ALZHEASE CARE
Alzheimer's Prediction using Deep Learning

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Abstract **- As per reports by the Alzheimer's Disease association, more than 5 million Americans are living with Alzheimer's Disease today, with an anticipated 16 million by 2050. 1 in 3 seniors die because of Alzheimer's disease or different types of dementia. No treatment developed so far can cure a patient who is already in AD. So prevention is better than cure. MR image samples were used to distinguish between healthy individuals, patients with Alzheimer's disease, and those with mild cognitive impairment. To understand the changes in the brain we use MRI images as input. Pre-processing methods were performed before images were given as input to the model. After preprocessing the image data, we created CNNs and performed evaluations on these models.**

Keywords - 3D Brain image , Image processing, Convolutional Neural Network

I. INTRODUCTION

Alzheimer's disease (AD), an irreversible, progressive neurodegenerative disorder, causes problems with memory, thinking, and behavior. The early symptoms of Alzheimer's disease are memory loss, mood changes, poor judgement, social withdrawal, changes in vision. This happens because Alzheimer's disease affects the hippocampus, which plays an important role in memory. One in every 3 seconds a new person somewhere is affected by dementia. At first, it typically destroys neurons and their connections in parts of the brain involved in memory, including the entorhinal cortex and hippocampus. Hence, to understand the changes in the brain need to be studied and explored. It is in this context that MRI images are used as input. and a use a deep learning approach is used to study the variations shown by various factors to calculate the transition from Mild Cognitive Impairment (MCI) to AD. So when changes are evident in those factors, one can be aware of such changes and take needed medications.

II. PROPOSED SYSTEM

The aim of our work is to aid in detecting the different stages of Alzheimer's Disease. The system predicts the conversion from Mild Cognitive Impairment (MCI) to probable Alzheimer's Disease using Image Processing. A website wherein the patients can access their case files and update their treatment regimen along with their test reports to know the prognosis of the disease has also been created. Here the various stages of Alzheimer's disease are detected and to maximize the accuracy of disease prediction.

III. LITERATURE SURVEY

Neelaveni and Devasena proposed machine learning techniques along with psychological parameters like Number of visits, Age, MMSE Score, and education of the patient used for early detection of AD. Machine learning algorithms Support vector machine and Decision tree were used to classify AD in patients and distinguish between cognitive impairment.

Shahbaz et al proposed a six different Machine learning algorithms and Data Mining techniques to classify five different stages of Alzheimer's disease and to distinguish different attributes for each stage of Alzheimer's Disease among ADNI dataset. The results of this paper revealed that Generalized Linear Model can efficiently classify the stages of Alzheimer's Disease with an accuracy of 88.24% on the test data set.

Alex Fedorov investigates the use of variants of DIM in a setting of progression to Alzheimer's's disease comparison with supervised AlexNet and ResNet inspired Convolutional neural networks. Here classification is done between four groups: patients with stable and progressive mild cognitive impairment, with Alzheimer's's disease and healthy control. ADNI database is used here.

Mr Amir Ebrahimi Oshnavieh proposed Alzheimer's disease prediction using Deep Learning. Intensity normalization and registration are key preprocessing methods in AD detection. Here for feature extraction patch-based methods are used on disease related regions. Convolutional neural network is used .

Taeho Jo used Data mining approaches for the early detection and automated classification of AD. Personal information, age, MMSE score is used as data set .Data Mining techniques like CNN and RNN were used. It produces higher accuracy.

Garam Lee's work proposes a method for prediction of the conversion of Mild cognitive impairment to Alzheimer's disease. A deep learning approach called multimodal recurrent neural network was used. There is a transitional stage between cognitively normal adults and AD patients called Mild cognitive impairment (MCI). This method takes the longitudinal and multi-modal nature of available data and it discovers nonlinear patterns associated with MCI progression. The goal of ADNI (Alzheimer's Disease Neuroimaging Initiative) is to test whether magnetic resonance imaging (MRI), positron emission tomography (PET), other biological markers, clinical and neuropsychological assessment could be

used to measure the progression of MCI and AD. The methods use a recurrent neural network and Multi-modal GRU for MCI conversion prediction. The results showed that they achieved the better prediction accuracy of MCI to AD conversion by using longitudinal multi-domain data. A multi-modal deep learning approach has the potential to identify the risk of developing AD who might benefit most from a clinical trial.

Aunsia Khan r presents a review, analysis and critical evaluation of the recent work done for the early detection of AD using ML techniques. Many other factors such as pre-processing, the number of important attributes for feature selection, class imbalance distinctively affect the assessment of the prediction accuracy. To overcome these limitations, a model is proposed which consists of an initial pre-processing step followed by imperative attributes selection and classification is achieved using association rule mining. The proposed model-based approach gives the right direction for research in early diagnosis of AD and has the potential to distinguish AD from healthy controls.

Ji Hwan Park in this research, it focuses on developing a progressing framework to diagnose and predict AD at a very early stage with the data collected for AD patients. The collected data is fed into the framework with the input needed to deploy the computational modelling and the machine learning techniques to predict and diagnose AD. The research depends on gathering data from various existing datasets such as ADNI, and it includes collected data related to DNA, dietary, medical history, lifestyle and any other related data linked to the risk factors of AD.

Fan Zhang proposed the methods accurate diagnosis of MCI is essential for the early diagnosis and treatment of AD. This paper presents a deep learning model for the auxiliary diagnosis of AD, which simulates the clinician's diagnostic process. The proposed model provides a comprehensive analysis about patient's pathology and psychology at the same time; therefore, it improves the accuracy of auxiliary diagnosis. The results of multimodal neuro-imaging diagnosis are combined with the results of clinical neuro-psychological diagnosis.

Ammarah Farooq this work proposes a deep convolutional neural network pipeline based on the diagnosis of Alzheimer's disease and its stages using magnetic resonance imaging (MRI) scan. Alzheimer's disease causes permanent damage to brain cells associated with memory and memory skills. Diagnosis of Alzheimer's in the elderly is very difficult and requires a differentiating factor due to similar brain patterns and pixel strength. Deep learning strategies are able to learn such representations from the data. In this paper, a 4-way classification is used to differentiate Alzheimer's (AD), mild cognitive impairment (MCI), late mild cognitive impairment (LMCI) and healthy persons. Tests were performed using the ADNI database on a high-resolution graphics system and new technological results were available for a variety of disease classifications. This proposed method results in a predictable accuracy of 98.8%, which is a significant increase in inaccuracy compared to previous studies and clearly demonstrates the effectiveness of the proposed method.

IV. ALGORITHM

After prepressing the image data, we created CNNs and performed evaluations on these models. CNNs are deep artificial neural networks and commonly used in image related applications such as image classification, clustering, and interpretation. They are inspired by the layered vision mechanism of humans. The improvement of the hardware and the increased processing capacity of graphics processing units (GPUs) has allowed the training of deep networks on computers more efficiently. Big data, which can be collected from many platforms, are the basis for the implementation of CNNs and other deep learning models. Because CNNs are designed as deep models, they can provide sufficient results in solving complex problems. The model, which is trained with the back-propagated algorithm, could make predictions on the pixels of the image without feature extraction. In the following years, many successful deep models such as AlexNet, ZFNet, GoogleNet, VGGNet, and ResNet have been created. The structure of CNNs consists of a convolutional layer, a pooling layer, and fully connected layers. Generally, many convolutional layers and pooling layers are stacked one after the other to produce a feature map, and the generated map is fed into the fully connected layer. In the convolutional layer, a filter with a determined size of n×n is applied to the image expressed as pixel matrices.

The filter is applied by moving over the pixel metrices and navigating the entire image matrix. Depending on the type of filter applied, some features of the image are revealed. In the pooling layer, the size of the spatial dimension is reduced by performing the sub-sampling process. In this way, pooling layers provide ease of computation as well as providing a solution for over-fitting. This layer can optionally be selected as maximum or average pooling. In the maximum pooling, the maximum pixel in the window is selected, while the average of the pixels in the window is obtained in the average pooling. After these operations, classification according to the feature map containing the extracted features is made by the fully connected layer, which might be multi-layer perceptrons. In the present study, three CNN models of similar structure were constructed. The type of pooling layer was determined as maximum pooling. A rectified linear unit (ReLU), which is widely used in modern deep learning models, was used as the activation function. Let x and f(x) be the number of inputs and an activation function, respectively. The ReLU is defined as $f(x) = \max(0, x)$. Moreover, a binary cross-entropy function was employed as a loss function.
This function is also called log loss due to logarithmic operations. Different models were obtained by changing the total number and positions of the layers.

V. METHODS

A. General Framework

To understand the changes in the brain we use MRI images as input. We use deep learning approach to study the variations shown by these factors to calculate the transition from MCI to AD. So, when changes are happening in those factors, we can be aware about that and take needed medications. Since the number of different prediction images was not the same, the data addition process was used. Other advancing methods were performed before the images were presented as input to the model. MR images were used to distinguish between healthy individuals, patients with Alzheimer's disease, and those with mild dementia. One of the MR data sets was used for the training process, while the other set of data was used for testing. Since the number of different prediction images was not the same, the data addition process was used. Other advancing methods were performed before the images were presented as input to the model. CNN models with different layers were created and then applied for the classification of Alzheimer's disease types. Performance was compared in terms of the diagnostic potential of the proposed model.

B. Preprocessing of brain MRI data

In prepressing of brain MRI data, volumetric brain MRI data were studied and imaging processing techniques used. Alzheimer's disease and dementia are neurological disorders that affect the nerve cells so it is wise to remove unnecessary information. Because the skull, eyes, fat, and muscles are unaffected by these diseases, these regions are unnecessary data in the green images. FSL is a complete library of data analysis tools for magnetic resonance imaging (FMRI), MRI, and diffusion tensor imaging (DTI) applications. BET is an automated method of classifying MRI images as areas of the brain and nonbrain areas. The amount of histogram is calculated from the input image. The triangular tessellation of the spinal cord is initiated internally in the brain and allows for slow rotation of one vertex at a time, following the force that keeps the area well separated and smooth, while trying to get to the edges of the brain. It is repeated with a high smooth bar until a clean solution is obtained. As a result of this process, nonbrain objects are removed from the input image. The nonbrain regions found are being analyzed. We selected ten slices from the axial, sagittal, and coronal projections for each patient's volumetric brain data. While selecting these slices, we paid attention to choose regions such as the hippocampus, thalamus, hypothalamus, amygdala, cerebellum, frontal lobe, parietal lobe, occipital lobe, and corpus callosum, which are affected in dementia and Alzheimer's disease. A data augmentation method was applied because of the unbalanced number of patient samples, which might lead to overfitting of the model. For this purpose, 10% right and left, up and down shifting, 20% zoom, and 20% shear operations were applied; zoomed and changed position images were produced. After an equal number of patient samples were obtained, the images were resized to 150×150×1.

The non brain regions obtained are processed. Image processing techniques like gray scaling and histogram equalization is mainly done on them. Grayscale is a range of monochromatic shades from black to white. Therefore, a grayscale image contains only shades of gray and no color. Gray-scaling is the process of converting a continuous-tone image to an image that a computer can manipulate. Histogram equalization is a method to process images in order to adjust the contrast of an image by modifying the intensity distribution of the histogram. The objective of this technique is to give a linear trend to the cumulative probability function associated with the image. And then these images are rotated to get the images at various angles. These are also flipped to get the mirror image. So, now we have more images in the dataset which can improve the training process and the accuracy. This will also help our model to classify the images even if they are given rotated or flipped.

C. Implementation of models

After pre-processing the image data, we created CNNs and performed evaluations on these models. CNNs are deep artificial neural networks and commonly used in image related applications such as image classification, clustering, and interpretation. They are inspired by the layered vision mechanism of humans. The improvement of the hardware and the increased processing capacity of graphics processing units (GPUs) has allowed the training of deep networks on computers more efficiently. Big data, which can be collected from many platforms, are the basis for the implementation of CNNs and other deep learning models. Because CNNs are designed as deep models, they can provide sufficient results in solving complex problems. The obtained desired image is then fed into the Convolutional Neural Network (CNN) Algorithm as input. The structure of CNNs consists of a convolutional layer, a pooling layer, and fully connected layers. Generally, many convolutional layers and pooling layers are stacked one after the other to produce a feature map, and the generated map is fed into the fully connected layer.

VI. TECHNOLOGY

A. Deep Learning

Deep Learning is an Artificial Intelligence function used to emulate the workings of the human brain in processing data and also generating tatters for use in decision making. It is also known as Deep Neural Learning or Deep Neural Network and is a subset of Machine Learning in Artificial Intelligence that involves networks capable of training unsupervised from data that is unlabeled or unstructured. Deep Learning is applied across all industries for a number of various tasks. Commercial apps that make use of image recognition, open source platforms with consumer apps, and medical research implements that probe the possibility of drug reusability for new ailments are some of the examples that come under Deep Learning incorporation.

B.Convolutional Neural Network(CNN)

In deep learning, a Convolutional Neural Network(CNN) or ConvNet encompasses a class of deep neural networks which is most commonly applied in order to analyze visual imagery. In neural networks as a whole, CNN is one of the most widely used neural networks to perform a number of applications like image recognition, image classification, object detection, face recognition etc. The Convolutional neural Network algorithm which basically takes in an input image, assigns learnable weights/biases to various objects/aspects in the image and enables differentiation of one from the other. Hence, in this project, the CNN algorithm is used for processing the images before the training. Other classification algorithms require much more pre-processing than is required in ConvNet.

C.Python

One of the popular and consistently ranked programming languages is Python. Its object oriented approach together with its language constructs aid programmers to write clear, logical codes for both small and large-scale projects. Being dynamically typed and garbage collected, it helps to support multiple programming paradigms comprising structured, object oriented and functional programming. Taking all the above facts into consideration, this project to detect Alzheimer's Disease was designed and implemented using Python and its various libraries, including a neural network platform library-Keras running on top of the open source machine learning platform-TensorFlow and a core Python library-Numpy.

1) Keras

A high level neural networks library and the most used deep learning framework written in Python programming language, running on top of the machine learning platform TensorFlow. This makes it an extremely simple and intuitive library to use.

2) TensorFlow

An end-to-end open-source Machine Learning platform for Keras. It consists of a comprehensive and flexible ecosystem of libraries, tools and various other resources that aid in providing workflows with high-level APIs.

3) NumPy

NumPy, a core Python library that provides the multidimensional array objects and a collection of routines for processing those arrays, is a simple yet powerful data structure used for scientific computing. This method uses NumPy arrays to store the images while it is in training.

VII. EXPERIMENT RESULTS

In our proposed model the deep Learning algorithm called Convolutional neural Network is used to detect Alzheimer's Disease. Feature extraction and classification are the two parts in Deep Neural Network's. Here, we use MRI images of the patient as input to detect the stage of the disease. The input image is then processed. In image processing, the images are divided into four stages; mild-demented, moderatedemented, non-demented and very-mild-demented. Before training the machine, we pre-processed the data to make the data set of the same type. To make the parameters the same, gray scale and adaptive equalization are used. Gray scaling is the process of converting an image from other color spaces (e.g RGB) to shades of gray. Adaptive histogram equalization is a method in image processing of contrast adjustment using the image's' histogram. To train the machine we want to maintain a minimum range. By maintaining it, the efficiency of the model increases. For that, rotate and flip functions are used to increase the number of images to maintain the minimum count.

In preprocessing the data, we count the number of images. Images can be rotated to any degree clockwise or anti-clockwise. We just need to define rotation matrix listing rotation point, degree of rotation and the scaling factor. When the range is above minimum value, flip and rotate functions can't be applied. They are used to increase the number of images. The processed data is given to train the model. In training, four classes named path1, path2, path3, and path 4 are used. The processed data folder contains the different stages of Alzheimer's disease. Path is an argument in the load image function where we can give an address. Load image function contains the path from the class. Here the images are stored as NumPy arrays. We use a horizontal stack function to make labels together. Int function is used to specify the data type. Here, we apply normalization to make every value in the same range. Shape function is used to get the number of classes of the images. For splitting our image for training and testing, the train and test function is applied. Convolution 2D is the input layer in model function where the input is taken.That's why input shape is specified. Max Pooling is used to bring the features of the convolution layer together. Drop layer eliminates the unwanted features.

Batch normalization normalizes the features of each layer deeply. Flatten is used to make images in one array. Next part in the deep neural network is the classification part. Here the dense layer contains the number of neurons. Final dense layer contains the total number of neurons. Soft max activation function is used to make the final model layer. Then we compile the model. Validation split function is used to split the 20% of data. Then we save the model. Matplotlib.pyplot is used to view the output of the model trained as a graph. Here we plot the graph as two satins. After testing the data 0.96is the accuracy and prints the data. In the testing part, it is a combination of pre-processing. Load image function in Keras model we load our model and assign it to a model.Then we normalize data. At final we got the corresponding patient's stage of Alzheimer's disease as output.

We implemented this as a website. The user can log into the site using their login credentials. Here the patient can input the brain images. After applying the CNN algorithm, the output determines the stage of Alzheimer's disease of the patient.

VIII. CONCLUSION

During this uncertain period of Covid-19, we came to the realization of how prevention is better than cure. We set out to find a suitable way to predict the occurrence of Alzheimer's, a serious disease. Besides the benefit of early diagnosis to the patients, it also contributes to the national economy. This economic contribution is related to the lower cost of treatments applied in early stages of dementia compared to in later stages.

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