ALZHEIMER'S DISEASE CLASSIFICATION USING DEEP LEARNING

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***Abstract*—**When patients are aware of their risk for developing Alzheimer's disease (AD), they are better able to take preventative steps before permanent brain damage occurs, making an accurate diagnosis of AD during inpatient treatment crucial. Among those aged 65 and up, Alzheimer's is so far the most popular form of dementia. There's a significant amount of interest in making use of machine learning to enhance the diagnosis of metabolic illnesses popularly known as Alzheimer's and diabetes. The rates at which they occur are increasing alarmingly every year. Alzheimer's causes brain changes due to neurodegenerative processes. Conditions impairing cognitive abilities are on the rise, burdening patients' loved ones and the healthcare system. The social, economic, and monetary sectors will all feel the effects of these shifts profoundly. Diagnosing Alzheimer's disease in its early stages is challenging. Studies have indicated that if Alzheimer's disease is treated early on, it has a better chance of being cured and has fewer side effects. Parameters used to forecast the onset of Alzheimer's disease can be optimized using a variety of classifiers, including Decision Trees, Support Vector Machines, Gradient Boosting, Random Forests, and Voting classifiers. Recently, deep learning (DL) has seen widespread use in the field of Alzheimer's disease early detection. After exploring how DL can help in the early identification of AD and presenting a brief literature review on the topic.

***Keywords*—**AD DETECTION, DEEP LEARNING KERAS MODEL, CNN MODEL,

I. INTRODUCTION

Alzheimer's disease (AD) is a nervous system disorder that shows symptoms such as short-term memory loss, psychosis, and delusional thinking. Most people believe that stress or old age are the primary causes of Alzheimer's disease. It is approximated that over 5 million persons in the US are suffering from this ailment. The medical treatment that is now offered for AD is insufficient. To keep Alzheimer's disease under control, constant medication administration is required. Because it is a chronic condition, AD can continue to affect a person for a significant number of years, and it may even endure for their entire life. It is essential to administer medication at the appropriate time to prevent long-term damage to the brain. This method takes a lot of time and money to discover this ailment in its early stages, a large amount of data is collected, and utilized complex algorithms for prediction and work with an experienced medical professional. Automated systems are not prone to the errors that are caused by humans, they are capable of being employed in medical decision support systems with a better degree of precision than human review. Quantitative data from MRI scans, together with other indicators (chemicals, blood flow) have been used to advance our understanding of AD. So that they could identify those who were suffering from mental illness. Eliminating the need for human intervention to arrive at a diagnosis of Alzheimer's is another advantage of automating the procedure. In addition to lowering total expenses, automation also yields more precise results. By studying MRI scans and using prediction tools, we can, for instance, determine if a patient is suffering from dementia. A person with Alzheimer's disease is regarded as mentally impaired in the early stages. More precision will result from this procedure. In the beginning stages of Alzheimer's, a person normally doesn't need aid from others to perform daily tasks. In some cases, a person may be able to keep working, driving, and participating in social events as usual.

Despite this, the individual may continue to experience anxiety or memory loss (such as forgetting frequently used terms or where they frequently go). Their loved ones have noticed that they have trouble calling them by their full name. The doctor may be able to tell if the patient has attention or memory issues by questioning them in depth. A few of the difficulties often encountered by those with Alzheimer's in the first stages of the disease.

• Challenging to recall the correct term or individual's name.

• Struggling to remember faces after meeting new individuals.

• Putting in a full day's labor in a professional or social context can be taxing.

• Forgetting something you just read or learned.

• Losing or not being able to locate something of importance.

• Making a strategy or organizing your day-to-day tasks and endeavors is becoming more and more challenging. This study aims to pinpoint areas of research concerning ML frameworks and EHR-produced data.

II. LITERATURE SURVEY

General-The purpose of a literature review is to examine the major findings and research methods that have been applied to a specific issue. Secondary sources are those that describe previously published information on a topic or, more specifically, about that topic within a defined time frame. Its ultimate purpose is to bring the reader up to speed on the state of the art in the literature on a particular topic; it lays the groundwork for another objective, such as potential future research needs in the area; it comes before a research proposal, and it may be as simple as a synopsis of sources. It often follows a certain structure and incorporates aspects of both summary and synthesis. Synthesis involves rearranging and rearranging material, while summary just restates key points from the source. It could offer a fresh perspective on previously established ideas, synthesize new and established ways of thinking, or chart the development of thought in the area from its inception to the present day, including its most heated conflicts. In some cases, a literature review will provide an assessment of the available sources and recommendations for those that are most useful to the reader.

Review of Literature Survey:-

[1]The Alzheimer's disease datasets on OASIS and Kaggle are used to train a wide variety of patient data with machine learning algorithms like SVM, a Decision tree classifier, Random Forest classifier,xg boost leading to quicker and more accurate identification of those with the disease.

Pros: used various machine learning techniques to categorize cases of Alzheimer's and compared their performance across a range of parameters.

Cons: Didn't rely heavily on CNN to determine Alzheimer's disease diagnosis.

[2]The purpose of this study is to train and test a deep learning system that can distinguish the period between aging and dementia to that of Alzheimer's disease based on a PET scan of the brain fluorodeoxyglucose (FDG) and compare its results to those of human radiologists. Data containing the prospective Alzheimer Disease Neuroimaging Initiative (ADNI) dataset imaging studies from 2005-2017 and the retrospective independent test set were combined to create a database of 18F-FDG PET brain pictures (40 imaging studies from 2006-2016, 40 patients). The clinical findings were recorded after the end of the follow-up time. Following training on 90% of the ADNI data set using the InceptionV3 architecture, the findings were compared to those of human radiologist readers on the remaining ten percent and a test set. Multiple metrics, including sensitivity, specificity, ROC, and ROC area, as well as a saliency map and a t-distributed stochastic neighbor embedding, were used to evaluate the model.

[3]Although many different methods and ML algorithms have been studied to extract patterns from the brain scan data to help in the clinical and research diagnosis of Alzheimer's disease, it has proven difficult to distinguish between dementia and healthy brain data in old people (age > 75) due to similar patterns of brain shrinkage and image intensities. These pipelines, run on a graphics processing unit (GPU) based high-performance computing platform, performed extensive and rigorous preprocessing of the data. Following this, a large number of training images were input into a convolutional neural network (CNN) to extract low- to high-level features that are robust to scale and shift changes. In this study, for the first time, deep learning was applied to fMRI data to assess medical imaging and diagnose Alzheimer's. The fMRI and MRI pipelines, respectively, achieved good, repeatable accuracy of 99.9%, and 98.84% after adopting the planned pipelines, which suggests an improvement in the differentiation of output in comparison to earlier investigations. In addition, subject-level categorization for therapeutic purposes was carried out, with approximate accuracy rates of 95.33% for the fMRI pipeline and 97.88% for the MRI pipeline. The decision-making system at the subject level enabled the fMRI rate to increase to

97.7 percent, while simultaneously enabling the MRI pipeline rate to achieve 100 percent.

[4]There has been a huge rise in the senior population as the effects of China's rapid aging become more apparent. Simultaneously, there has been a rise in the number of people diagnosed with Alzheimer's disease (AD). The current gold standard for diagnosing Alzheimer's disease requires radiologists with extensive experience to examine brain structural nuclear magnetic resonance (MRI) images and make a subjective diagnosis. Potential for an incorrect diagnosis. Image classification using a deep learning Convolutional Neural Network (CNN) shows excellent performance and accurate classification when applied to MRI scans of Alzheimer's patients and healthy controls (NC). By leveraging deep learning and transfer learning, evaluating and contrasting the VGG 16 network model of the convolutional neural network with the MobileNet network model. When comparing classification accuracy, and discovering the MobileNet network model outperforms the VGG 16, network model.

[5]Researchers have been able to gain a deeper understanding of the problem at hand and discover novel solutions to previously intractable medical dilemmas thanks to the proliferation of machine learning techniques in the biomedical sciences over the past decade. These techniques have been used in everything from drug delivery systems [7] to medical imaging. Deep learning is a machine learning technique that excels in categorization and feature extraction at a high level. To distinguish Alzheimer's disease brains from healthy brains, we trained a convolutional neural network in this study. This form of medical data classification is important because it may be used to create a prediction model or system that can distinguish between disease types and healthy patients, or estimate the severity of a disease. Selecting the most discriminative features has traditionally been the most difficult component of clinical data classification, especially for diseases like Alzheimer's. Using a Convolutional Neural Network with the popular architecture LeNet-5, we successfully segmented functional MRI data from Alzheimer's patients and healthy controls with an accuracy of 96.85% on test data based on trained data. This research proves that extracting shift- and scale-invariant features with CNN and subsequently classifying the data with deep learning is the most efficient method for distinguishing clinical data from healthy data in fMRI. Taking this approach allows us to extrapolate our methods to predict behavior in systems with greater complexity.

[6]Alzheimer's disease is a devastating kind of dementia. It kills off brain cells, leaving victims unable to remember things, thinks clearly, or carry on with their regular lives. Although there is currently no cure for Alzheimer's disease, early diagnosis can greatly improve quality of life. The accuracy of Alzheimer's disease diagnoses can be greatly enhanced by using machine learning techniques. Recent years have seen tremendous advancements in the application of deep learning to medical image processing.

It has received scant attention that deep learning methods can be used to diagnose and classify Alzheimer's disease. Based on Brain MRI data, a deep-learning model was introduced for identifying and categorizing multi-class Alzheimer's disease. We show the Opening of Access Series of Imaging Studies database can benefit from an extremely deep convolutional network that has been developed.

III. CNN CLASSIFICATION SYSTEM

Alzheimer's diagnosis follows the same classification pattern. With cutting-edge technology and deep learning, neurologists may soon be able to diagnose Alzheimer's disease noninvasively. In the realm of image categorization, deep learning's convolutional neural network has proven to be highly effective (CNN). A database of T1-weighted contrast-enhanced MRI images including or not containing Alzheimer's disease was used for categorization. Since we used unaltered photos as input, no preparation of Alzheimer's data was required. Larger numbers of photos from various categories, including "normal" and "abnormal," are collected as samples. Each input image classification results in a different number of photographs being collected. Our method involves using Deep Learning (DL) to predict Alzheimer's disease outcomes. A DL method called Convolutional Neural Networks (CNN) was used in this study. If Alzheimer's is successfully classified via CNN and additional feature extraction techniques, the results may be improved.

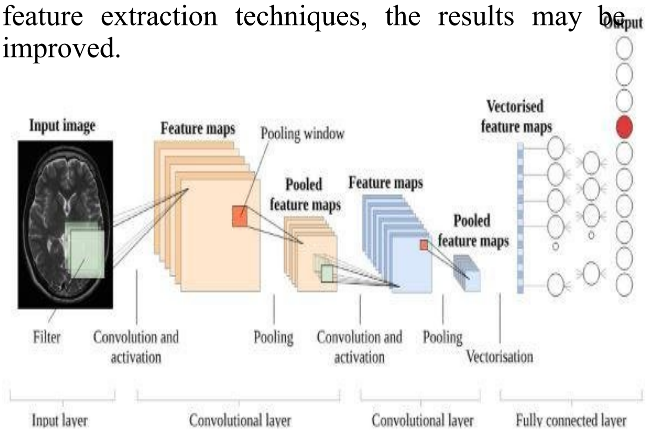

Fig.1 CNN architecture

Training the model (Convolutional Neural Network): Images are resized, cropped, and converted to array format as part of the preprocessing of the dataset. Even the test image undergoes the same treatment. A collection of Alzheimer's disease images numbering in the hundreds; each one of these pictures can serve as a test case for your program. As a result of being trained on the training dataset, the model (CNN) can correctly detect the disease in the test image. Dense, Dropout, Activation, Flatten, Convolution2D, and MaxPooling2D are some of the layers that make up a CNN network. Following successful model training, the software is able to correctly identify Alzheimer's disease from images of the affliction in the training dataset. The test image is compared to the learned model once training and preprocessing have been completed successfully.

Input shape: An N-dimensional tensor of the form (batch size, input dimensions). The most typical scenario involves a 2 dim as input of shape (batch size, input dimensions).

Output shape: Tensor in N dimensions, of the form (size of batch, units). The shape of the output would be (batch size, input dim) for a 2D input, for instance.

Image Data Generator:

It is that which does a resizing transformation, a shearing transformation across a specific range, a zoom transformation, and a horizontal flipping transformation on the image. All conceivable image orientations are represented in this image data generator.

Training Process:

The train dataset directory's data can be prepared for use using the train datagen. flow from the directory function. The image's intended size can be set with the target size parameter. All of the aforementioned is also true for the model-testing utility known as Test catagen. flow from a directory. The steps per epoch variable indicate the number of times the model will be run on the training data, while the fit generator is used to fit the data into the model built in the preceding section.

Epochs:

It tells us how many iterations of forward and reverse training the model will undergo.

Validation process:

The validation and test data are taken from the validation data. The quantity of validation/test samples is denoted by validation steps.

One kind of ANN is a Convolutional ANN (or simply CNN). Image processing, classification, and segmentation are just a few applications of convolutional neural networks, which are neural networks with one or more convolutional layers.

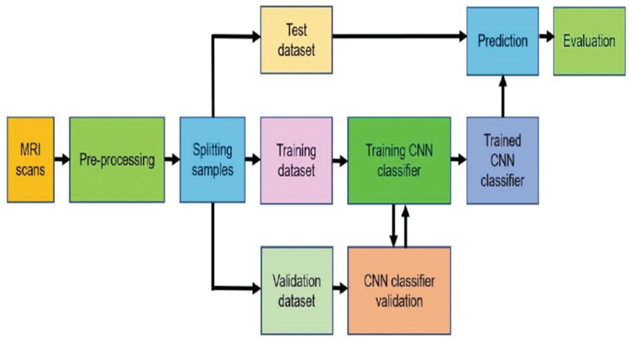

Fig.2 Architecture diagram

Keras models can be made in three distinct ways:

Despite being the simplest model (it's just a list of layers), the sequential model is limited to stacks of layers with a single input and output (as the name gives away). The Functional API is a simple, feature-rich API that may be used with any kind of model design. You should be employing this method for the vast majority of users and uses. The Keras model is considered "industry strong." This is achieved through model subclassing, in which you create your implementation of the model.Incorporate this into your investigation if you're trying something completely new.

IV. PROCESS EVALUATION

PREPARING THE DATASET:

This dataset contains approximately 400 train and 100 test images, which were then classified into 2 classes:

- DEMENTED - The person is having Alzheimer disease.
- NON-DEMENTED-The person is not having Alzheimer disease.

DATA SET:

Our dataset is in the format of .jpg which was divided into demented and non-demented forms.
Training: 387 images.
Testing: 104 images.

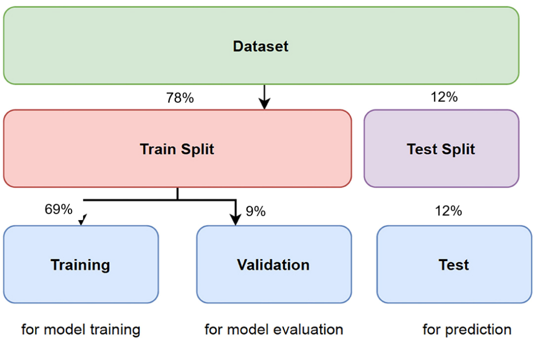

Fig.3 Dataset Splitting

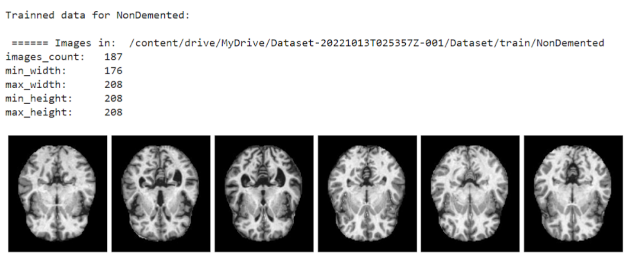

Fig.4 Non-Demented Images

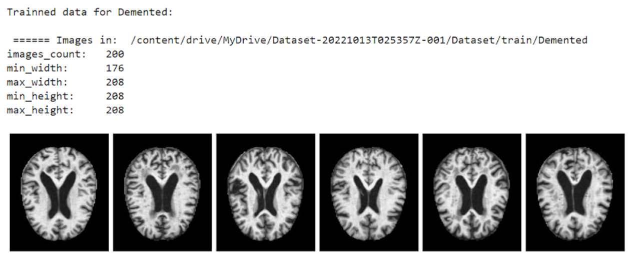

Fig.5 Demented Images

V. RESULT AND DISCUSSIONS

After evaluating various performance metrics like accuracy, precision, and loss. To determine the best performance, no of epochs so that for each epoch the accuracy got increased. A novel Machine Learning classifier was created for predicting and separating actual Alzheimer's disease-affected people from a given population and verified the model's ability to identify these individuals. For this analysis, The parameters used are to compute precision, accuracy, and loss metrics. The accuracy of an Alzheimer's diagnosis is measured by how often healthy individuals are accurately excluded from the diagnosis. On the other hand, accuracy measures how many people were correctly identified, whereas recall is the weighted average of these two metrics. Patients are given a report detailing their Alzheimer's disease stage based on the test results. Identifying the stages is crucial because the stages are determined by the patient's reactions. The disease's progression can be better understood by doctors if they are aware of the patient's stage. The experiments and analyses in this study made use of the following environments, tools, and libraries:

- men are more prone than women to develop dementia or Alzheimer's disease.
- Dementia sufferers had less years of schooling than the general population.
- The volume of the brain is larger in people who do not have dementia compared to people who do
- The percentage of patients aged 70-80 in the dementia group is much higher than that of the non-dementia group.

TRAINING DATA:

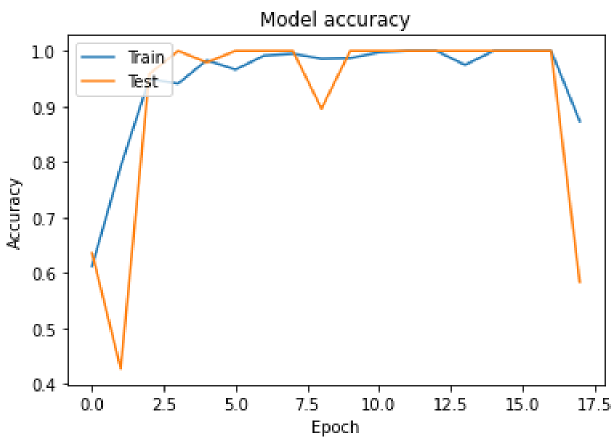

Fig. 6 Acc vs Epoch graph for trained data

The graph in fig.6 shows the graphical representation between accuracy and epoch during the training process

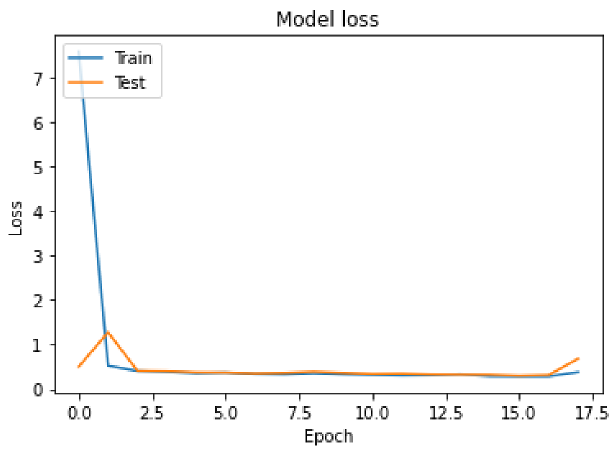

Fig.7 Loss vs Epoch graph for training data

The graph in fig.7 shows the graphical representation between loss and epoch during the training process

TESTING DATA:

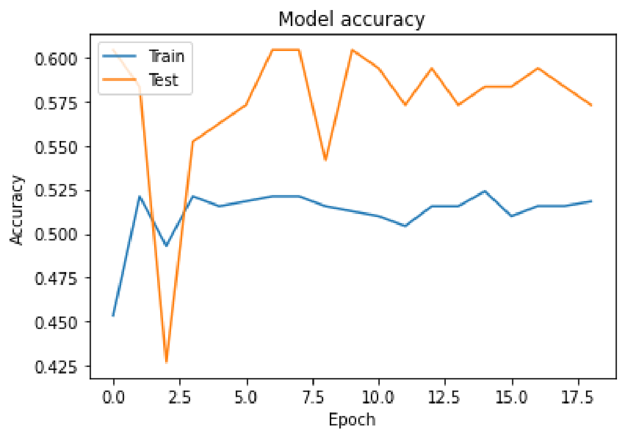

Fig.8 Acc vs Epoch graph for testing data

The graph in fig.8 shows the graphical representation between accuracy and epoch during the testing process

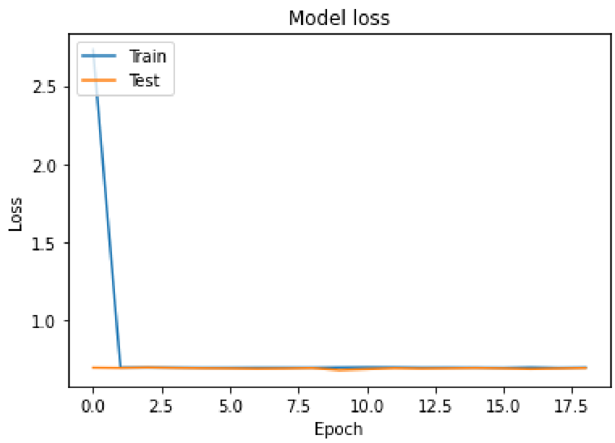

Fig.9 Acc vs Epoch graph for testing data

The graph in fig.9 shows the graphical representation between loss and epoch during the testing process

VI. CONCLUSION

After conducting a systematic assessment of the relevant literature and discovered that the majority of the articles in this field concentrate on biomarkers and neuroimaging, with an increasing emphasis on image processing. The majority of the selected patients already had a diagnosis of AD, hence the work didn't contribute much to the initial discovery of the disease. Some of the most relevant AD datasets, as well as diagnostic methods and detection strategies, were discussed in this article. For preliminary neuroimaging studies, this method is practical.

Predictions of the start of Alzheimer's disease can be made by ML systems using a feature selection and extraction technique using the oasis longitudinal dataset. This article will provide a high-level overview of the field by quickly discussing the several approaches utilized to analyze brain images to identify brain diseases. This research utilizes data from the reviewed literature to address some serious issues with applying machine learning and deep learning to diagnose brain illnesses. Findings from this study about the most effective method of detecting brain disorders can be utilized to create more precise diagnostic tools in the future.

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