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Alzheimer's Disease Detection Using Deep Learning

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ABSTRACT

Alzheimer's Disease (AD) is found to be a serious issue aroundthe world and India. Hence it is a concern issue to be addressed benefiting India as well human kind of world. To support AD/MCI patients in turn to caregiver and family members it is always evident to provide a complete solution starting from early diagnosis of AD which will reduce adverse effects on patients as well an Aid helping the AD patients live their life as a normal individual. Emerging technologies like machine learning and deep learning have promising roles [1]to achieve the solution for the problem stated. On reviewing the research works till this point of research we found that noresearch focused on complete solution for the problem right from early detection to helping aid forAD/MCI patients so herein the project we implement deeplearning. We propose to use Inception v2 model in which LSTM is one of the RNN type classifier for classification problem

KEYWORDS: Alzheimer's disease, Inception model,Memory loss, Nerve cells, Brain

I. INTRODUCTION

One of the great challenges faced by neuropsychologists over the past 50 years is to understand the cognitive and behavioral manifestations of dementia and their relationship to underlying brain pathology. This challenge has grown substantially over the years with the aging of the population and the age-related nature of many dementia-producing neurodegenerative diseases.Alzheimer's Disease (AD) is[2] a neurological disorder that causes the death of nerve cells in the human brain. AD usually begins gradually and its first symptoms may be attributed to the increment of the age or common forgetfulness. As the disease progresses, the patient's cognitive abilities deteriorate, including the ability to make decisions and carry out daily tasks. Currently there is no cure for the disease, only a series of guidelines can be followed to perhaps delay the progress of it. For this reason, an effective diagnosis will be a key factor in order to improve the quality of life of their patients

The motivation for the creation of innovation to support the battleagainst Alzheimer's disease is evident, not only from an ethical perspective but also due to the continuous proliferation of Alzheimer's cases in our society[3]. Today, 50 million people worldwide live with dementia, where two-thirds of them have Alzheimer's disease . Alzheimer's cases have overtaken cancer ones to become the most feared disease in the United States, with a new case appearing every three seconds in the world . At the moment the diagnosis of this disease is made by combining an analysis of the patient's medical history,different cognitive tests and various clinical tests, such as photographic scans of the brain.

II. OBJECTIVE

To design a efficient tool for identification of Alzheimer's Disease using deep learning deep CNN model (Inception v2) for better accuracy predection.

III. LITERATURE SURVEY

Origin of Alzheimer's disease:

Alzheimer's disease is named after Dr. Alois Alzheimer. In 1906, Dr. Alzheimer [4] noticed that changes in the brain tissue of a woman(Auguste) who died of an unusual mental illness. Her symptoms included memory loss and language problems, and unpredictable behavior. After she died, they have examined her brain and found many abnormal clumps (now called amyloid plaques) and tangled bundles of fibers

Hansson O[1] describes evidence supports an important role for β-amyloid (Aβ) in the pathogenesis of Plagiarised Unique AD.They investigate baseline levels of the 40- and 42-amino-

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acid-long Aβ peptides (Aβ40 and Aβ42) in cerebrospinal fluid (CSF) from a cohort of patients with mild cognitive impairment (MCI, n= 137) in relation to the final diagnosis after 4–6 years of follow-up time

J P Brion [2] describes the neuropathologicaldiagnosis of AD relies on presence of both the neurofibrillarytangles and senile plaques. It is tightly linked to the degree of dementia, suggesting that the formation of neurofibrillary tangles more directly correlates with neuronal dys function.

Joseph Gaugler et al[3] describes the public health impact of Alzheimer's disease (AD), including incidence and prevalence, mortality and morbidity, use and costs of care, and it overall impact on caregivers and society. They discusses the challenges of providing equitable health care for people with dementia in the United States.

James C Vickers[4] describes the development of beta- amyloid plaques in the brain may cause physical damage to axons, and the abnormally prolonged stimulation of the neuronal response to this kind of injury ultimately results in the profound cytoskeletal alterations that underlie neurofibrillarypathology inhibition of the neuronal reaction to physical trauma may be a useful neuroprotective strategy in the earliest stages of Alzheimer's disease.

3.2. Neural network :

In deep learning, convolutional neural network is a class of deep neural networks, most commonly applied to analyze visual imagery. when they think of neural network then we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics convolution is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other

Fig: Neural network model

IV. PROPOSED MODEL

Method based on an enhanced version of CNN model known as the Inception V2 model was proposed to analyze MRI images to [6]identify AD. In the Inception V2 architecture. The 5×5 convolution is replaced by 3×3 convolutions. This also decreases computational time and thus increases computational speed because a 5×5 convolution is 2.78 more expensive than a 3×3 convolution. So, Using two 3×3 layers instead of 5×5 increases the performance of architecture.

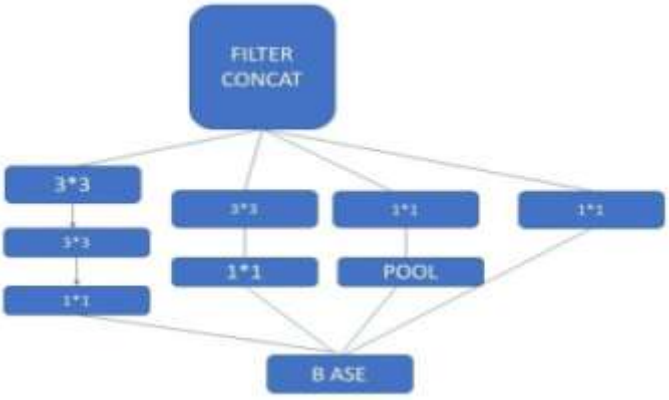

FIGURE:1 - 3* inception model

This architecture also converts nXn factorization into 1xn and nx1 factorization. As we discussed above that a 3×3 convolution can be[7] converted into 1×3 then followed by 3×1 convolution which is 33% cheaper in terms of computational complexity as compared to 3×3. To

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deal with the problem of the representational bottleneck, the feature banks of module that were been expanded instead of making it deeper. This would prevent the loss of information that causes.

Type	Patch size/stride or remarks	Input Size
conv	3*3/2	299*299*3
conv	3*3/1	149*149*32
Conv padded	3*3/1	147*147*32
pool	3*3/2	147*147*64
conv	3*3/1	73*73*64
conv	3*3/2	71*71*80
conv	3*3/1	35*35*192
3*inception	As in figure 1	35*35*288
5*inception	As in figure 2	17*17*768
2*inception	As in figure 3	8*8*1280
pool	8*8	8*8*2048
linear	logits	1*1*2048
SoftMax	classifier	1*1*1000

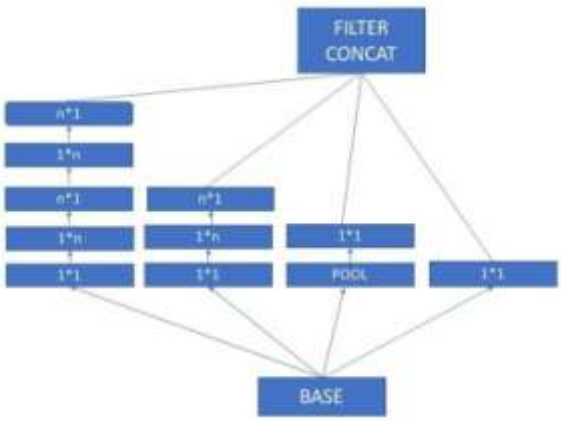

FIGURE:2 - 5* inception model

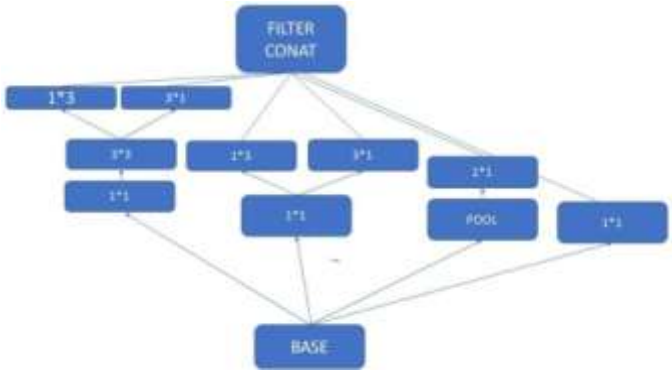

FIGURE:3 - 2*inception model

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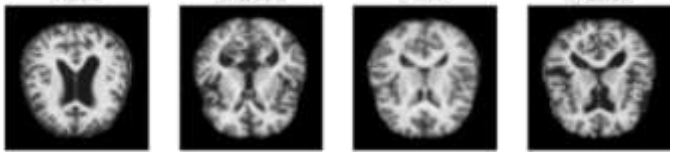
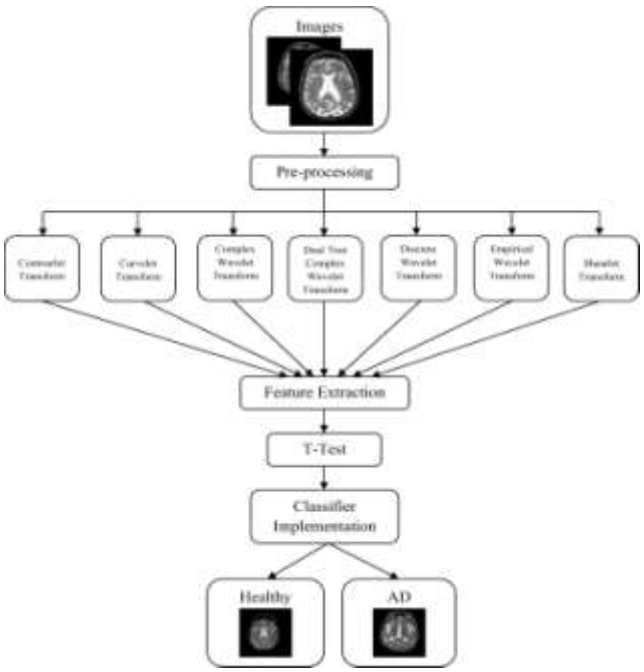
V. MRI SAMPLE DATASETS

Brain imaging techniques can be used to non-invasively visualize the structure,[8] function, or pharmacology of the brains. The imaging techniques are generally divided into two categories: structural imaging and functional imaging Structural imaging provides information about the brain's structure, including neurons, synapses, glial cells, etc. Functional imaging provides information about the activities performed by the brain .The neuroimaging techniques mostly used for AD are the following: 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 it measures brain volumes in the vivo to detect the brain degeneration (loss of tissue, cells, neurons, etc.). [14]Brain degeneration is an inevitable progressive component of AD . fMRI provides a useful information about the human brain's activity, i.e., how the brain functions. fMRI methods, such as brain imaging based on arterial Blood Oxygenation Level Dependent (BOLD) contrasts andspin- labelling (ASL), are sensitive to the cerebral metabolic rateof oxygen consumption and cerebral blood flow (CBF).



VI. SYSTEM ARCHITECTURE



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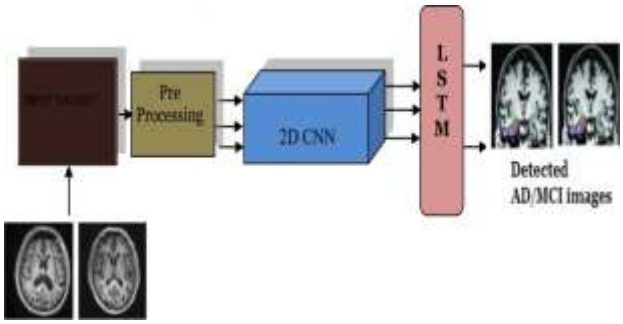
VII. METHODOLOGY

Early detection of AD/MCI will be carried out by considering MRI dataset from Kaggle. The detection process [9]starts from dividing the data set into training set and testing set. Validation will be carried out considering bench mark dataset. The entire process of early detection will be done as

1. Processing: It performs a series of mechanical operationson (something) in order to change or preserveit.
2. Image segmentation: It is the process of dividing a digital image into multiple image segmemts, also known as image regions or objects.The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to[13] locate objects and boundaries in image. More precisely , it is the process of assigning a label to the every pixel in an image such that pixels with the same label share certain characteristics.
3. Feature extraction: Feature extraction is a type of dimensionality reduction where the large number of pixels of the image are efficiently represented in such a way interestingparts of image are captured effectively.
4. Cortical atrophy measurement: Cortical atrophy mainly occurs in cerebal areas supplied by the anterior circulation. On investigated the location and characteristics of atrophy,especially difference in cerebal atrophy between the hemisphere affected by severe stenosis and the contralateral hemisphere.
5. Classification: It is a function that assigns the items in a collection to target categories or classes. The goal of classification is to accurately predict the target class foreach case in the data. For example, a classification model could be used to identify applicants as low, medium, or high credit risks



VIII. LIBRARIES

1.**PANDAS**:

Pandas is a Python package providing fast, flexible, and expressive data structures designed to make working with “relational” or “labeled” data both easy and intuitive. It aims to be the fundamental high-level [10]building block for doing practical, real-world data analysis in Python. Additionally, it has the broader goal of becoming the most powerful and flexible open source data analysis/manipulation tool available in any language. It is already well on its way toward this goal.

2.**NUMPY**:

In Python we have lists that serve the purpose of arrays, but they are slow to process.NumPy aims to provide an array objectthat is up to 50x faster than traditional Python lists.The array object in NumPy is called ndarray, it provides a lot of supporting functions that make working with ndarray very easy.3.**SEABORN:**

Seaborn is an amazing visualization library for statistical graphics plotting in Python. It provides beautiful default styles and color palettes to make statistical plots more attractive. It is built on the top of matplotlib library and also closely integrated to the data structures from pandas.

4. MATPLOTLIB:

Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi-platform data visualization library built on NumPy arrays and designed to work with the broader SciPystack.

5. TENSORFLOW:

TensorFlow is an open source machine learning framework for all developers. It is used for implementing machine learning and deep learning applications. To develop and research on fascinating ideas on artificial intelligence, Google team created TensorFlow. TensorFlow is designed in Python programming language, hence it is

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considered an easy to understand framework.

6. KERAS:

Keras is an open source deep learning[12] framework for python. It has been developed by an artificial intelligence researcher at Google named Francois Chollet. Leading organizations like Google, Square, Netflix, Huawei and Uber are currently using Keras. This tutorial walks through the installation of Keras, basics of deep learning, Keras models, Keras layers, Keras modules and finally conclude with some real-time applications.

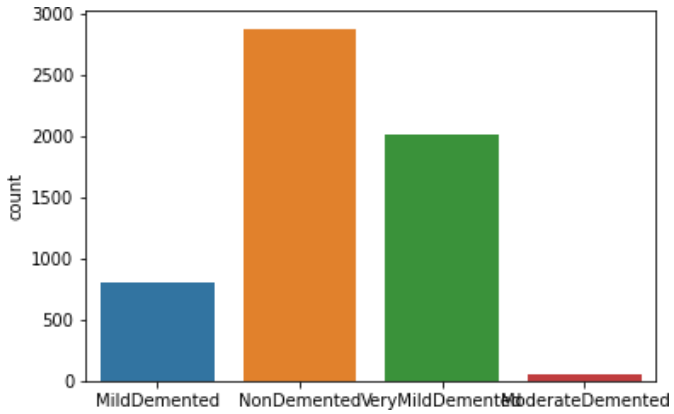
7. OS(OPERATING SYSTEM):

Python OS module provides the facility to establish the interaction between the user and the operating system. It offers many useful OS functions that are used to perform OS-based tasks and get related information about operating system.The OS comes under Python's standard utility modules. This module offers a portable way of using operating system dependent functionality.

8. OPENCV:

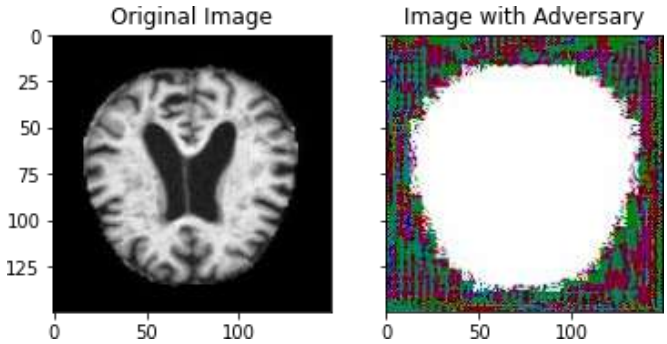
OpenCV (Open source computer vision) is a library ofprogramming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was latersupported by willow garage then Itseez (which was later acquired by Intel).

IX. DATASET COUNT



X. ADVERSARIAL ATTACK

An **Adversarial Attack** is a technique to find a perturbation that changes[11] the prediction of a model. The perturbation can be very small and imperceptible to human eyes.



XI. RESULT GRAPH

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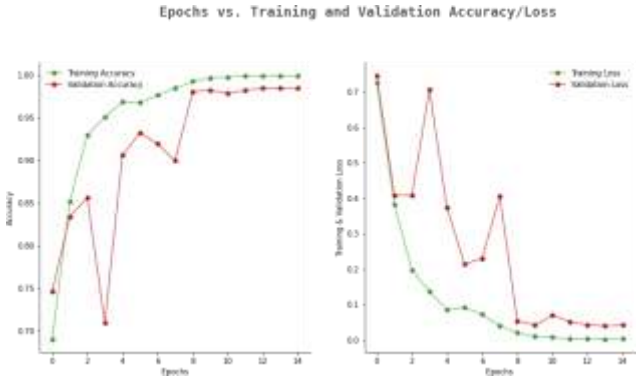

XII. RESULT TABLE

S.no	precision	recall	F1 - score	support
0	0.98	1.00	0.99	61
1	1.00	1.00	1.00	3
2	0.98	1.00	0.99	156
3	1.00	0.96	0.98	107

accuracy			0.99	327
Macro avg	0.99	0.99	0.99	327
Weighted avg	0.99	0.99	0.99	327

XIII. CONCLUSION:

It has been demonstrated that it is possible to measure the probability of having AD by means of combining clinical history, lifestyle habits and cognitive examinations presenting an accuracy result of above 90%. Moreover, it has been demonstrated that even though this type of data has been medically claimed to be insufficient to confidently diagnose the disease, adequate results can be obtained. Across the report it has be shown that this can be achieved with intensive data cleansing and the selection and design of the right model.

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