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Perception of Alzheimer's Disease using CNN and Multi-model Image

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Abstract -*Alzheimer's Disease (AD) is a progressive neurodegenerative disease. In spite of the fact that most popular Alzheimer disease symptoms include trouble thinking, making judgment and decision, not able to do familiar task it's going to also cause alteration in personality and behavior .The factor of AD development is poorly known. As the sickness advances, an individual with Alzheimer disease will develop severe amnesia and lose the capacity to perform everyday activation. This incurable disease is mainly found within elderly people. The deep learning approach has been taken up for the classification process. Neuroimaging technique like MRI and PET scan are used for AD detection. For better result multi model neuroimaging technique are used with deep learning algorithm for Alzheimer classification. In this project we are going to use MRI along with PET scan and CNN (convolution neural network) for image classification into normal cognitive (NC), mild cognitive impairment (MCI) and Alzheimer disease (AD).*

Key Words: Alzheimer disease, deep learning, convolutional neural network, transfer learning, MRI, PET

1. INTRODUCTION

In Alzheimer disease brain cell degrades that results in shrinkage of hippocampus, shrinkage of cerebral cortex, enlargement of ventricals that eventually causes memory loss .A person diagnose with Alzheimer faces difficulties in managing day to day life. It affects patients social life. The Alzheimer's Association estimates nearly 6 million Americans suffer from the disease and it is the 6th leading cause of death in the US. The estimated cost of AD was $277 billion in the US in 2018. The association estimates that *early and accurate* diagnoses could save up to $7.9 trillion in medical and care costs over the next few decades. Early detection of the Alzheimer disease will help in early treatment, which can prevent the exaggeration of the symptoms. There is no medication that stops or reverses the progression of AD. For successful Alzheimer disease detection , several examination is required like mini mental state examination, physical and neuro biological exams along with patients detail history is also required. Manual diagnoses of Alzheimer's disease is time consuming and prone to human error therefore it is reasonable to use computer advantages such as speed and accuracy to make Alzheimer's diagnosis. In Convolutional Neural Networks there are four main types of layers that perform the basic tasks of such networks: convolution, pooling, normalization and connection. Because of the Convolution Layer, the input image picture is prepared by an variety of convolutional filters to separate the attributes contained in those parts. Pooling Layer is being use for reducing the size of the data being analyzed,, thereby decreasing the sensitivity of the network to the distortion of the analyzed scene. The essential strategies utilized in this layer are max pooling, when the biggest value is chosen in the parsed window and averaging, when its value is averaged. The ReLED layer (Rectified Linear Units Layer) by data normalization builds the networks capacity to tackle nonlinear issues. CNN comprise of numerous layers on progressive levels, yet the last connection in such a system is the accommodation of results to the last layer – Fully Connected Layer. This layer brings about the last rating, permitting the different assignments. The distinctive component of CNN over classical neural network is that the quantity of layers is a lot higher. The depth of neural network architecture is defined as the length of the longest path between the input and output neurons. There is no precise threshold of the layers number, allowing one to call the network "deep", but it has been assumed that it refers to the network with more than two hidden layers. CNN is used to Minimize computation compared to a regular neural network. Convolution simplifies computation to a great extent without losing the essence of the data. They are great at handling image classification. They use the same knowledge across all image locations.

2. LITERATURE REVIEW

In [1], the author visualized 3D Structural MR-Images in 3 perpendicular planes namely Axial, Coronal, Sagittal planes. They have done feature extraction based on first order statistics for gray matter and white matter of all three orthogonal images. After that they calculated Co-relation matrix for feature Extraction and for feature reduction they used PCA(Principal Componet Analysis). Finally they did binary classification using SVM(Support Vector Machine), AdaBoost, Naïve Bayes and logistic Regression classifiers. They achieved accuracy of 99.9% on white matter using naïve bayes classifier.

In [2], the author have used 3D Structural MR-Images to get away from information loss which occur during 3D image slicing into 2D. For this research work they have used ADNI and OASIS both publicly available datasets they build 3D VGG variant CNN(Convolutional Neural Network).For binary classification of Alzheimer's and achieved accuracy of 73.4%

± 0.04(mean, standard deviation) and 69.9% ±0.06(mean, standard deviation) on ADNI and OASIS dataset respectively.

In [3], the author have used 3-4 image slices from single scan for every subject after preprocessing these slices CNN network was trained for AD classification. CNN architecture includes 4 conv2D layers each followed by max pool layer and after that 2 fully connected layer. Author have used 3 types of activation functions sigmoid, relu and to avoid vanishing gradient problem leaky relu is used.

In [4], the author have used 3D CNN to FDG and AV-45 PET images for classification of AD/NC. After training this network author gave MCI subject images as input to predict whether MCI subject will develop a AD in future. This method achieve accuracy of 96% for AD/NC and 84.2% for MCI to AD converting subject

In [7], the author have proposed to combine transfer learning on 2D CNN with LSTM(Long Short Term Memory) network. Pretrained CNN was used to extract feature for MR-Images and LSTM is used to include spatial dependency across the MRI slices .

In [8] the author used deep convolutional neural network (DCNN) to extract the most useful features of the structural magnetic resonance imaging (MRI). Firstly, the structural MRIs are pre-processed in a strict pipeline. Then, instead of parcellating regions of interest, we re-slice each volume, and put the resliced images into a DCNN directly. Finally, four stages of Alzheimer's are identified, and the average accuracy is 94.5% for NC versus LMCI, 96.9% for NC versus AD, 97.2% for LMCI and AD, 97.81% for EMCI versus AD, 94.8% for LMCI versus EMCI. The results show that the DCNN outperforms existing methods.

In [9], the proposed method is that the 3D images are given as input (axial Sagittal or Coronal) slices at a time, each slice is the like a pixel of an image (176x220) axial slice dimension. They applied PCA+TSNE for dimension reduction, as this becomes highly complex for classification. The reduced dimension now becomes into an 609x3=1827 for single RAW MRI scan the above dimension are obtained by a generated CNN features. So the Output results will be 2 different working principle to be compared, Navies Bayes and KNN, whichever has the highest accuracy among them will be the output.In this case, the Trained CNN with the proposed idea has the highest accuracy with 88.2%.

In [10] DATASET is used for preprocessing. The data used consists of MRI images of the brain in DICOM format which is collected from (ADNI) database. The images are MRI, fMRI, PET, which is one of the functions used in the deep learning approach. This is used to insert non-linearity into the network to offer better performance.The pre-trained networks(softmax layer) is used for performance comparison are AlexNet(25 layered network which is 8 layers deep), ResNet-18(18 layers), and GoogLe Net(144 layers). The satisfactory within a minimum span of time is the network which is selected. The training, testing, and Classification are carried out in GPU platform. The final output is compared and the true positive, true negative, false positive, false negative are the values obtained from the confusion charts used to find the other performance metrics like recall, specificity and prediction, and score. So the Final output is converted to RGB format. AlexNet being the smallest, Resnet-18 and GoogLe Net with the same performance but shows that has attained the optimum value of accuracy.

In [11], 30 2D slices in the axial plane located above the eye is selected for each visit examination for every subject these images are directly given as input to CNN for feature extraction . After feature extraction, random forest , SVM, KNN where used for AD classification accuracy of this method is 0.88%, 0.95% and 0.85% for random forest, SVM and KNN respectively. Images used for this work was obtained from MIRIAD dataset.

3. OUR PROPOSED METHOD

We are going to use combination of MRI and PET scan. So that model can extract both structural and function feature of brain for Alzheimer classification. To avoid data loss we are going to use 3D images. We are going to build our own Convolution neural network and train it with neuroimages to classify into CN,MCI,AD .we are going to give both MRI and PET images for train and test .After that we will compare performance of above classification. And then load pretrained network(like Alexnet , Vgg16) to compare the performance of our proposed network and pretrained network. In this we are going to use feed forward CNN with back propogation

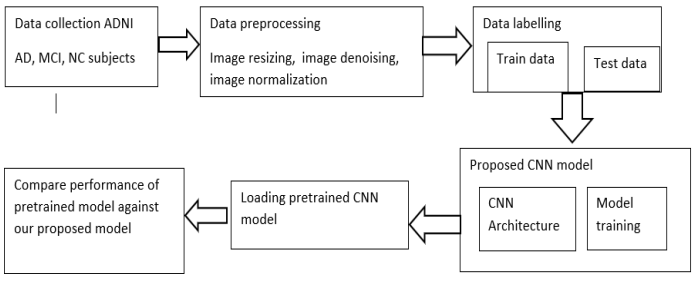

Fig -1: System Diagram

4. EXPERIMENTAL DATA

ADNI1 is an exploration activity that unites scientists to gather, approve, and use a few sorts of information, for example, clinical, hereditary, MRI, PET, and biospecimen to approve biomarkers for AD. ADNI is framed in 2004 and dispatched three distinct stages up until this point, to be specific ADNI 1, ADNI GO/2, and now ADNI 3.

Notwithstanding the main stage, ADNI 2 contains data from 150 older controls, 100 EMCI subjects, 150 late mild cognitive impairment (LMCI) subjects, and 150 mild AD patients.

For our project we are using ADNI 2 dataset with 500 structural MRI Scan T1- weighted and FDG PET images. 100 subjects of AD , 100 subjects of NC , and 150 subjects of MCI.

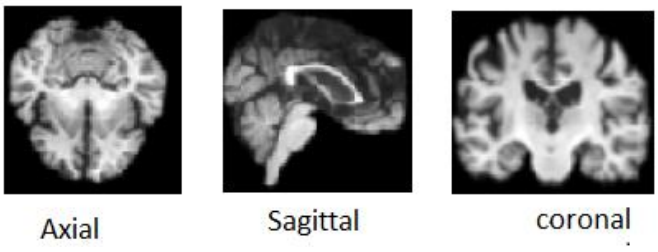

Fig -2: MRI Images slices

Fig -3: 3D PET IMAGE SLICES

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