Alzheimer's Disease Detection Using CNN and Vision Transformation

Dr. P. Jeevana Jyothi, Department of CSE, Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt., Andhra Pradesh.

G. Navya Sri, Ch. Annie Anuhyaa, B. Akhila, B. Bhanu
UG Students, Department of CSE, Vasireddy Venkatadri Institute of Technology, Nambur, Guntur Dt., Andhra Pradesh.

DOI: 10.48047/IJFANS/V11/I12/211

Abstract
Alzheimer’s disease is a brain related issue which affects the mental stability of a person. It degrades the thinking capability and targets the memory of a person. The person who is effected with the Alzheimer’s finds difficult to even remember simple daily things[8]. Even the very recent or latest event is also difficult for them to remember or keep track of. The Alzheimer’s disease is challenging one because there is no treatment for the disease. This disease is currently ranked as the seventh leading cause of death in the United States among older adults. There is no permanent cure or treatment for this. Thus, if the disease is predicted earlier, the progression or the symptoms of the disease can be slow down. In this paper we intend to create a model that detects Alzheimer disease using GAN and CNN. GAN can be adopted to fulfil the role of data augmentation. GANs are generative models: they create new data instances that resemble your training data. Classification process can be fulfilled by using the CNN model to the data for improving the efficiency and to ensure higher accuracy.

Keywords: CNN, GAN, Vision Transformer

Introduction
There could be many reasons for the disease. One of them is genetical occurrence, which is possible to be seen in the family members who are already effected due to the Alzheimer’s. The Alzheimer’s can be treated and diagnosed properly if the disease was detected at the early stages. If the disease remains untreated it slowly affects the functioning of all the crucial systems in the body moreover leads to death[7].

A person who is effected with Alzheimer’s disease may not be guaranteed with permanent treatment or cure, But the living period can be extended from 4-5 years to 20 years maximum when the person is given better treatment with detection in the early stage[9]. The persons who are closely related and the own family members can easily observe
the changes in the person’s behaviour or the symptoms that are really detectable. The Alzheimer’s is often observed in people who are aged above 60. It is also not sure that the young people are safe and not have a chance of getting attacked by it. The studies have revealed that main cause of Alzheimer’s can also be the prolonged inactive state of brain which lead to malfunctioning of it.

**Role of ADNI**

The ADNI stands for Alzheimer's Disease Neuroimaging Initiative, a website which contains some standard datasets of Alzheimer’s disease, these consists of MRI scans of the brains in 3D structures. The researchers can find it easy to access the data and hence perform the desired analysis on how the disease is extended in the patient and know how its progression effects the patient[10]. The ADNI also helps the people who are interested in working on the way to detect and study the characteristics of the disease. The purpose of ADNI is to provide help in performing natural study of dementia and Alzheimer disease and its progression in stages.

**Literature Survey**

Many researches have been done on Alzheimer disease detection and classification helped in better understanding of the treatment and diagnosis to be given for the patient. One of the researches involves the 3D RVN and CNN models to detect the disease with an accuracy of 83.27% and 84.62% respectively [1].

One of the proposed method uses modified capsule network, which takes the data as an input, makes the parent vector by considering the various features available in the OASIS dataset. The model shows the highest accuracy achieving 92.39% and lowest error rate of 7.61%[2].

Other work involves OASIS data which is taken and used for comparison of output produced by different models like XGoost, SVM, Random forest and an overview is given[3]. One of them ensured that combination of Deep triplet network and conditional triplet network is applied and the techniques CNN, ResNet, VGG are implemented out of which VGG is efficient [4].

**Problem Identification**

The person who is affected with AD need to be given immediate treatment in order to prevent the progression of the disease. Also, the stage of the disease should also be known for the proper diagnosis. The delay in the detection or start of treatment may increase risk of person leading to death. Hence proper and efficient algorithms need to be adopted and implemented to ensure proper results. The treatment and diagnosis results depends on the result obtained from the detection and classification itself. For this we could use deep
learning techniques which can process and give results with high performance. Various models in deep learning can be adopted which help in producing more accurate results.

**Methodology**

The dataset containing the 3D MRI scan images will be taken and processed so as to undergo smooth detection process. The data augmentation is also adopted to ensure accurate results. The GAN model is used for data augmentation and the CNN model will involve the detection and classification.

![Fig.1 WorkFlow](image)

The Fig 1. Represents the workflow which is adapted for the implementation in the detection of the Alzheimer's Disease. The MRI scans which are given as raw data are now sent to be augmented using GAN which will help in increasing the performance for the deep learning techniques. The modified and augmented scans are now sent to the CNN classifier and the Vision transformer, the vision transformer divides the scan images into some patches or segments which can help in easy processing of images. Later on the outputs are compared in terms of accuracy and performance.

**Implementation**

**Data augmentation**

Data augmentation is a technique which deals with creating modified data points which increase the amount of data by generating new data points from the data which is already existed. Some of models for data augmentation are GANs, Neural style transfer, Reinforcement learning. The dataset containing the MRI scans will be passed to the GAN in order to perform data augmentation. The modified copies of existing data are created resulting in the augmented data set, which will enhance the ease of detection of Alzheimer's disease. [11-19]
Convolutional Neural Networks
Convolutional Neural Networks is a form of deep learning model that is motivated by the structure of animal visual cortex, are used to analyse input with a grid pattern, such as photographs. It is effective for jobs involving image processing and recognition. Convolutional layers, pooling layers, and completely connected layers are among the layers that make up this structure. The key part of a CNN is its convolutional layers, where filters are used to extract characteristics like edges, textures, and forms from the input image. Once the augmented dataset is ready we could pass the data to the CNN classifier so as to perform the detection and classification procedure on the data.

Generative Adversarial Network
A deep learning architecture called the Generative Adversarial Network (GAN) sets two neural networks against one another. GANs are designed to produce new, synthetic data that closely mimics a pre-existing data distribution[6]. One of the most well-liked and effective GAN implementations is DCGAN. ConvNets are used instead of multi-layer perceptrons in its development. Convolutional stride actually replaces max pooling in the ConvNets implementation. The layers are also not entirely connected.

Vision Transformer
The use of vision transformers in common image recognition tasks like object detection, image segmentation, picture classification, and action recognition is widespread. It is an image classification model that applies a Transformer-like architecture to different picture patches[5]. ViTs allows models to learn image structure independently since images are represented as sequences and class labels for the image are predicted.

Results & Conclusion

<table>
<thead>
<tr>
<th></th>
<th>Precision</th>
<th>Recall</th>
<th>F1-score</th>
<th>support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Demented</td>
<td>0.70</td>
<td>0.89</td>
<td>0.78</td>
<td>1907</td>
</tr>
<tr>
<td>Moderate Demented</td>
<td>0.93</td>
<td>0.96</td>
<td>30.94</td>
<td>1991</td>
</tr>
<tr>
<td>Non Demented</td>
<td>0.87</td>
<td>0.75</td>
<td>0.81</td>
<td>1990</td>
</tr>
<tr>
<td>Very Mild Demented</td>
<td>0.76</td>
<td>0.63</td>
<td>0.69</td>
<td>1874</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td>0.81</td>
<td>7762</td>
</tr>
</tbody>
</table>
Alzheimer’s disease is classified into 4 classes which are Mild Demented, Moderate Demented, Non-Demented, Very Mild Demented. The accuracy obtained from vision transformer model is 81%.

Table 1. Classification Report for VIT model

The below figure 2 showing dependency between training accuracy and validation accuracy with respect to the number of epoch is as shown below

![Training Accuracy vs Validation Accuracy](image)

Fig.2 Training Vs Validation Accuracy for VIT model

The training and validation accuracy depends on the number of epochs which are decided. More the number of epochs, higher the training and validation accuracy for the model.

<table>
<thead>
<tr>
<th></th>
<th>Precision</th>
<th>Recall</th>
<th>F1-score</th>
<th>support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Demented</td>
<td>0.99</td>
<td>0.88</td>
<td>0.93</td>
<td>639</td>
</tr>
<tr>
<td>Very Mild Demented</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>635</td>
</tr>
<tr>
<td>Mild Demented</td>
<td>0.75</td>
<td>0.97</td>
<td>0.85</td>
<td>562</td>
</tr>
<tr>
<td>Moderate Demented</td>
<td>0.91</td>
<td>0.75</td>
<td>0.82</td>
<td>624</td>
</tr>
<tr>
<td>Micro avg</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>2560</td>
</tr>
<tr>
<td>Macro avg</td>
<td>0.91</td>
<td>0.90</td>
<td>0.90</td>
<td>2560</td>
</tr>
<tr>
<td>Weighted avg</td>
<td>0.91</td>
<td>0.90</td>
<td>0.90</td>
<td>2560</td>
</tr>
<tr>
<td>Samples avg</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>2560</td>
</tr>
</tbody>
</table>

Table 2. Classification report for CNN

The Table 2 shows the classification report of CNN model for the Alzheimer’s Disease.
The Table 3 clearly shows that the CNN model outperforms the Vision Transformer. The CNN model gives accuracy of 94% and VIT shows an accuracy of 81%.

**Future scope**

The proposed models are accurate however, the GAN technique takes a lot of time for execution which also requires data augmentation as a mandatory task. CNN alone cannot guarantee the accurate results, it can be ensembled with some other model which is a bit complex. Moreover, the ordinary datasets also do not provide the right way to perform research. Hence, ADNI datasets should be used for the proper training and detection of disease with the test data. The 3D MRI scans that are provided in ADNI datasets ensure more capability in processing the brain structures and helps in easy detection and classification of Alzheimer.

**References**


