INNOVATIVE APPROACHES FOR EARLY ALZHEIMER'S DISEASE DETECTION THROUGH NOVEL ANALYSIS OF BRAIN MRI IMAGES

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SUMMARY

Alzheimer's is one of the most well-known reasons for Dementia. Alzheimer's sickness (AD) is an irreversible, moderate cerebrum issue that gradually obliterates memory and thinking abilities. Alzheimer's and different types of dementia positioned seventh driving reason for death by WHO. Picture handling is broadly utilized in the clinical field to recognize illness and help specialists in dynamics dependent on perception. The paper means to recognize the Alzheimer's sickness at the most punctual with the goal that patients can be forestalled before irreversible changes happen in the mind. We propose the picture handling method to deal with the Magnetic Resonance Imaging (MRI) of the cerebrum from the pivotal plane, coronal plane, and sagittal plane. The picture division is utilized to feature the impacted locale in cerebrum MRI. The analyzed area in mind MRI incorporates the hippocampus and volume of the cerebrum. A similar ID of people impacted with the Alzheimer's illness, Healthy partner, and Mild Cognitive weakness is finished.

KEYWORDS

Alzheimer's, Classification, Transfer learning, CNN (Convolution Neural Network), Voting classifier

NOMENCLATURE

AD	Alzheimer's Diseases
MRI	Magnetic Resonance Imaging
SRS	Software Requirement Specifications

1. INTRODUCTION

The cerebrum is the essential organ of the human body. The illnesses that influence cerebrum are exceptionally essential to deal with since for the most part once changes happen it is irreversible in outrageous cases. Dementia implies the deficiency of intellectual utilitarian reasoning. Alzheimer's is the most normal reason for Dementia. Alzheimer's first shows up in their mid-60's. It is assessed that more than 5.5 million individuals are having Alzheimer's. The Alzheimer's sickness indications incorporate cognitive decline, language issue, conduct changes. The non-memory angle indications are trouble in word finding, vision issue, weakened thinking and debilitated judgment. The organic signs are cerebrum pictures, cerebrospinal liquid and blood. The Alzheimer's infection can be delegated Mild Alzheimer's illness, moderate Alzheimer's sickness and extreme Alzheimer's. The Cause of Alzheimer's Disease are some hereditary parts for beginning stage Alzheimer's and Late – beginning Alzheimer's start from complex series of mind change. Different causes are hereditary climate Lifestyle, Health and Detecting changes in body liquid and changes in body liquid and changes in mind can recognize Alzheimer's sickness. The Chemical or protein found in Alzheimer's sickness are strange bunches (amyloid plaques), tangled heaps of fiber (Tau Tangle) and Loss of association between nerve cell in the mind. The indications of the Alzheimer's sickness seem decade later it start or beginning. The store of protein Tau Tangle and amyloid plaques all through mind lead to halting of usefulness of solid neuron and when its stop work the association, with the other neuron is lost and pass on. The harm will initially influence hippocampus, the piece of the cerebrum fundamental illuminating recollections. Gradually it spread to other parts and, the mind impacted because of this compound beginning contracting and till definite stage the total cerebrum size is avoided altogether. Based on the study we can classify Alzheimer's into four various stages using transfer learning. We are using OASIS dataset which contains 4098 images for training the models. VGG16, VGG19, Densenet121, Resnet50, XceptionNet, ALexNet are used in this project for training the

models. Ensemble learning has been applied for predicting the final output stage of Alzheimer's from brain MRI images. Based on the probabilities of the stages of all models, we are obtaining the final output by voting classifier.

1.2 STAGES OF ALZHEIMER'S

Various stages of Alzheimer's which can be classified through this study are,

1. Non-Demented Stage (Normal Behavior)
   - Alzheimer's is one of the diseases which starts very silently and will be difficult for anyone to predict a person is having a problem. There won't be any visible symptoms which can be spotted in a person who is suffering in this stage. Only a proper scan can reveal the functioning of the brain and can be able to find out the issue. As the stage progresses only, we can able to identify the change in reasoning and thinking of the person.

2. Very Mild Stage
   - We can able to find some thinking and memory issues in this stage, Persons who are in this stage may have memory lapses for the things which can be very easily memorized. They may get lost in conversations and misplace things which are to be done.

   The person may even have faced the issue of making decisions and managing time in a better way. Based on the analysis of the doctors and proper scan this stage can be diagnosed.

3. Mild Dementia due to Alzheimer's disease.
   - This is the stage where a person can be easily diagnosed and they will be having troubles related to memory, thinking and reasoning skills which are affecting their personal or professional life.

   In this stage people may experience,
   - Expressing thoughts: It becomes difficult for people to perfectly organize what they are thinking in proper words and will be unable to express it in a better way.
   - Repetition disorder: People may even repeat the same again and again without their knowledge.
   - Memory loss: People may face difficulty in remembering the names of their loved ones, may have problems with replacing things and even forget the most recent activities done by them.
   - Difficulty in sound judgement and problem solving.

   Helping people in this stage for them to organize everything may lead them to a happy life.

4. Moderate dementia due to Alzheimer's disease
   - In this stage the problems faced may become even worse than in the previous stage. People who are in this stage need an immediate helper always to help with daily activities as well.

   Various symptoms in this stage are,
   - People generally forget about themselves in this stage
   - Face more and more memory issues
   - Unable to complete their daily activities
   - Fall into deepening confusion
   - Some may lose control of bowel movements or bladder
   - Wander for searching their own house

2. LITERATURE SURVEY

Nathaniel W. Jenkins et al. They propose a model to extract FDG-PET inputs and examine the requited patten in accordance of modality data accusation requirements. The calculation accomplished region under the ROC bend of 0.98 (95% certainty span: 0.94, 1.00) when assessed on foreseeing the last clinical finding of AD in the autonomous test set (82% explicitness at 100 percent awareness), a normal of 75.8 months preceding the last finding, which in ROC space beat per user execution (57% [four of seven] responsiveness, 91% [30 of 33] explicitness; P , .05). Saliency map exhibited consideration regarding known areas of interest yet with centre around the whole cerebrum.

Sergey Korolev, Yulia Dodonova et al. They showed execution of the remaining and plain convolutional neural organizations in view of the ADNI dataset which is a biggest accessible dataset of underlying MRIs of subjects with Alzheimer's infection and typical controls.

Agneta, Nordberg et al. PET imaging of AD brain is important both for comprehension of underlying of infection processes and clinical setting The outcomes from FDG-PET examinations on twins support the finding that 48% of the weakness for non familial (inconsistent) AD can be credited to hereditary variety.

Polikar, Tilley et al. Utilizing troupe strategy, every classifier was prepared on each datasets from various sources. Classifiers were then joined utilizing a proper blend rule The Sum and basic greater part casting a ballot (SMV) rules were utilized to get the information combination indicative correctness's. Followed by the 5-overlap cross approval ,the result showed the grouping exactness of 85.55% which is 10% - 20% improvement as contrasted with combination of any of two referenced modalities. Although the authors reduced the class unbalance effect but they did not mentioned how they dealt with missing data.

Klöppel et al. Utilized the underlying MRI to recognize Alzheimer's sickness from solid controls at beginning phase. The creators applied SVM to MRI for the solid location of sickness while recognizing it from ordinary maturing. However, the proposed research showed speculation by consolidating information from various focuses nonetheless, the informational collection is excessively little for comparisons.

O. Kohannim [2010], has shown that the mix of MRI and CSF fundamentally further develops grouping exactness. Nonetheless, CSF measures are profoundly obtrusive and could cause trouble for patients which might give a premise for blend of MRI and PET rather than MRI and CSF. Besides, the informational index isn't neurotically demonstrated and creator referenced nothing in regards to missing information which might diminish the general exactness of the proposed strategy.

J. Ramírez, et al. Expounded the early conclusion later on by discretizing the consistent characteristics of highlight selection. images were utilized to acquire a veil utilizing histogram division additionally for PET, information of 150 members was gathered which contained 75 AD and 75 sound controls. The outcomes uncovered 96.61% precision for SPECT while 92% exactness for PET while correlation was made with VAF-SVM and PCA-SVM.

Aunsia Khan, Usman M. The info information type is changed over from numeric into ostensible/numeric to ostensible qualities with the goal that calculations which employments said information type as info can be carried out. Classification is finished utilizing 10-overlap cross approval that is, information is isolated into 10 sections. One section is utilized as test and staying 9 are utilized as preparing information and the interaction is rehashed multiple times to approve the results. The proposed technique manages neurotically demonstrated information and beats the class unevenness and overtraining issues.

Ronghui Ju et al., recommended method for early detection of AD. In this method, autoencoder is used on regions of brain susceptible to AD. Data is collected and blood oxygen levels of brain are observed. This involves establishing brain network information and presenting it in the form of matrix. This autoencoder model gives data about intellectual growth of nervous system and data on brain networks. After sufficient info is obtained, cross verification is done.

Chut et al., he observed MRI images and found dissimalirities between healthy controls (HCs) and MCI subjects. Here they said about 4 feature selectors namely: univariate t-test filtering, recursive feature elimination (RFE), and t-testing filtering limited with ROIs, and also comparison is done among these four features. Figures 1-4 represnts the example of a model data set images.

Tong et al., recommended MIL method for detection of AD and MCI. The accuracy is 89% for discriminated AD from HC and 70% accuracy is for sMCI from pMCI. Features were extracted from MR images.

3. PREPARING THE DATASET

3.1 DATA ACQUISITION

For a model to recognize Alzheimer's it has to be trained well with a large amount of data available to us. If the training is done properly then our model will be able to recognize new MRI images. In this model we have used a dataset which consists of 4098 training images and 1279 testing images. It consists of images of 4 classes.

(a) Non-Demented (No symptoms of Alzheimer's, Normal Behaviour)
(b) Very Mild Demented stage
(c) Mild Demented stage
(d) Moderate Demented stage

3.2 DATA AUGMENTATION

If we train the model with less dataset then this leads to overfitting. Consider an example of a model that classifies whether the input is dog or not, if we train the model using dog images which are turned towards right only and when we give new image of dog and it is turning towards left the model is not able to classify the image, this comes under over fitting. To expand the images present in the dataset without collecting

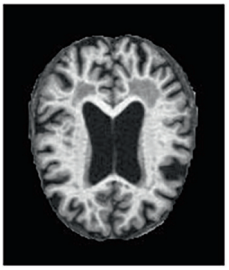

Figure 1. **(a)**

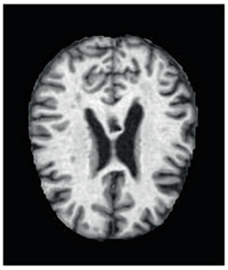

Figure 2. **(b)**

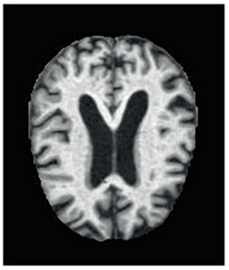

Figure 3. **(c)**

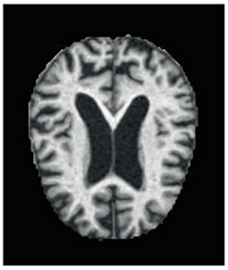

Figure 4. **(d)**

new images we required several augmentation techniques to be used. Due to this augmentation the CNN model encounters various new images at each epoch in the training time. Some of the augmentation techniques used are rescaling, translation, flipping, rotation, cropping etc. in this model. Figures 5-11 represents the augmentation technique.

Some of the augmentation techniques are:

- Flipping – We can flip the images that we used in this experiment in horizontal as well as in vertical direction. Rotating the image by 180 degrees is considered as vertical flip.
- Rotation – In this we can rotate the image clockwise or anticlockwise by 90 degrees and the image size may change if we rotate it by finer angles.
- Translation – In this technique the image is moved along horizontal axis or vertical axis or we can move the object in image in both directions.
- Scaling – if we perform scaling technique on the image the image size varies and if we do outward scale the image size will grow.
- Crop – in this we select a part of image and this part can be resized to normal size of image and there is a difference between scaling and cropping.
- Zoom – The images in the collection can be enlarged by 2 or 3 times than original images in the dataset or it can be either zoom in or zoom out.
- Shearing – In this technique some minor part of picture is shifted in the shape of parallelogram, and it is one type of bounding box technique.

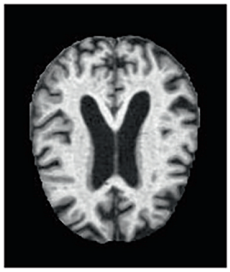

Figure 5. Original

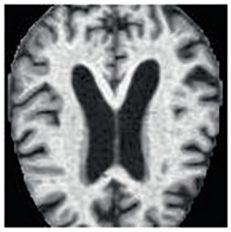

Figure 6. Cropping

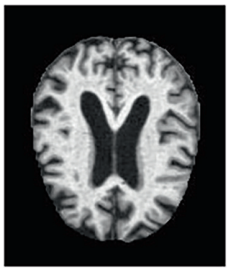

Figure 7. Horizontal flip

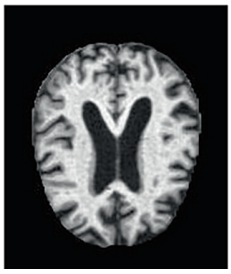

Figure 8. Padding

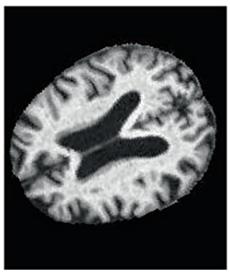

Figure 9. Rotation

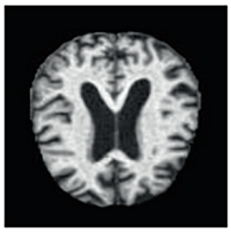

Figure 10. Scaling

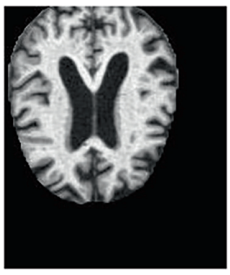

Figure 11. Synthetic

3.3 CONVOLUTION NEURAL NETWORK

Convolution Neural Networks is a part or subset of deep neural technology, and it is based on neurons which take image as input in the appearance of pixels, and it has many layers like input layer, hidden layers, and output layer. Each neuron in one layer connects to other neurons in another layer and takes weight as sum and produces the output finally. CNN is very popular in the study or interest of computer domains, and it is mainly used for image classification, detection of objects and image segmentation etc. weights are important in terms of output, and it influences the image input on the output, similarly bias are constants and they are extra terms added to subsequent layer.

How Computer Reads an Image?

If we observe any images there are very small boxes that form the entire image, and those little square boxes are called by us as pixels. Each pixel has rgb colors that vary from 0 to 255. Therefore, the system understands the given image in the well-known form of 0's and 1's that is nothing but binary language which the system can understand easily. There were different number of channels in each pixel and the image considered as bunch of pixels.

Layers on CNN

The convolution neural network is constructed with the help of small units which are called nodes or neurons and every node has some weight and they are changed in the training time using various optimization techniques. The model has two parts i.e the first phase is feature extraction and it is done using pooling and convolution layers and the second part is

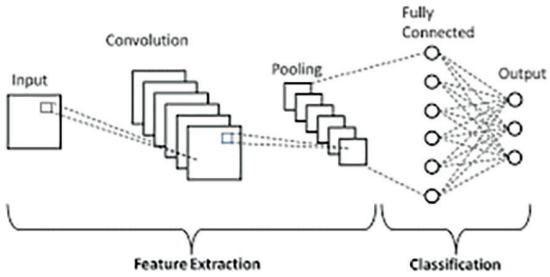

Figure 12. Convolution neural network

whatever the features extracted in the first part is given as input to dense layer which classifies the input and produces the output. Figure 12 shows the Convolution neural network.

Some of the layers in CNN are:

1. Convolution Layer: The convolution layer is used to extract features from the image which is given as input. The convolution operation is performed like this, we take a filter that is capable to identify the features and the filter is passed over the image and at each pass the values in the filter are multiplied with the values overlapped on the image and it performs sum of all the values, and this outputs an image with reduced size showing the extracted features. Here for filter, we use stride that is moving the one square box at a time in any direction if stride is taken as one.
2. Batch Normalization: This is used at the end of each convolution layer to maximize the rate of learning and it generally normalizes the image which is given to the CNN model like input.
3. Pooling Layer: It is similar to the above layer, and it is also very helpful to extract main or dominant features of the image and it is very helpful to minimize the training time and it is also used to decrease the time for computing. There are 2 types in this layer one is max pooling which takes maximum value in a particular stride and other one is average pooling which takes average value of all the values present in a stride.
4. Activation: While constructing the CNN model people generally use the activation function and the mostly used one is Relu called as Rectified Linear Unit and what it does is it removes all negative values and replace them with zero and no effect on positive values and it is helpful to fire a neuron. Another activation function used is dense sigmoid function which is used at end of the model.
5. Dropout: The dropout layer is used to inactivate some neurons at a particular epoch and may be active at some time and this is used to decrease one thing that is overfitting. In this research we used a value of 0.5 for dropout.
6. Dense Layers: Normally we use 2 dense or fully connected layers in the network and these dense take the output of pooling and convolved layers and classification is done. The name dense is because it is the layer which connects to all neural units or nodes in previous layer because it is fully connected. The input is changed in the form of one dimensional as dense layer accepts vector as input and it does not accept anything other than string format. Figure 13 shows the transfer learning.

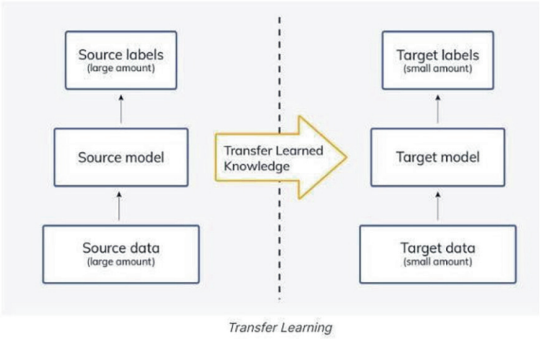

Figure 13. Transfer learning

3.4 TRANSFER LEARNING

This process involves the transfer of knowledge from previously trained to a new model which is closely related or linked with the previous problem. This technique uses a small amount of CPU.

In Transfer Learning, a pre-trained model is been reused as the starting point for the new model which is to be trained. Already trained model with a huge amount of dataset is reused for a second task which helps it in rapid progress while training the second model. With the help of transfer learning, we can gain high performance when compared to training with less amount of data. VGG16, VGG19, Densset121, Xception and ResnNet50 are some of the examples of transfer learning which we are using in this project for training.

3.5 VARIOUS MODELS IN TRANSFER LEARNING

Various models which are used for classification of Alzheimer's in this project are

1. VGG16
2. VGG19
3. DENSENET121
4. RESNET50
5. XCEPTIONNET50
6. ALEXNET

VGG-16 Model

Vgg-16 is a convolutional neural net Architecture, which is proposed by Karen Simonyan and Andrew Zisserman had proposed idea which was based on a. ImageNet challenge. The primary reason for becoming standout architecture in the regards of convolutional neural network model is its uniform filter size of small size 3 X 3, with a stride

1. whereas to compare with some other popular CNN architectures like Alex Net uses kernel size of 11X11 with stride 4 for the first convolutional layer. The main thought of being using this instead of moving for such popular Architectures like Alex Net and ZF Net, let's discuss about the kernel size used at VGG-16 which is 3X3 where two consecutive kernels could match an effective kernel of 5X5 and three consecutive kernels could match an effective kernel of 7X7. The key idea of using 3X3 instead others here is increase in no' of layers and multiple times nonlinear activation functions are been used, if there is larger kernel holds up larger receptive area and with larger stride makes the decision functions discriminative as a result the ability to the network converges faster over on that case it even reduces the ability to adjust weight parameters to bring out much significant model.

VGG CONFIGURATIONS:

The configurations of VGG were a stack of convolutional layers of multiples 1,2 and 3 of the kernel with a size of 3X3 which terminates with a max pooling layer each time with a kernel size of 2X2 and at last there are three fully connected layers two at a size of 4,096 and last one at a size of 1,000. This is the basic format of building a VGG model. There is a set of multiple configurations which has appeared to achieve the model at distinct levels of depth at the model.

VGG-16 Architecture:

In fig 1.12 a is the VGG16 architecture

VGG16 is the best performing model based on the Image Net dataset. The input for the architecture is 224X224X3 where the 3 is the RGB channel for every pixel.

So, now the image of size 224X224 is passed through the first two convolutional layers which has small receptive size of 3X3 with stride 1and padding same followed by an Activation function RELU which brings nonlinearity to the model where each of the convolutional layer has 64 kernels at each. This configuration captures spatial resolution and the size of the output feature map could be of same size of input image. Now, this feature map must pass from the Max pooling layer over a kernel 2X2 with stride 2. Whenever we found to be stride as 2 then the feature map gets halved in its

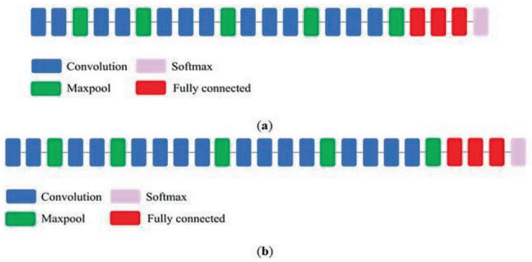

Figure 14. VGG16 configurations

size of activation as a result the final input to the next couple convolutional layers gets 112X112X128 where the feature map size is halved from 224 to 112.

So, this is how we evaluate the size of the feature map for the next coming convolutional layers input which is the output of the previous stack of max pooling layer. Figure 14 shows VGG16 configurations.

VGG 19 MODEL

VGG-19 is a convolutional brain network which has 19 layers. We can stack a pre-trained transformation of an association arranged with more than million pictures from the lImageNet informational collection. This model is used for purposes like feature extraction from an image.

Architecture of vgg19: -

- A size of 224 x 224 RGB picture is given as commitment to the collection which suggests that the grid is in the shape 224, 224, 3.
- Here (3) is a RGB channel in the vgg19 model which is represented in 224, 224, 3.
- The preprocessing which is done and been deducted for RGB regard from every pixel and gets handled on the whole arrangement set.
- Bits of (3 x 3) size with a stage size of single pixel, this enables the cover of full features thought about an image.
- The spatial padding is used to save the spatial objectives of the image.
- Max pooling layer will perform more than 2 x2 pixel window and stride 2.
- Now, the process is followed by Rectified linear unit(ReLul)function to familiarize nonlinearity with making a model gathering better to chip away at estimated time as the past model's used tanh or sigm0oid limits and it showed clearly considerable than others.
- Down 3 completely related layers that of first 2 are of size 4096 and after this a layer of 1000 channels for 1000-ways for gathering the data set and last layer is softmax work.

Performance Of VGG mode l: -

VGG19 particularly beats all previous types of models in the IILiSVRC-2012 and ILSiVRC-2013 competitions. Moreover, VGG16 is results looking for request champ (GoogLe-Net with 6.7% misstep) altogether beats the iILSVRC-2013 success convenience Clarifies. It gained i11.2%i with outward readiness data and around 11.7% without it.

To the extent that the single-net execution, the VGGNet-19 model achieves the best result with around 7.0% test botch, thusly beating a lone GoogLeNet by around 0.9%.

Complexity and Challenges: -

The number of channels that we can use duplicates on every movement or through each load of the convolution layer. This is a critical rule used to design the plan of the VGG16 association. One of the imperative downsides of the VGG16 network is that it is a goliath association, and that infers that it requires more prominent speculation to set up its limits.

On account of its profundity and number of completely associated layers, the VGG16 model is more than 533MB. This makes carrying out a VGG network a tedious undertaking.

The VGG16 model is utilized in a few profound learning picture grouping issues, yet more modest organization designs, for example, GoogLeNet and SqueezeNet are frequently best. Anyway, the VGGNet is an incredible structure block for the end goal of advancing as it is direct to carry out. On account of its profundity and number of completely associated layers, the VGG16 model is more than 533MB. This makes carrying out a VGG network a tedious undertaking.

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RESNET-50

In deep learning technology there are many neural networks,where each performs different types of operations and has their own architecture .ResNet-50 comes under convolutional neural networks which is 50 layers deep. In ResNet-50 totally there are 50 layers, 48-layers are Convolutional layers 1-Maxpool and 1-Average pool layer. In the below fig you can see the architecture.

A pretrained ResNet-50 network can classify images nearly into 1000 object categories, such as cat,dog,elephant etc. Most likely this type of architecture is used in computer vision image classification, objects object detection.

Above Figure 15 shows the architecture data flow from starting to end. First followed with input image up next convolution with kernel size 7x7.Next there is max pooling with a strid size of 3.

Next we see a kernel of 1x1 followed by 3x3 and again two times 1x1 this type of pattern is repeated in every phase we observe in the architecture flow. Similarly there is another pattern which is 1x1 followed by 3x3 and 1x1 this pattern was repeated twice in phase 1. This type of patterns are

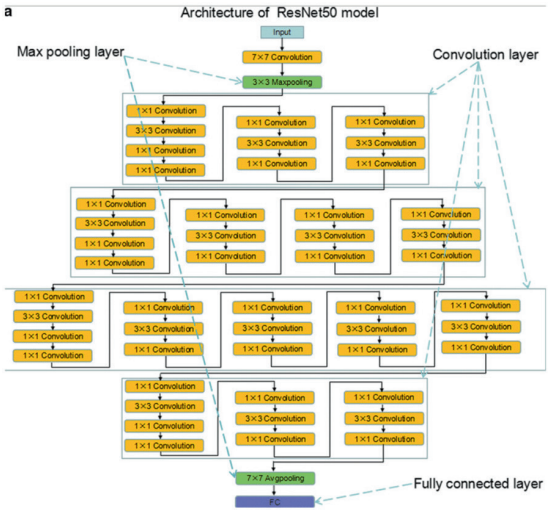

Figure 15. Xception architecture

repeated in every phase in first phase we had 3x3 kernel 3 times and 1x1 7 times.

In second phase 9 1x1 kernel layers and 4 3x3 layers. In third phase 11 1x1 kernel layers and 5 3x3 layers. In last phase 7 1x1 kernel and 3 3x3 kernel layers.so totally there are 34 1x1 layers and 14 3x3 kernel layers and one 7x7 kernel layer (34+14+1) 50.

50 deep layers we actually don't count pooling layers and fully connected layers.

DENSENET ARCHITECTURE

DenseNet is the latest model in Neural Networks. DenseNet is identical to RenseNet where this model uses the additive method (+) that combines the earlier layer and next layer whereas DenseNet concatenates(.) the result of the earlier layer and next layer.

Densenet is used to improve the decreased accuracy caused when information fades before approaching its destination in the large track connecting the input and output layers.

DENSENET ARCHITECTURE

It uses composite function operation which makes the result of the earlier layer act as the input layer of the next layer. This operation contains a convolution layer, pooling layer, batch normalization, and non-linear activation layer. This model has various categorizations: densenet-121, densenet-160, densenet-201. The number 121 in densenet121 indicates a number of layers. Figure 16 shows Denset architecture.

The number 121 is parted has:

DenseNet-121: -

5+(6+12+24+16) *2=121

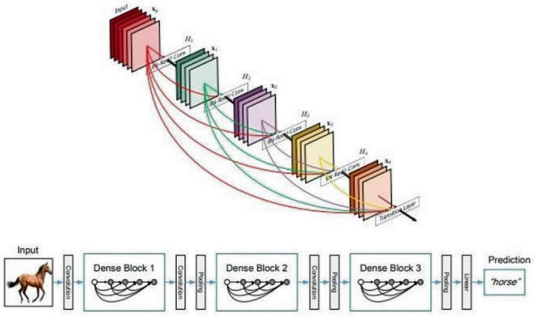

Figure 16. Denset architecture

5-Convolution and Pooling Layer

3-Transistion layer (6,122,24)

1-Classification Layer (16)

2-DenseBloack (1x1 and 3x3 conv)

Xception Net:

Xception is a kind of Neural Network Architecture that has depth wise separable convolutions. This was developed by the researchers at google. This model was created by replacing the depth wise separable convolutions in Inception models.

In this process the data first flows from entry flow then to the middle flow eight times and finally through the exit flow.

The architecture of Xception has performed very well when compared to VGG16, ResNet and Inception v3 in all of the classification challenges.

The architecture of ResNet consists of Depth wise separable convolution blocks and maxpooling which are linked.

The Xception model is hard to train but has improved when compared to Inception. The Xception architecture was inspired by inception where the inception modules are replaced by depth wise separable convolutions. This architecture performs better than the inception v3 using the ImageNet dataset. The Xception architecture has an equal number of parameters as the Inception v3 but the performance increase is due to efficient use of parameters.

ALEXNET ARCHITECTURE

AlexNet is name of Convolutional Neural Network which had won in a competition named LSRC in year 2012 abbreviation of LSRC is Large Scale Visual Recognition Challenge. In this competition various research teams compete with each other to have higher accuracy for images having label. It is similar to LeNet but they have significant differences. Figure 17 shows Xception architecture, Figure 18 shows AlexNet architecture and Figure 19 shows Voting classifier.

AlexNet is a composition of 8 layers in which 5 are convolution layer and the remaining 3 are fully connected layer, there is an activation function ReLu is applied at the end of each layer except at the end of last layer. Max-pooling is applied to the first, second and fifth convolution layers. Second, fourth, and fifth convolution layers which are connected to previous layers which lie on the same GPU. All kernels of Third and second layers are connected. First Layer has a window shape of 11x11, in the second layer its 5x5, and the followed by 3x3. After first, second and fifth convolution layers maximum pooling layer is added

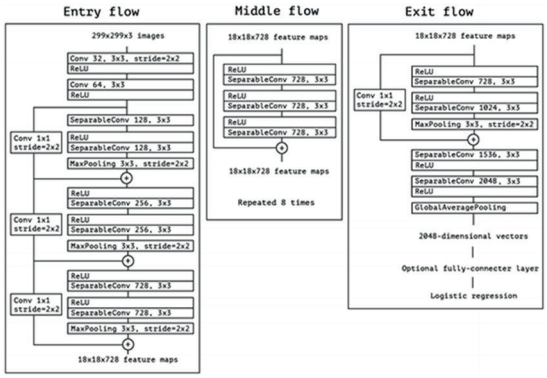

Figure 17. Xception architecture

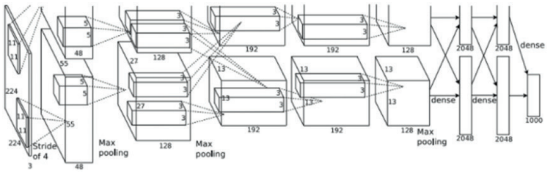

Figure 18. AlexNet architecture

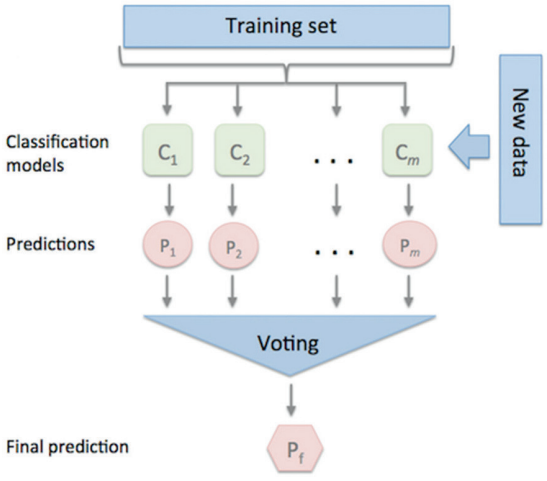

Figure 19. Voting classifier

with window shape of 3x3 with stride 2. Main difference between AlexNEt and LENet is ALexNet has convolution channels ten times more than LeNet.

F. Voting Classifier

The entire training data is been trained using various models

The data is been trained using models C1, C2, C3,..., Cm

When an image is given for prediction to the models, each model produces an output based on its learning from the training data.

P1, P2, P3,…,Pm are the outputs which are been predicted by models C1,C2,C3,...Cm respectively.

Now we use the voting classifier to find out the final output. Based on the frequency of the outputs or based on the probabilities we get to know the final output Pf.

Generally, a single model is used for predicting a new image, but usage of more models helps in getting better accuracy.

4. SOFTWARE REQUIREMENT SPECIFICATIONS(SRS)

A document that specifies the nature of a software model or project is commonly referred to as Software Requirement Specifications (SRS). This can be stated as manual of project and is prepared before proceeding onto the project. We have to follow some important guidelines in preparing an efficient SRS document which can be understood easily. This consists of scope, purpose, functional and non-functional requirements of software application as well as requirements of software and hardware. This also consists of details regarding conditions of environment, safety, security, quality attributes etc.

HARDWARE and SOFTWARE REQUIREMENTS:

Memory :	16GB
Processor:	Intel(R) Core™ i7-9750H CPU @ 2.60GHz
GPU:	NVIDIA GeForce GTX 1650 4GB GDDR6
Operating System:	Windows 8 or later versions of Windows
Presentation Tier:	HTML, CSS
Anaconda Software	

5. ALGORITHM PERFORMANCE

Training Accuracy and Validation accuracy graphs for each model are as follows. Figues 20-23 shows results in accuracy different models.

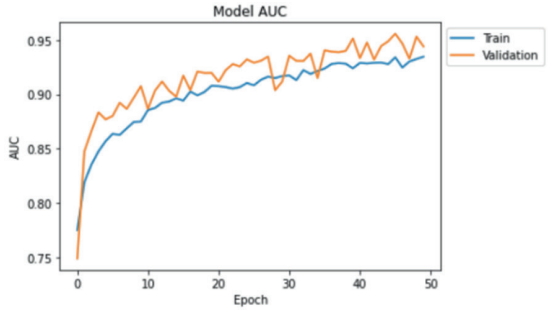

Figure 20. VGG16-Accuracy

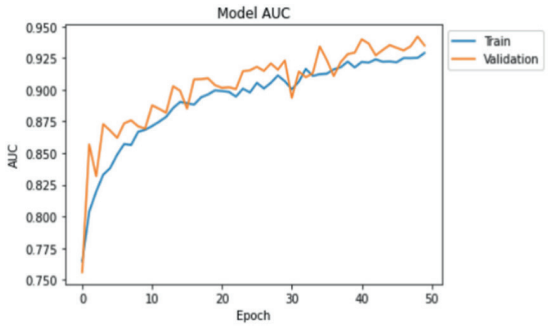

Figure 21. VGG19-Accuracy

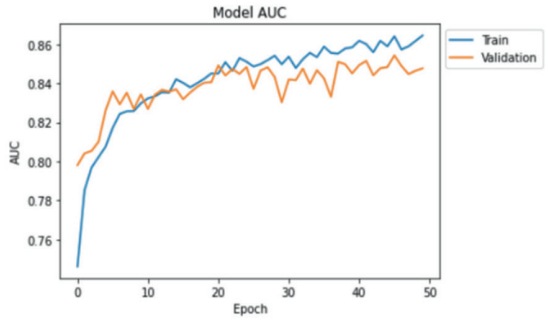

Figure 22. RESNET50-Accuracy

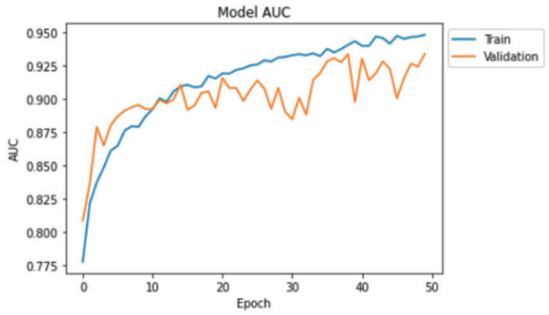

Figure 23. DENSENT121-Accuracy

6. RESULTS AND DISCUSSION

The proposed approach was implemented using Keras, Tenserflow and Python on a windows x86-64 machine with Intel7 10th gen CPU, 16GB RAM and NVIDIA GeForce GTX1650TI. We have used ensemble learning. It's a

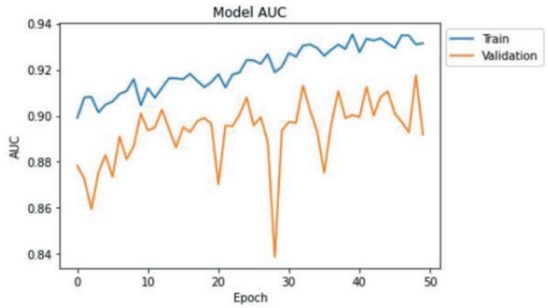

Figure 24. Xception-accuracy

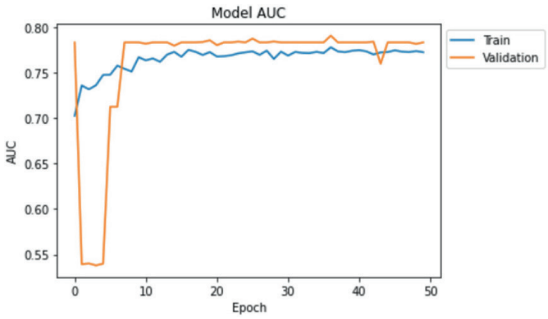

Figure 25. ALEXNET-accuracy

process which gives the result with the help of multiple models which can be experts or classifiers. We combine in such a way so that it can solve a problem. It is mainly used to improve prediction, classification, etc. In model M1 is built with the help of 16 (3X3 convolution layers) in order to improve accuracy, we have added 3 dropouts of 0.5 each, flatten layers, Batch Normalization and used relu activation function. Similarly for model M2 but instead of 16 it has 19 (3x3 convolution layers). For M3 we have 48 (3X3 convolution layers) with 1 Average and MaxPool layers along with the other layers to which used in M1 to improve the accuracy. The model M4 consists of 120(3X3 convolution layers) with 4 Average Pool layers. M5 is somewhat different than other models it consists of 71 convolution neural network in Wich is combination 1x1, 3x3, 5x5 and 3x3 max pooling layers. We have implemented 2 variants of our model using ensemble learning. Figures 24 and 25 shows proposed method results.

- In first we have used ensembled four of deep convolution neural networks: M1, M2, M3 and M4.
- In the second one we used five deep convolution neural networks: M1, M2, M3, M4 and M5.
- We have tested each model individually.

We have used various models' individual accuracy of M1 (VGG16) 95.581%, M2 (VGG19) 94.202, M3 (RESNET50) 85.432, M4 (densent121) 93.358, M5 (XCEPTION) 91.743. With the help of ensemble M1 + M2 + M3 + M4 we had an accuracy of 96.01%. On the M1 + M2 + M3 + M4 + M5 we had an accuracy of 96.2%.

7. CONCLUSION AND FUTURE SCOPE

As technology is updating day by day, artificial intelligence comes into picture. Alzheimer's disease is a major thing where most of the old people were facing. People of the age 50-60 were facing these types of issues and this can be seen in future also with a high possibility rate. People who were suffering with this disease are dying within 5-10 years. To avoid such type of issues and to prolong the life span of people suffering from it, this Early Detection of Alzheimer's using MRI images is introduced.

Here, we used a few models and noted the ratings the highest accuracy is 94%, and in future with advanced technology the accuracy may increase. When CNN is used, the accuracy and performance is better when compared to other machine learning techniques. By using multisite data sharing (ex: ADNI for AD) the sample sizes can be increased and this can be done by different AI technologies by improving in coming years. Augmentation techniques reduce the prepossessing time. Here, after detecting the image of the brain the grey matter volume is observed. By observing it, this can be an early detection of Alzheimer's disease which is also an advantage for medico students.

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ETHICS APPROVAL

Not applicable.

CONFLICTS OF INTEREST

No conflicts of interest.

DATA AVAILABILITY

Not applicable.

CONSENT TO PUBLISH

Nil.

AUTHOR CONTRIBUTION

Conceptualization, B.K. & M.S.A.; methodology, B.K.; software, B.K.; validation, M.S.A.; formal analysis, M.S.A.; investigation, B.K.; resources, B.K.; writing—original draft preparation, B.K; writing—review and

editing, B.K.; visualisation, B.K.; supervision, M.S.A. All authors have thoroughly reviewed and provided their consent to the final version of the work that has been published.

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