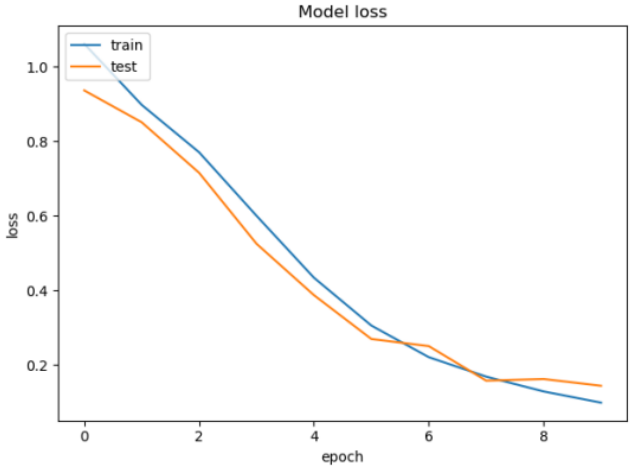
D) MILD DEMENTED



Accuracy v/s Epoch



Accuracy v/s Loss



5. CONCLUSION

The purpose of early detection of Alzheimer's disease is achieved. The implementation is doneusing image processing method for the identification of disease. The Disease will classify the patient stage of disease as MILD DEMENTED, MODERATE DEMENTED, NON DEMENTED, VERY MILD DEMENTED. CNN does not require any tedious preprocessing of input images and hand designed features, faster convergence rate and good training performance, it is preferred for many applications rather than the conventional algorithms. The classification accuracy can be further increased by providing more images in the dataset and tuning the parameters of the CNN model.

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