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AlZHEIMER'S DISEASE DETECTION USING DEEP LEARNING

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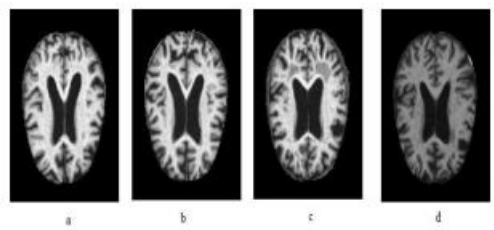
Abstract*— The accurate diagnosis of Alzheimer's disease (AD) plays an important role in patient treatment, especially at the disease's early stages, because risk awareness allows the patients to under go preventive measures even before the occurrence of irreversible brain damage. Although many recent studies have used computers to diagnose AD, most machine detection methods are limited by congenital observations. AD can be diagnosed-but not predicted-at its early stages, as prediction is only applicable before the disease manifests itself. Deep Learning (DL) has become a common technique for the early diagnosis of AD. Here, we briefly review some of the important literature on AD and explore how DL can help researchers diagnose the disease at its early stages

Keywords— Alzheimer, Alzheimer's disease detection , Magnetic resonance image (MRI) , Preprocessing, Medical image analysis, Dementia ,deep learning

I. INTRODUCTION

Alzheimer's disease is a progressive neurological disorder that affects cognitive functions such as memory, thinking, and behavior. Early detection of the disease is important to provide timely treatment and improve patient outcomes. Deep learning, a subset of machine learning, has shown promise in detecting Alzheimer's disease from medical imaging data such as magnetic resonance imaging (MRI) scans. Deep learning algorithms are able to learn complex patterns and relationships from large amounts of data, making them well-suited for medical image analysis tasks. In the case of Alzheimer's disease detection, deep learning models can be trained on MRI scans of healthy individuals and those with Alzheimer's disease. The trained model can then be used to analyze new MRI scans and predict whether the individual has the disease.



AD presented by MRI images (a) mild dementia;
(b) moderate demented; (c) nondemented; and (d) very mild demented

II. **Convolutional neural networks (CNN**).

CNNs are a type of deep learning model that are particularly effective at analyzing image data.
The model is trained on a large dataset of MRI scans, and it learns to identify features in the images that are associated with Alzheimer's disease.

Once trained, the model can be used to analyze new MRI scans and predict whether an individual has the disease. Overall, deep learning has the potential to improve early detection of Alzheimer's disease, which could lead to earlier interventions and better patient outcomes. However, there are still challenges to overcome, such as the need for large and diverse datasets to train accurate models, and the need for further validation and testing of the models in real-world clinical setting

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A. Input layer

Alzheimer's disease detection using deep learning would depend on the type of data being used for the analysis. Generally, the input layer of a deep learning the model is being trained using MRI images, the input layer would consist of image data. Each MRI scan would be fed into the input layer of the model..

B. Convolutional Layer

convolutional layer is a critical component of a deep learning model for Alzheimer's disease detection using MRI images. The primary purpose of the convolutional layer is to extract features from the input images. In this case, the input to the convolutional layer would be the MRI images of the brain.
The convolutional layer comprises a set of filters or kernels, which are small matrices that slide over the input images to detect patterns in the data. Each filter generates a feature map, which is a two-dimensional representation of the detected features

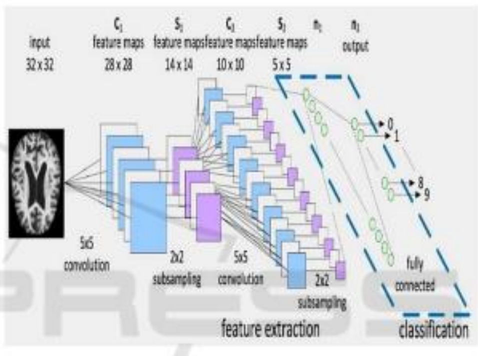
C. Magnetic Resonance Image (MRI)

This imaging technique utilises radio waves and magnetic fields to generate high-quality and high-resolution 2D and 3Dimages of brain structures. No harmful radiations from X-rays or radioactive tracers is generated. The most commonly used MRI for AD cases is the structural MRI, which measures brain volumes in vivo to detect brain degeneration (loss of tissue, cells, neurons, etc.)

D. Output layer

The output layer of a deep learning model for Alzheimer's disease detection using MRI images is usually a binary classification layer. The purpose of the output layer is to predict whether the input MRI image is associated with Alzheimer's disease or not.

In the case of a binary classification layer, the output would be a single scalar value that represents the probability of the input image being Alzheimer's disease-positive. A value close to 0 indicates that the image is Alzheimer's disease-negative, while a value close to 1 indicates that the image is Alzheimer's disease-positive.



2: Brain image classification with the CNN model framework

III. RELATED WORK

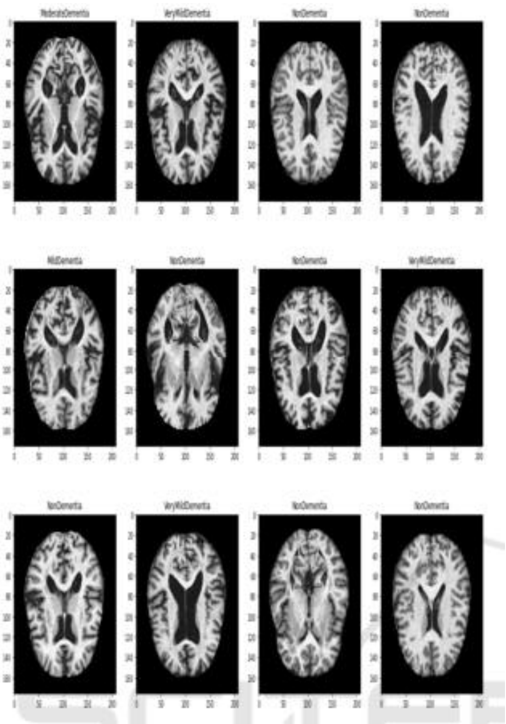
deep learning is a promising tool to perform automatic early detection of Alzheimer's disease from MRI data. The proposed model is able to effectively identify CN and AD subjects based on MRI data, clearly outperforming the model.

A. CNN Model Architecture

A convolutional neural network (ConvNet) is deep learning type algorithms that take images as input, assign features based on their importance (biases and learnable weights) to different image objects, and also be able to separate one from the other (Krizhevsky, Sutskever, en Hinton 2017). When compared with other classification models, ConvNet possesses low complex pre-processing steps. In CNN, each input image is gone through sequence convolution layers namely pooling layers, filtering layers (kernels), and fully connected layers (FCs). To make the proposed model easier for understanding, we created a dense layer block and convolution block. The architecture of the CNN model is inspired by the article (Pan et al. 2020). We built the CNN model by using five convolutional slabs covered with convolution layers, feature engineering, max pooling, and classification. We have used cross-entropy as a loss function and Adam as an optimizer. SoftMax has been used to classify the multiclass AD stages since it is associated with a mutually exclusive relationship. The feature representation works as an input to the SoftMax layer and interprets output brain stages

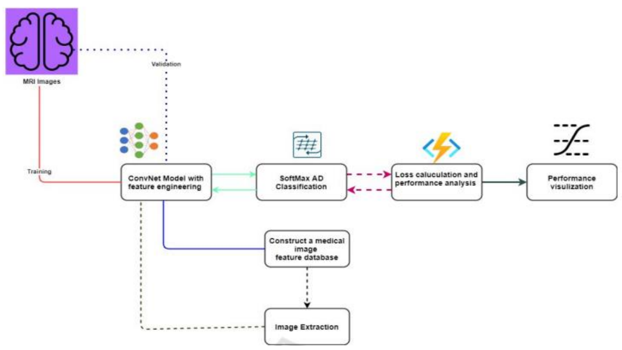
B. Dataset.

- The Open Access Series of Imaging Studies (OASIS) contains MR scanning information that is openly accessible to scientific communities. They released OASIS-1 (cross-sectional) and OASIS-2 (longitudinal) MRI datasets among different subjects and these datasets are widely used in many studies (Sweeney et al. 2013; Palumbo et al. 2021). OASIS3 is the extension of previous datasets. It includes 1,098 patients aging from 42 to 95 years. Among participants, 609 are associated with normal cognitive decline (very mild), and 489 were associated with different cognitive decline stages. OASIS-3 dataset incorporated both functional and structural features of more than 2,000 MRI images. The dataset outcome of four categories of MR images has presented in below.



Dataset outcome of different dementia stages (3*4 image matrix).

IV. EXPERIMENTAL SETUP

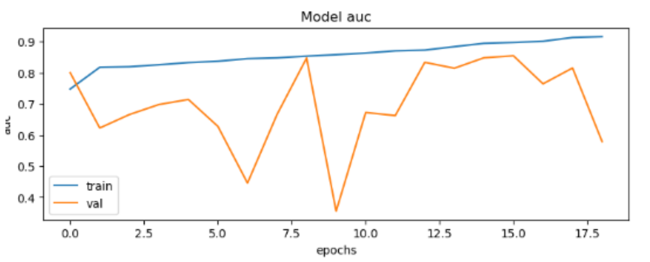


Above pic presents the most relevant procedures followed to construct the feature data of brain images and extraction of AD images developed in this paper. After pre-processing steps, the given image dataset has been divided into training and validation files with standard division.

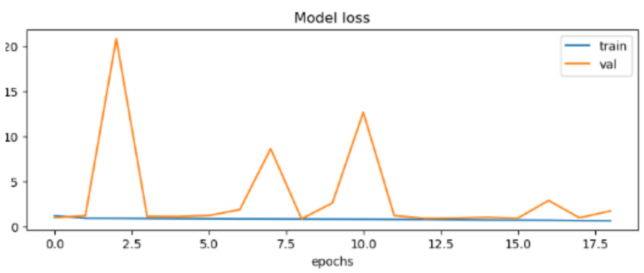
The procedures indicated red line are MR images that fed to the CNN model for training purposes. The model extracts the input image features of trained images under present parameters and supplies them to the SoftMax classifier for testing. The SoftMax function calculates the loss and model accuracy. For avoiding high loss, network parameters are adjusted by the back-propagation algorithm. After applying several iterations (epochs) the better-trained parameters have been achieved. The model visualization metrics like loss and receiver operating characteristic area under the curve (ROC AUC) have been taken as the performance parameter for AD classification since it has been considered one of the key metrics in multi-image classification techniques. The experimental setup and AD detection and classification have been done through TensorFlow and python languag.

V. RESULTS AND DISCUSSIONS

To do efficient training on our CNN model, a backpropagation algorithm is set to adjust the rate of learning and stop the model automatically once it reaches maximum accuracy. Since the learning rate is one of the hyperparameters that decides model accuracy and time to process the model.



The model is being trained with the epoch value as 50.The longer training time allows the model to learn and analyze from a larger set of brain images, which improves its accuracy and sensitivity in detecting disease.



The models are being trained with different epoch values to provide the better accuracy for the datasets

VI. CONCLUSION

This paper defines about the Alzheimer detection using convolutional neural network algorithm with the MRI dataset and the models are being trained with different epoch values to know in which epoch value the model gives better accuracy for the outcomes

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