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Alzheimer's Disease Detection Using Brain MRI Images

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A B S T R A C T

A number of approaches that are involved in the machine learning (ML) has to be proposed to classify the Alzheimer's disease (AD) from the data through brain imaging of the data. But, there are many articles were proposed based on the convolutional neural networks (CNNs) for classify the AD from the MRI image. Our project mainly focuses on Deep learning which is one of the machine learning approach which has shown promising results and performance as compare to traditional algorithms of machine learning in terms of high dimensional data of MRI brain image. In this article the usage of deep learning in medication field is addressed. There are many algorithms for review in the deep learning methods for the forecast of Alzheimer's disease done, in which the AD is the very increasing disease for the older aged people leads for the destroying of brain memory cells and effects on remembering power caused by dementia. The datasets are referred from the sites like ADNI and OASIS. We are classifying the disease into four stages and set the separate datasets for each stage to make classification easily after the extraction of feature from the image processing which is taken from the MRI (Magnetic Resonance Imaging) scan.

Keywords: Neurological disorder, Alzheimer's disease, Deep learning, Convolutional neural network, MRI, Brain imaging

1. Introduction

Alzheimer's disease (AD) is one of the deadly cognitive disease in which people develop various dementia symptoms. Physicians commonly use series of tests to diagnose the Alzheimer's disease. Damaging of brain cells is one of severe effect of AD. There are some functional parts of brain such as hippocampus, amygdala which regulate all activities of our brain and they suffer a lot due to AD .People suffering from AD have progressed through early stage of disease known as mild cognitive impairment. This stage shows mild form of AD and as per investigation of physicians it has been declared that eight out of ten persons with MCI develop AD after seven years.

To detect early stage of AD a technique called Magnetic Resonance Imaging is widely used by neurologists which involves scanning of tissues-by-tissues of brain. The usual AD diagnosing system that contains various tests like medical examination, remembrance test, genetic news. Physicians used the amazing technique that the utilization of brain images for AD classification and that has been taken less time to diagnose the AD than the traditional techniques.

In today's world, many Deep Learning techniques are developed to diagnose these type of diseases like ANN, MRI and CNN has gained popularity due to its high efficiency and accuracy which has been used variety of perceptron's. Many CNN models were qualified administering set of sagittal, axial, coronal MRI slices of brain, Thus by integrating neurologists detect early stage of AD. In our proposed system CNN based on eight-layer network Structure used to automatically retrieve features from Brain MRI data which is used to differentiate subjects with clear clinical diagnosed AD and MCI.

Data used in our system was obtained from ADNI database. The ADNI was started in 2003 as public-private participation surpassed by analyst, Michel. The fundamental Goal of ADNI follow test either after MRI, positron ejection tomography (PET), additional organic grains, and dispassionate and few estimates are linked to measure the progress of MCI and early AD.

To facilitate the CNN models training, verification, and testing a 3D images were sliced into 2D images with each of its sagittal, axial, coronal and transverse planes and CNN has been suitable for learning representations of image features which is typically composed of feature extraction and feature mapping which has been provided accurate spatial relationships of neurons and nervous system.

2. Literature Survey

In [1], the author's proposed a systematic and critical literature review, which highlighted several important problems. Then, the authors have proposed an open-beginning framework for reproducible judgment of AD categorization utilizing CNNs and MRI. Finally, they have applied the framework to compare different CNN approaches and to check the impact of key components on the performance.

In [2], the author's proposed a conditional deep Triplet network to overcome the limitation of lack of data in machine learning problems. This model uses a conditional Triplet loss including the worst and best triplets. Results indicated the higher performance and accuracy of the model and showed that it significantly outperformed in term of accuracy.

In [3], the author's introduce AD biomarkers, preprocessing methods, feature extraction methods and depth models in AD diagnosis. When it comes to classification methods, CNN is most commonly used and performs better than other deep models. There is, however, still a problem with overfitting based on the data set. Due to the limited medical data, unsupervised and self-monitoring methods are emerging research fields in medical images. The success of deep learning technology in AD classification cannot be ignored, despite the challenges remaining.

In [4], the author's proposed a binary classification for the performances of CNNs in the testing datasets. The results demonstrated that high levels of accuracy were achieved in all the comparisons. Highest veracity, awareness and specificity (above 98%) were showed up the AD vs HC categorization tests exploiting two together the ADNI dataset and the linked ADNI + Milan dataset. CNNs were better to select c-MCI sufferers and HC following an best accomplishment (truth, sense and accuracy principles above 86%). CNNs show promises for construction a model for the automatic, individual and early discovery of AD and accordingly stimulating the authorization of fundamental MRI in routine practice to help estimate and administration of subjects.

In [5], the author's defined work has sufficiently addressed the problem of discovering well performing Capsule-based features for increased CBIR performance. The exploratory results demonstrated able acting of the overall model. The invention is fast, plain for the Alzheimer categorization and appropriate for low computational resources. Nevertheless, the evaluation system used for experiments could be considered a systematic approach to CBIR research. Moreover, the complexity is fully explored and the factors that contribute to the CBIR. With a good F1 score of both models we can be sure that it can be implemented in an efficient manner.

In [6], the author's proposed a neural network model with a VGG16 feature extractor to extract the deep features in the MRI images. The neural networks are models which are well known for classification of images. In particular, neurological networks have existed promoted in many areas, to a degree weather science, figure classification, and healthcare, detecting the AD stage. This research has happened done utilizing miscellaneous MRI concepts and happened in the classes in four forms. The results have been identified as AUC, accuracy, precision, recall, and F1-score as 0.969, 90.4%, 0.905, 0.904, and 0.904, respectively.

In [7], the author's collected the following best acting versification for foreseeing Alzheimer's disease from MRI accompanying Matthew's Correlation Coefficient (MCC) of 0.77; veracity of 0.89; F1-score of 0.89; AUC of 0.92. The computational period for the fitting of a Convolutional Neural Network takes inferior 30 second accompanying a GPU (design fitting part). The belief takes inferior 1 sec. on an ideal PC. The reflect approves that an important MRI check maybe took advantage of to resolve as long as that an understanding has Alzheimer's contamination.

In [8], the author's proposed a new classification framework based on multi-model deep CNNs for jointly learning hippocampal segmentation and disease classification. First, a deep CNN model was erected to all at once find the appearance for hippocampal break-up and malady classification. Based on the separate hippocampal domain, an additional 3D Dense Net was bosomy to gain the rich and counted idea face for scourge classification. Finally, the well-informed lineaments from the CNN and Dense Net models are connected to classification affliction rank. The planed groundwork can not only yield the affliction rank, but likewise support the hippocampal separation result. No fabric separation and nonlinear enrollment are required for MR concept handle. The exploratory results established the ADNI dataset have illustrated that our projected approach has completed hopeful acting for Alzheimer's disease.

In [9], the author's grown a flexible and plain structure for extracting facial characteristics and constructing predictive models from longitudinal MRI in relation to cognitive aging and dementia, based on blended impacts models and gathering machine learning strategies. A strength of the approach is its inherent ability in tackling longitudinal data sets, including situations with sets of subjects with a varying number of scans, taken at different time intervals, which is a common occurrence in in long-term studies.

In [10], the author's defined that as it were classified utilizing CNN arrange, the misclassification rate was much higher. So, highlight choice is accomplished with include positioning calculations like Mutinffs, ReliefF, Laplacian and UDFS and so on conjointly tried with distinctive machine-learning procedures like Bolster Vector Machine, K-Nearest Neighbor and Subspace Gathering beneath distinctive testing condition. The execution of the result is palatable with classification exactness around 98% to 99% with 7:3 proportion of arbitrary holdout parcel of preparing to testing picture sets.

In [11], the author's proposed a model using Tensor flow Keras and Python on a Linux X86-64 machine with AMD A8 CPU, 16 GB Slam and NVIDIA GeForce GTX 770. We connected the SGD preparing with a mini-batch measure of 64, a learning rate of 0.01, a weight rot of 0.06 and a force calculate of 0.9 with Nesterov optimization. We connected early ceasing within the SGD preparing prepare, whereas there was no change (alter of less than 0.0001) in approval misfortune for final six age. Show gives critical enhancement for multi-class classification. In spite of the fact that the proposed demonstrate has been tried as it were on Advertisement dataset, we accept it can be utilized effectively for other classification issues of therapeutic space. Additionally, the projected approach has dependable potential to be employed for referring CNN into other zones accompanying a strained dataset.

In [12], the author's proposed a fundamental represent based on MRI is an integral component of the analytic estimate of patients accompanying suspicious AD. Structural MRI markers now support earlier and more-precise diagnosis and measurement of progression. The nearness of disintegration of median temporary structures maybe an incompletely certified bidder marker for early end of the affliction at the MCI organize. Rates of whole-brain and hippocampal decay are sensitive and efficient markers of change of neurodegeneration and, suitable way, are to a greater extent took advantage of, alongside clinical calculations, as results in dispassionate troubles of potential disease-modifying treatments. Measures of cortical diminishing and mechanized classification approaches that evaluate the by and large design of decay appear to appear guarantee or the conclusion of AD.10the recently proposed demonstrative criteria for aD43 must be approved in numerous expansive information sets.

In [13], the author's proposed a method of detection of AD using DL techniques and sagittal MRI images. The TL technique was used, using the ANN ResNet feature extractor with the SVM classifier. The model was tested in two sets of reference data, proving it's goodness-of-fit by means of previously

Agreed evaluation strategies and metrics. The exploratory conclusions show in this model is acceptable distinguished to former everything accompanying the simple level plane MRI, exceptionally when detecting the initial stages of the AD. These are ultimate troublesome stages to discover, on account of the reduced phenotypic proof, and more basically, to the better productiveness of the healing in beginning. Unlike this method, accompanying the use of TL, skilled is no risk of create cases that do not look or be like phenomenon or that copy labeling mistakes. In addition, using pertained models that require fewer data makes processing a task faster, accelerating the experiment design.

In [14], the author's defined the aim of AD classification is to produce an individual diagnosis resorting to different MRI scan by administering categorization models previously prepared on a big pool of unhealthy and healthful things, and to predict future progress at former affliction stages. Several neuroimaging approaches, as debated in this place review, holding fundamental and occupied MRI, DTI, FDG-PET, and amyloid-PET, have confirmed aspect alterations in the intellects of AD and MCI sufferers this can help decide-in the pathophysiological process of AD. No unique neuroimaging approach possibly enough, as each has concluding merits and restraints.

In [15], the author's proposed a real-time deep and transfer learning features and classification approaches that efficiently identify the multiclass categorization of Alzheimer's disease. For transfer knowledge helped deep feature discovery, we have secondhand a pre-well-informed Alex Net network. We reformed and changed these models to meet the necessity of our question. Handcrafted visage are constituted of textural and mathematical physiognomy. For deep face model and spun from home feature origin model's evaluation, SVM, KNN, and RF are used as classifiers. That achieved the best accuracy of 90.21% for a deep feature Results displayed that seemingly, studies based on transfer knowledge models acted well distinguished to other forms. These models are pre-trained with large amounts of a dataset which reflects in these networks results as they have achieved the highest accuracies.

3. System design

3.1 System Architecture

We made this system using Convolutional neural network algorithm, it is always most used language in the image processing method, cnn has so many layers in it. It has most commonly 3 layers 1.input layer 2.network layer and 3.Output layer

1st layer is the input layer it take the image as input and then it process in network layer it extract the feature from the input object then it send it as a output. And this gives the accurate result of the image or object and train the data for further.

2nd layer make the matrix and calculation about the data and extract the features from the data and process it into the model and give the proper output for it. It has trained data for the prediction of the output send it into the next layer to get the predicted output after combining the trained dataset.

3rd layer is output layer. It takes the output of the 2nd layer of CNN as a input and then it send the result about the processed data and send the predicted value and accuracy percentage about how much the predicted data is correct or not.

Our proposed model is based on CNN network in 1st step it take the brain MRI image (MT55) as a input and it process the data and send it into the 2nd step preprocessing it process data the data and extract the feature from it then it compare to the train data from the data set mostly we using ADNI dataset which has more than 100000 images in it we can train based on it and then it compare the data and then it send to the next layer to clean up data and send it into the next step and classify the Alzheimer stage and send the output as a result.

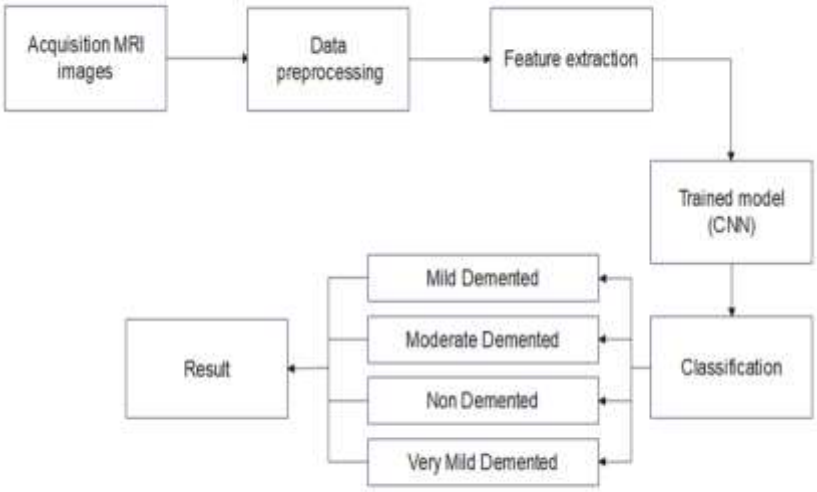

Fig.1- Architecture of proposed Alzheimer's disease Prediction System

3.2 Block Diagram

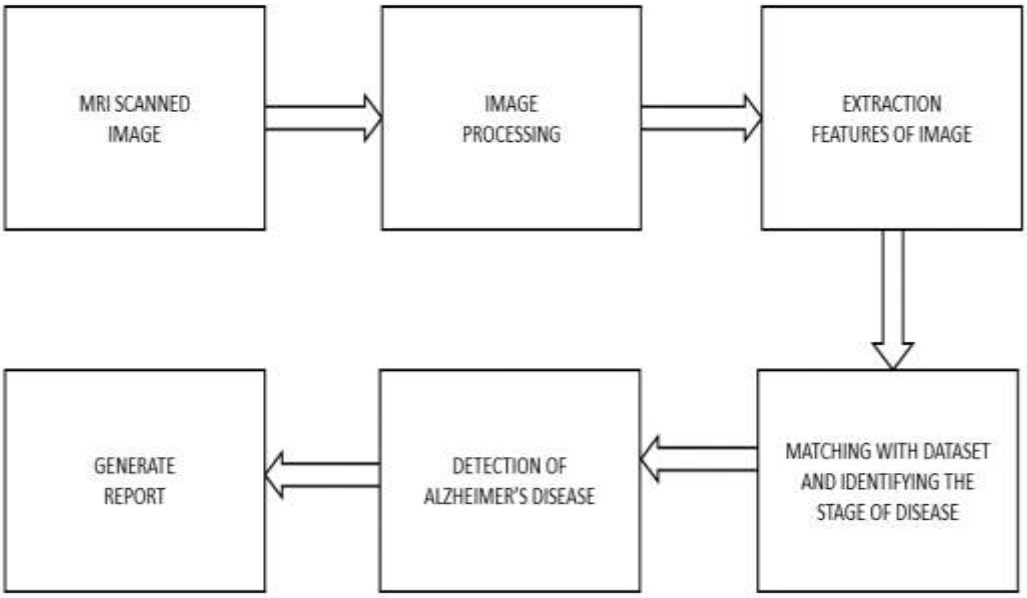

Fig.2- Block Diagram of proposed Alzheimer's disease Prediction System

3.3 Sequence Diagram

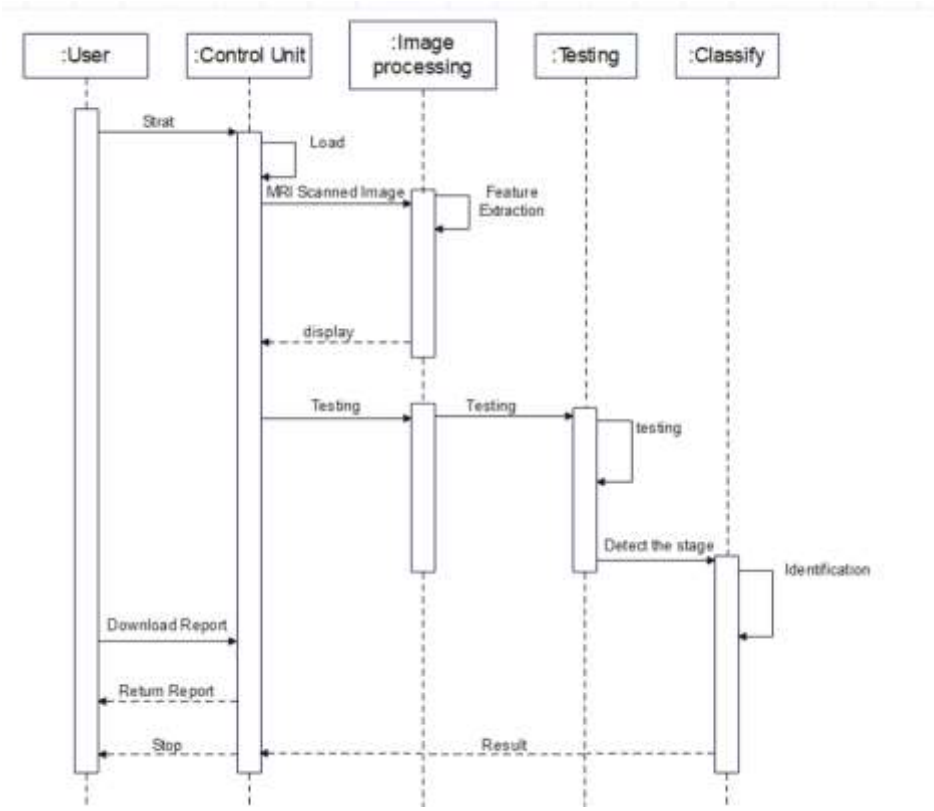

Fig.3- Sequence Diagram of proposed Alzheimer's disease Prediction System

3.4 Activity Diagram

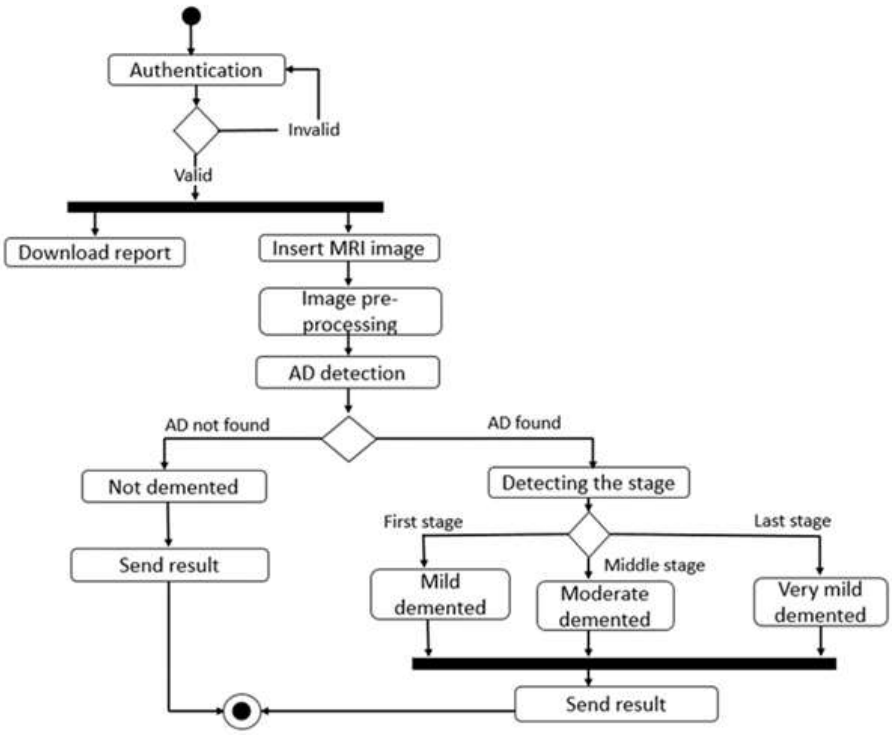

Fig.4- Activity Diagram of proposed Alzheimer's disease Prediction System

4. Implementation

1. Data Collection: Collect MRI scans from patients diagnosed with Alzheimer's disease and healthy individuals. Divide the dataset into training, validation, and test sets. We have taken dataset from ADNI https://adni.loni.usc.edu/data-samples/access-data/

(a) (b) (c) (d)

Fig.(a) Mild Demented **Fig.(b) Moderate Demented** **Fig.(c) Non Demented** **Fig.(d) Very Mild Demented**

2. Data Pre-processing: Pre-process the MRI scans to normalize the intensity levels, remove noise, and correct any image artifacts. Rescale the pixel values expected in the range of [0,1].
3. Feature Extraction: feature extraction refers to extracting features from the learned representations of the CNN model. These features can be used to train a separate classifier or to visualize and understand the learned representations of the model.
4. CNN Architecture: This architecture consists of three convolutional layers with increasing number of filters, followed by max pooling layers to down sample the feature maps. The flattened feature maps are passed through two fully connected layers, with the last layer using a sigmoid activation function to output a binary classification result.
5. Training: Train the CNN model using the pre-processed and augmented dataset. Compile the model using binary cross-entropy loss and an optimizer such as Adam. The train_generator and val_generator are data generators that provide batches of preprocessed and augmented images for training and validation, respectively.
6. Classification: The classification task in a CNN-based Alzheimer's disease detection system involves training the model to distinguish between images of individuals with Alzheimer's disease and those without it. This is typically done using a multiple classification approach, where the output of the CNN model is a probability score indicating the likelihood that the input image belongs to one of the four classes (mild, moderate, very mild or non-dementia).
7. Deployment: we deploy the trained model to classify MRI scan images into Alzheimer's disease detection or healthy individuals.

5. Results and Screenshot

The figure 5 shows the output screen of the proposed system. It is the home page in which we get registration and login button. We use Django framework for front-end. Once we start the Django server, we get this page https://localhost:8000/Home in our localhost port

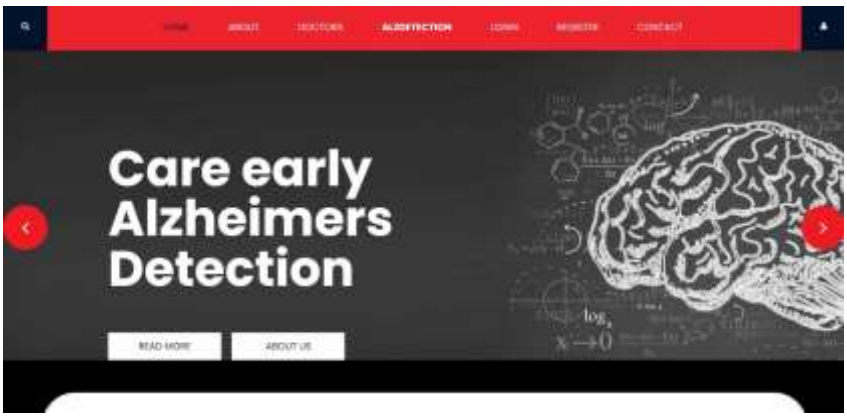

Fig.5- Home Page

The figure 6 shows the login page for the Alzheimer detection

Fig.6- Login Page

The figure 7 shows the predicted result for the uploaded image. It shows which stage the Alzheimer disease if present with the uploaded brain MRI

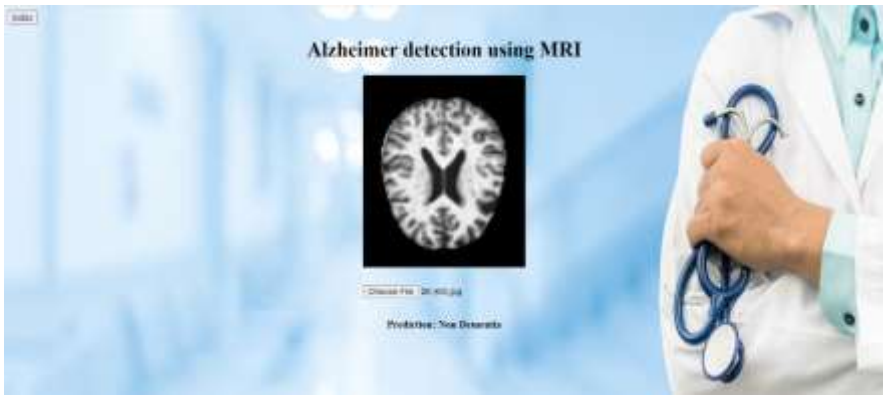

Fig.7- Predicted result of the uploaded result.

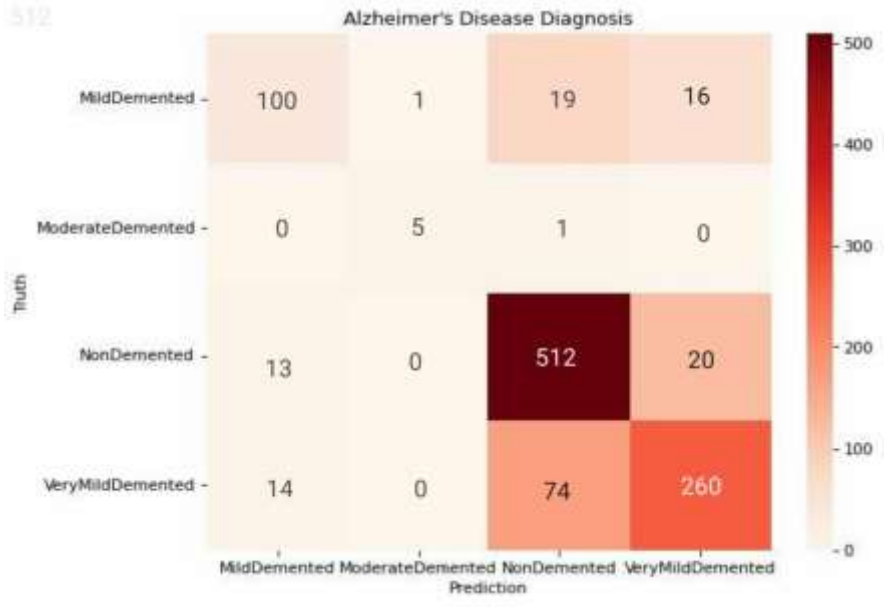

Fig.8- Confusion Matrix of the system.

6. Conclusion

In this paper, we are using a deep learning technique to solve the problem or to overcome the limitations which were facing with the traditional algorithms like SVM, KNN, etc. CNN solve the nearest neighbor problem which is the most major limitation of KNN. The model completely depends on the MRI scanned images and process the image for feature extraction to match the scanned image with our dataset. In our proposed model, we are classifying the

Alzheimer's disease into four stages which decides to be curable or not curable. In depth the mild demented stage is curable, moderate demented stage may or may not be curable and very mild demented stage should not be curable. Datasets from OASIS and ADNI are more in number to refer for the detection of Alzheimer's disease which reaches to show the results up to outstanding level of accuracy like 90% based on the performance of the model.

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