

DETECTION OF ALZHEIMER STAGES BY USING CONVOLUTIONAL NEURAL NETWORK ARCHITECTURE

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Biotechnology

Interdisciplinary project

By

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SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

CATEGORY – 1 UNIVERSITY BY UGC

Accredited with Grade “A++” by NAAC | 12B Status by UGC | Approved by AICTE

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Harhini S** (Reg.No. 41230021) and **Swetha S** (Reg.No. 41230067) who carried out the Interdisciplinary Project entitled **"DETECTION OF ALZHEIMER STAGES BY USING CONVOLUTIONAL NEURAL NETWORK ARCHITECTURE"** under our supervision from January 2024 to April 2024.

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DECLARATION

We, Harhini S (Reg. No. 41230021) and Swetha S (Reg. No. 41230067) hereby declare that the Project Report entitled “**DETECTION OF ALZHEIMER STAGES BY USING CONVOLUTIONAL NEURAL NETWORK ARCHITECTURE**” done by us under the guidance of **Ms.A Kavi Praba M.Tech.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE: 06-05-2024

PLACE: CHENNAI

A rectangular box containing a handwritten signature in blue ink that reads "S. Harhini".

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Alzheimer's disease is a progressive neurodegenerative disorder affecting millions of people worldwide, primarily among the elderly population. Early diagnosis and staging of the disease are crucial for effective intervention and patient care. This research proposes a novel approach to diagnose and stage Alzheimer's disease using CNN architectures applied to brain imaging data. The dataset comprises magnetic resonance imaging (MRI) scans obtained from individuals at different stages of Alzheimer's disease.

The CNN architectures are designed to automatically extract meaningful features from MRI scans, capturing both local and global patterns associated with disease progression. To validate the proposed approach, a comprehensive evaluation is performed on an independent test dataset. Performance metrics such as accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AUC-ROC) are calculated to assess the diagnostic and staging capabilities of the CNN models.

The experimental results demonstrate the efficacy of the CNN architectures in accurately diagnosing Alzheimer's disease and staging its progression. The models achieve high accuracy and the CNN models show robustness and generalizability when tested on unseen data.

Keywords: *Alzheimer's Disease, neurodegenerative disorder, diagnosis, staging, accuracy, CNN Architectures, Magnetic Resonance imaging scans, CNN Models.*

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LIST OF SYMBOLS AND ABBEREVIATIONS

CNN	Convolutional Neural Network
MRI	Magnetic Resonance Imaging
AD	Alzheimer Disease
AI	Artificial Intelligence
NMDA	N-methyl D-aspartate
CAD	Computer Aided Detection
PET	Positron Emission Tomography
OASIS	Open Access Series of Imaging Studies
CT	Computerized Tomography
DFD	Data Flow Diagram
ML	Machine Learning
MCI	Mild Cognitive Impairment
CST	Cognitive Stimulation
ADNI	Alzheimer Disease Neuroimaging Initiative
fMRI	functional Magnetic Resonance Imaging
A β	Amyloid beta
NFT	Neurofibrillary Tangles
ChE	Cholinesterase
AchE	Acetylcholinesterase
BuChE	Butyrylcholinesterase
FDG	Fluorodeoxyglucose

CHAPTER 1

INTRODUCTION

1.1 An overview of Alzheimer's Disease

Alzheimer's disease is a brain disorder that gets worse over time. It's characterized by changes in the brain that lead to deposits of certain proteins. Alzheimer's disease is a progressive neurologic disorder that causes the brain to shrink (atrophy) and brain cells to eventually die (Saman Sarraf, *et al*, 2016). Alzheimer's disease is the most common cause of dementia — a continuous decline in thinking, behavioral and social skills that affects a person's ability to function independently. The early signs of the disease include forgetting recent events or conversations. As the disease progresses, a person with Alzheimer's disease will develop severe memory impairment and lose the ability to carry out everyday tasks (Bringas S, *et al* ,2020). Medications may temporarily improve or slow progression of symptoms. These treatments can sometimes help people with Alzheimer's disease maximize function and maintain independence for a time. Different programs and services can help support people with Alzheimer's disease and their caregivers.

There is no treatment that cures Alzheimer's disease or alters the disease process in the brain. Currently, there are only two classes of approved drugs to treat AD, including inhibitors to cholinesterase enzyme and antagonists to *N*-methyl D-aspartate (NMDA), which are effective only in treating the symptoms of AD, but do not cure or prevent the disease. In advanced stages of the disease, complications from severe loss of brain function — such as dehydration, malnutrition or infection — result in death (Scheltens P, *et al*, 2021). Alzheimer's disease is not a normal part of aging. Memory problems are typically one of the first warning signs of Alzheimer's disease and related dementias (Bringas S, *et al* ,2020).

Alzheimer's disease (named after the German psychiatric Alois Alzheimer) is the most common type of dementia and can be defined as a slowly progressive neurodegenerative disease characterized by neuritic plaques and neurofibrillary tangles as a result of amyloid-beta peptide's (A β) accumulation in the most affected area of the brain, the medial temporal lobe and neocortical structures. Alois Alzheimer noticed a presence of amyloid plaques and a massive loss of neurons while examining the brain of his first patient that suffered from memory loss and change of personality before dying and described the condition as a serious disease of the cerebral cortex. Emil Kraepelin named this medical condition Alzheimer's disease for the first time in his 8th edition psychiatry handbook. Progressive loss of cognitive functions can be caused by cerebral disorder like Alzheimer's disease (AD) or other factors such as intoxications, infections, abnormality in the pulmonary and circulatory systems, which causes a reduction in the oxygen supply to the brain, nutritional deficiency, vitamin B12 deficiency, tumors, and others (Scheltens P, *et al*, 2021).

1.1.1 Stage 1 – Mild Cognitive Impairment

Mild cognitive impairment (MCI) is a condition in which people have more memory or thinking problems than other people their age. There is no single cause of MCI, 2 and it's more likely to occur as someone ages. Roughly 10% to 20% of people over age 65 have MCI, with the risk increasing as someone gets older. Other factors like genetics and certain conditions including diabetes, depression, and stroke may affect a person's risk for MCI. Symptoms include losing things often, forgetting to go to important events or appointments, and having more trouble coming up with words than other people of the same age. At the MCI level of impairment, when daily function and behavior are not significantly affected, the most typical presentations of AD are amnesic (single or multidomain amnesic-MCI) (Atri A, 2019). Mild cognitive impairment is associated with a greatly increased risk of incident Alzheimer disease and a more rapid rate of decline in cognitive function.

1.1.2 Stage 2 – Mild Alzheimer disease

In mild Alzheimer's, a person may seem healthy but has more and more trouble making sense of the world around them. The realization that something is wrong often comes gradually to the person and their family. Problems can include: memory loss

that disrupts daily life, poor judgment leading to bad decisions, loss of spontaneity and sense of initiative, taking longer to complete normal daily tasks, challenges in planning or solving problems, mood and personality changes.

1.1.3 Early diagnosis

The current AD treatment paradigm is multifaceted management of symptoms and reduction of long-term clinical decline. First and foremost, management should involve truthful and compassionate disclosure of the diagnosis, according to the patient-caregiver dyad's wants and capacities, along with tailored psychoeducation regarding the syndrome, level of impairment, the disease name and stage, expected course, management options and expectations, and life and care planning needs (Atri A, 2019). Cholinesterase (ChE) inhibitors currently used in the treatment of Alzheimer's disease (AD) are the acetylcholinesterase (AChE)-selective inhibitors, donepezil and galantamine, and the dual AChE and butyrylcholinesterase (BuChE) inhibitor, rivastigmine. Three ChE inhibitors are commonly prescribed for the symptomatic treatment of AD—the acetylcholinesterase (AChE)-selective inhibitors, donepezil 3 and galantamine, and the dual AChE and butyrylcholinesterase (BuChE)inhibitor, rivastigmine. In clinical practice, a 1-step dose-escalation schedule to a usual therapeutic dose is used for donepezil, galantamine, and rivastigmine. After “getting on” treatment, when the patient is stabilized at a usual therapeutic dose, the second and, indeed, final stage of treatment is “staying on,” or maintenance, treatment. (Grossberg GT, 2003) CST (Cognitive Stimulation) was designed to stimulate people in an implicit, natural way, reducing the anxiety that can accompany feeling ‘put on the spot’. For example, in the faces session, participants were shown a selection of faces from the past. A comprehensive CST training manual is available. The manual includes the guiding principles of CST, a session-by-session plan, details of equipment needed and ways of monitoring progress. A 1-day certified training course in CST is also available. CST was designed to be delivered by anyone working with people with dementia, such as nurses, occupational therapists, care staff and psychologists, provided they follow the manual, have some training in dementia care and receive supervision and support(Spector A et al., 2008).

1.2 Artificial Intelligence

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving.

AI programming focuses on three cognitive skills: learning, reasoning and self-correction.

1.1.1 Learning processes

This aspect of AI programming focuses on acquiring data and creating rules for how to turn the data into actionable information. The rules, which are called algorithms, provide computing devices with step-by-step instructions for how to complete a specific task.

1.1.2 Reasoning processes

This aspect of AI programming focuses on choosing the right algorithm to reach a desired outcome.

1.1.3 Self-correction processes

This aspect of AI programming is designed to continually fine-tune algorithms and ensure they provide the most accurate results possible.

In Radiation Oncology, AI has been successfully applied to automatic tumor and organ segmentation and tumor monitoring during the treatment for adaptive treatment. As AI became more popular and also more medical images than ever have been generated, these are good reasons for radiomics to evolve rapidly. Radiomics is a novel approach for solving the issue of precision medicine. These researches have demonstrated a great potential of the role of AI in medical imaging. The main research area in diagnostic imaging is detection. Researchers started developing computer-aided detection (CAD) systems in the 1980s. Traditional machine learning algorithms were applied on image modalities like CT, MRI, and mammography. The new era of AI—the deep learning has so far demonstrated promising improvements in the research area over the traditional machine learning. In fact, deep learning algorithms have become a methodology of choice for radiology imaging analysis. This includes

different image modalities like CT, MRI, PET, ultrasonography etc and different tasks like tumor detection, segmentation, disease prediction etc. Researches have shown that AI/deep learning-based methods have substantial performance improvements over the conventional machine learning algorithms (Tang X., 2019).

1.3 Deep Learning

Deep learning is a branch of machine learning which is completely based on artificial neural networks, as neural network is going to mimic the human disease so deep learning is also a kind of mimic of human disease. Deep-learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks and convolutional neural networks have been applied to fields including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, material inspection and board game programs, where they have produced results comparable to and in some cases surpassing human expert performance.

The use of machine learning (ML) has been increasing rapidly in the medical imaging field, including computer-aided diagnosis (CAD), radiomics, and medical image analysis. Recently, an ML area called deep learning emerged in the computer vision field and became very popular in many fields (Suzuki K.,2017).

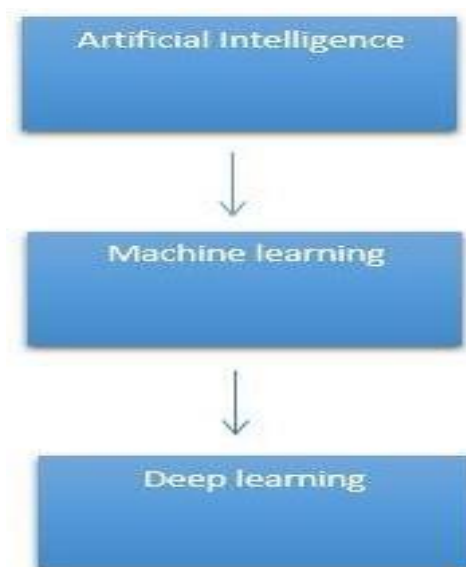


Fig:1.3: Deep Learning

1.4 Convolutional Neural Network

The deep learning CNN technique is used in the majority of AI medical image analyses, especially for the diagnosis of different types of diseases such as breast cancer, Alzheimer's, brain tumors, etc. Deep CNN-based algorithms have achieved promising outcomes in the analysis of medical images. Several types of TL have been proposed for medical imaging data and have been very effective, such as Alex Net, SPP-Net, VGGNet, ResNet, GoogLeNet, etc. The major aim of this review is to highlight the most crucial CNN components so that researchers and students may easily gain a comprehensive understanding of CNN and transfer learning (Salehi AW, *et al*, 2023).

CNNs may help to enable highly representative, data-driven, layered hierarchical image features to be learned from sufficient training data. CNNs can help enable highly representative, data-driven, layered hierarchical image features to be learned with sufficient training data (Dutta P, *et al*, 2020).

The deep convolutional neural network (CNN) is the state-of-the-art solution for large-scale visual recognition. CNN is a hierarchical model for large-scale visual recognition. It is based on the observation that a network with enough neurons is able to fit any complicated data distribution. (Chua LO. ,1997).

1.5 Overview of the system

- Define a problem
- Gathering image data set
- Evaluating algorithms
- Detecting results

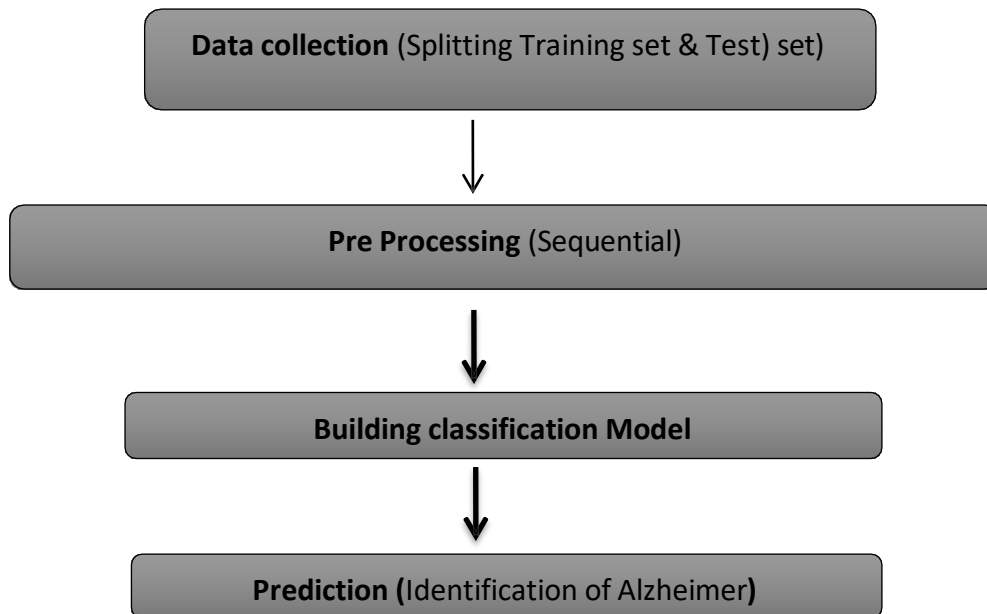


Fig.1.5: Data flow diagram for CNN model

1.6 Proposed system

We proposed a system to develop the project using Deep learning algorithm. Recently, Deep learning and Artificial intelligence plays a big role in various industries for their improvement and development. So we tried to implement Deep learning algorithm to diagnosis the Alzheimer. We collected the previous record of patient who had the Alzheimer and who doesn't had the disease and those who had symptoms. By collection those people information our machine is tried to identifies the pattern of the datasets by various performing calculations. After identifies the pattern in image using various deep learning algorithm the model can able to predict the instance based on previous information's. If you image related to his has given to input then the algorithm can tell whether it is affected or not. Some of the advantages are we build production level application for deployment process, a deep learning predictive model, also we implemented advance neural network architectures and compared more than two architecture to getting better accuracy and performance level.

CHAPTER 2

REVIEW OF LITERATURE

Yiming ding, *et al*, 2013, developed a deep learning algorithm model that predicts the final diagnosis of Alzheimer disease (AD), mild cognitive impairment, or neither at fluorine 18 (18F) fluorodeoxyglucose (FDG) PET of the brain. PET brain images from the Alzheimer's Disease Neuroimaging Initiative (ADNI) which were 2109 imaging studies from year 2005 to 2017 was collected from 1002 patients and retrospective independent test set around 40 imaging studies from year 2006 to 2016 from 40 patients were collected and recorded final clinical diagnosis was recorded. They trained the Convolutional neural network of InceptionV3 architecture model to 90% of ADNI data set and tested on the remaining 10%, as well as the independent test set. They studied Model with sensitivity, specificity, receiver operating characteristic (ROC), saliency map, and t-distributed stochastic neighbor embedding which resulted in 57% sensitivity, 91% specificity. For the independent test set the criteria followed was, patient must have had at least one follow-up with a neurologist at local institution.

Saman Sarraf, *et al*, 2016, developed a model based on Alzheimer Disease Classification using Deep Convolutional Neural Networks from MRI and fMRI. Their model outlines state-of-the-art deep learning-based pipelines employed to distinguish Alzheimer's magnetic resonance imaging (MRI) and functional MRI (fMRI) from normal healthy control data for a given age group. fMRI data was used for the first time in deep learning applications for the purposes of medical image analysis and Alzheimer's disease prediction by the authors. Three major modules were formed for the recognition pipeline: preprocessing, data conversion and classification. This proposed model resulted in high and reproducible accuracy rates of 99.9% and 98.84% for the fMRI and MRI pipelines, respectively.

Xiaoling Lu, *et al*, 2018, reported that as the aging of Chinese society becomes more and more serious, the number of elderly people has increased dramatically. At the same time, the number of patients with Alzheimer's disease (AD) has increased. At present, the main diagnostic method for Alzheimer's disease relies on experienced radiologists to analyse brain structural nuclear magnetic resonance (MRI) images to judge the condition, but this method is time-consuming and labor-intensive, and there is a certain subjectivity. This may cause misdiagnosis. By classifying the MRI images of patients with Alzheimer's disease and healthy controls, for image classification, the Convolutional Neural Network (CNN) in deep learning has outstanding performance and accurate classification.

Jyothi Islam and Yanqing ZHnag, 2017, reported that Alzheimer's disease is a severe neurological brain disorder. It destroys brain cells causing people to lose their memory, mental functions and ability to continue daily activities. Alzheimer's Disease is not curable, but earlier detection can help improve symptoms in a great deal. Machine learning techniques can vastly improve the process for accurate diagnosis of Alzheimer's Disease. In recent days deep learning techniques have achieved major success in medical image analysis. But relatively little investigation has been done to applying deep learning techniques for Alzheimer's Disease detection and classification. This paper presents a novel deep learning model for multi-Class Alzheimer's Disease detection and classification using Brain MRI Data. We design a very deep convolutional network and demonstrate the performance on the Open Access Series of Imaging Studies (OASIS) database.

Saman Sarraf and Ghassem Tofighi, 2016, reported that Deep learning is power learning machine learning algorithm in classification while extracting high-level features. In this paper they used convolutional neural network to classify Alzheimer's brain from normal healthy brain. The importance of classifying this kind of medical data is to potentially develop a predict model or system in order to recognize the type disease from normal subjects or to estimate the stage of the disease. Classification of clinical data such as Alzheimer's disease has been always challenging and most problematic part has been always selecting the most discriminative features.

CHAPTER 3

AIM AND SCOPE

The aim and objective of our project is

- To develop an accurate and efficient system for the early diagnosis of the disease based on the neuroimaging data.
- To facilitate timely intervention and treatment planning, potentially improving the prognosis and quality of life for individuals affected by Alzheimer's Disease.
- To enable precise identification of structural changes associated with Alzheimer's Disease

The goal is to develop a deep learning model for Alzheimer disease image classification by convolutional neural network algorithm for potentially classifying the results in the form of best accuracy by comparing the CNN architectures.

CHAPTER 4

MATERIALS REQUIRED AND METHODOLOGY

4.1 Project Requirements

4.1.1 Preparing the Datasets

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

- STAGE 1
- STAGE 2
- NON-DEMENTED

4.1.2 Functional requirements

It is the first step in the requirements analysis process. It lists requirements of a particular software system. The following details to follow the special libraries like TensorFlow, keras, matplotlib.

4.1.3 Non-Functional Requirements

Process of functional steps, problem defines, preparing data, evaluating algorithm, improving results and prediction of the result.

4.1.4 Environment Requirements

Frameworks used is Keras.

4.1.3.1 Hardware requirements

Processor: Intel i3

Hard disk: minimum 400 GB

RAM: minimum 4 GB

4.1.3.2 Software Requirements

Operating System: Windows / Linux

Simulation Tool: Anaconda with Jupyter Notebook

Language: Python

4.2 Methodology

4.2.1 Splitting of dataset

The data use is usually split into training data and test data. The training set contains a known output and the model learns on this data in order to be generalized to other data later on. It has the test dataset (or subset) in order to test our models and it will do this using Tensor flow library in Python using the Keras method.

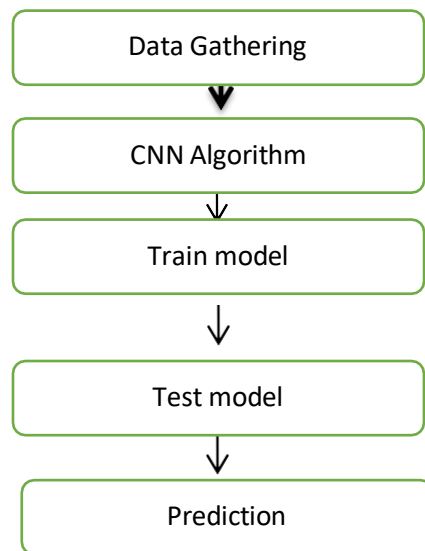


Fig:4.2.1: Construction of a detecting model

4.2.2 Design Architecture

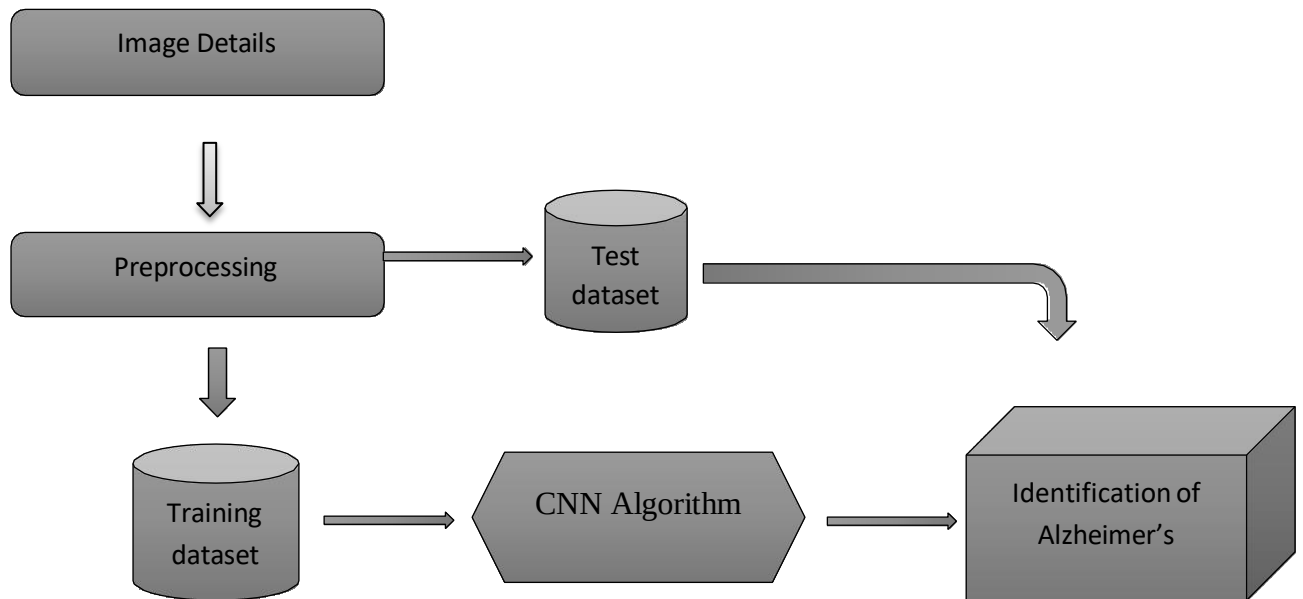


Fig:4.2.2: Process of dataflow diagram

A DFD is often used as a preliminary step to create an overview of the system without going into great detail, which can later be elaborated. DFDs can also be used for the visualization of data processing (structured design). A DFD shows what kind of information will be input to and output from the system, how the data will advance through the system, and where the data will be stored. It does not show information about process timing or whether processes will operate in sequence or in parallel, unlike a traditional structured flowchart which focuses on control flow, or a UML activity workflow diagram, which presents both control and data flows as a unified model. Data flow diagrams are also known as bubble charts. DFD is a designing tool used in the top-down approach to Systems Design.

4.2.3 System Architecture

Preprocessing and training the model (CNN): The dataset is preprocessed such as Image reshaping, resizing and conversion to an array form. Similar processing is also done on the test image. We have already divided Demented and Non-Demented MRI Brain image dataset and also has test images for the software.

The train dataset is used to train the model (CNN) so that it can identify the test image and the disease it has CNN has different layers that are Dense, Dropout, Activation, Flatten, Convolution2D, and MaxPooling2D. After the model is trained successfully, the software can identify the Alzheimer's and normal images contained in the dataset.

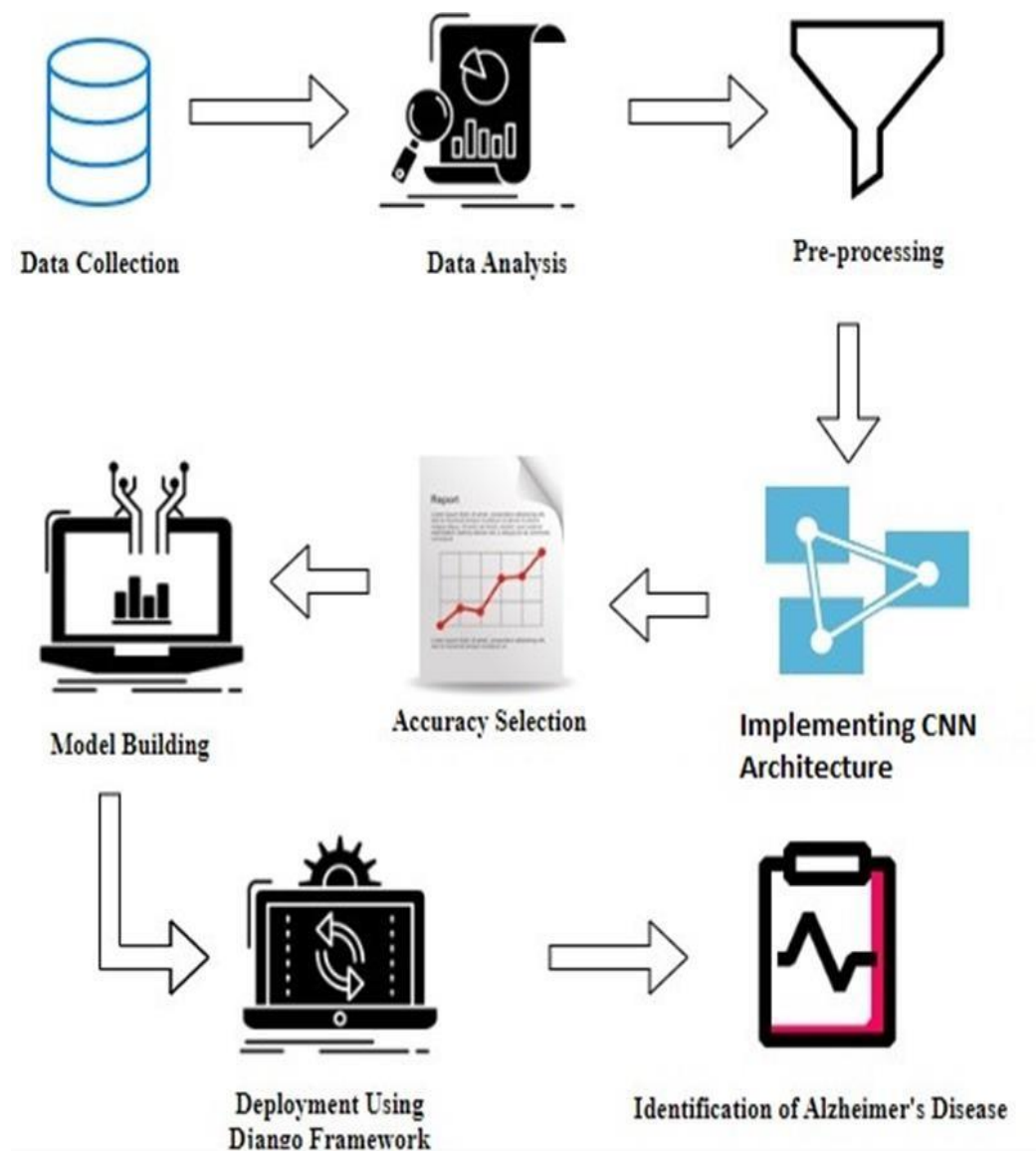


Fig.4.2.3: System Architecture

4.2.4 Workflow Diagram

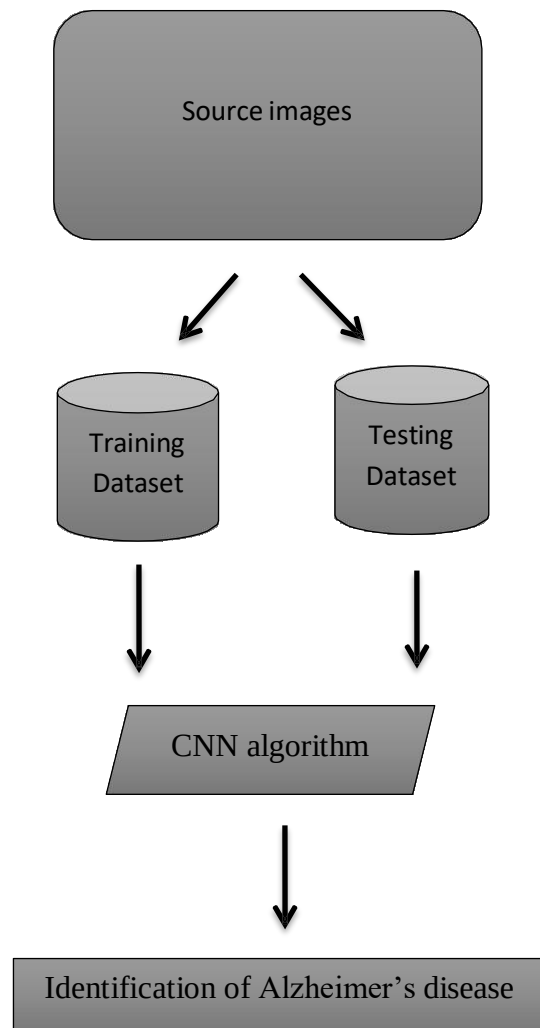


Fig:4.2.4: Workflow Diagram

4.2.5 Collaboration Diagram

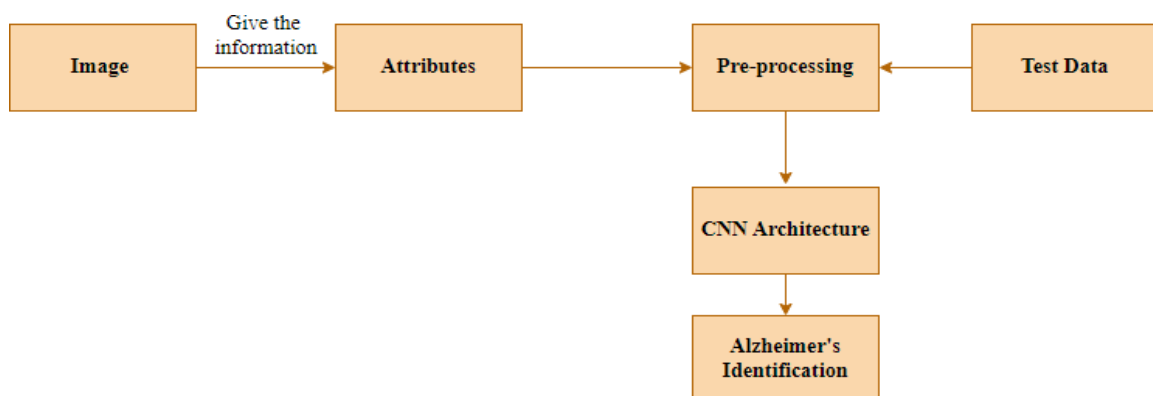


Fig:4.2.5: Collaboration diagram

4.2.6 Dataset

4.2.6.1 Demented datasets

Trained data for Demented:

```
===== Images in: dataset/Train/Demented
images_count: 300
min_width: 176
max_width: 208
min_height: 208
max_height: 208
```

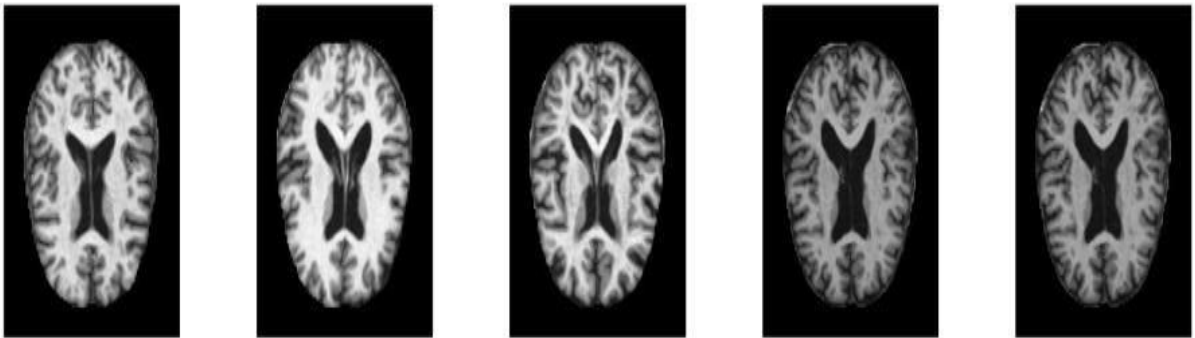


Fig:4.2.6.1: Demented dataset

4.2.6.2 Non-demented datasets

TRAINING DATA FOR NON_DEMENTED:

```
===== Images in: DATASET/TRAIN/NON_DEMENTED
Images_count : 666
Min_width : 128
Max_width : 128
Min_height : 128
Max_height : 128
```

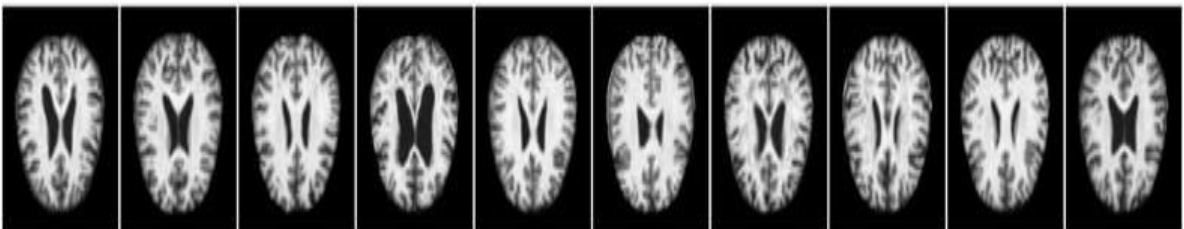


Fig:4.2.6.2: Non-demented datasets

4.2.7 Coding

In [1]:

```
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
import tensorflow
import tensorflow as tf
print(tf.__version__)

import keras
import keras.backend as K
from keras.models import Model
from keras.layers import Input, Dense, Conv2D, Conv3D, DepthwiseConv2D,
SeparableConv2D, Conv3DTranspose
from keras.layers import Flatten, MaxPool2D, AvgPool2D, GlobalAvgPool2D,
UpSampling2D, BatchNormalization
from keras.layers import Concatenate, Add, Dropout, ReLU, Lambda,
Activation, LeakyReLU, PReLU

from IPython.display import SVG
from keras.utils.vis_utils import model_to_dot

from time import time
import numpy as np

from keras.callbacks import ModelCheckpoint
from tensorflow.keras.callbacks import EarlyStopping

import warnings
warnings.filterwarnings('ignore')
2.11.0
```

In [3]:

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator

train=ImageDataGenerator(rescale=1./255, shear_range=0.2, zoom_range=0.2, hori
```

```
zontal_flip=True, validation_split = 0.2
```

```
train_data=train.flow_from_directory(directory =  
'DATASET/TRAIN',target_size=(224,224),
```

```
batch_size=32,class_mode='categorical')
```

```
Found 1998 images belonging to 3 classes.
```

In [4]:

```
test=ImageDataGenerator(rescale=1./255)
```

```
test_data=test.flow_from_directory(directory =  
'DATASET/TEST',target_size=(224,224),
```

```
batch_size=32,class_mode='categorical')
```

```
Found 1998 images belonging to 3 classes.
```

```
def mobilenet(input_shape, n_classes):
```

In [5]:

```
def mobilenet_block(x, f, s=1):
```

```
x = DepthwiseConv2D(3, strides=s, padding='same')(x) x = BatchNormalization()(x)
```

```
x = ReLU()(x)
```

```
x = Conv2D(f, 1, strides=1, padding='same')(x) x = BatchNormalization()(x)
```

```
x = ReLU()(x)
```

```
return x
```

```
input = Input(input_shape)
```

```
x = Conv2D(32, 3, strides=2, padding='same')(input)
```

```
x = BatchNormalization()(x)
```

```
x = ReLU()(x)
```

```
x = mobilenet_block(x, 64)
```

```
x = mobilenet_block(x, 128, 2)
```

```
x = mobilenet_block(x, 128)
```

```
x = mobilenet_block(x, 256, 2)
```

```
x = mobilenet_block(x, 256)
```

```

x = mobilenet_block(x, 512, 2)
for _ in range(5):
    x = mobilenet_block(x, 512)

x = mobilenet_block(x, 1024, 2)
x = mobilenet_block(x, 1024)

x = GlobalAvgPool2D()(x)

output = Dense(n_classes, activation='softmax')(x)

model = Model(input, output)

model.compile(optimizer='Adam', loss='categorical_crossentropy', metrics=['accuracy',
tensorflow.keras.metrics.Precision()])

return model

```

```

input_shape = 224, 224, 3
n_classes = 3

```

```

K.clear_session()
model = mobilenet(input_shape, n_classes)
model.summary()
model_path = "MOBILENET.h5"

```

```

from keras.callbacks import ModelCheckpoint

```

```

M = ModelCheckpoint(model_path, monitor='accuracy', verbose=1,
save_best_only=True)

```

In [7]:

```

epochs = 100
batch_size = 64

```

In [8]:

```

#### Fitting the model

```

```

history = model.fit(
    train_data, steps_per_epoch=train_data.samples // batch_size,
    epochs=epochs,
    validation_data=test_data, validation_steps=test_data.samples //
batch_size,
    callbacks=[M])
history.history.keys()

import matplotlib.pyplot as plt
import numpy as np

plt.figure(figsize=(20, 8))
plt.plot(history.history['accuracy'])

for i in range(epochs):
    if i%5 == 0:

plt.annotate(np.round(history.history['accuracy'][i]*100,2),xy=(i,history.h
istory['accuracy'][i]))

plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.show()

plt.figure(figsize=(20, 8))
plt.plot(history.history['loss'])

for i in range(epochs):
    if i%5 == 0:

plt.annotate(np.round(history.history['loss'][i]*100,2),xy=(i,history.histo
ry['loss'][i]))

plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.show()

```

CHAPTER 5

RESULT AND DISCUSSION

5.1 Perform Analysis of a Model

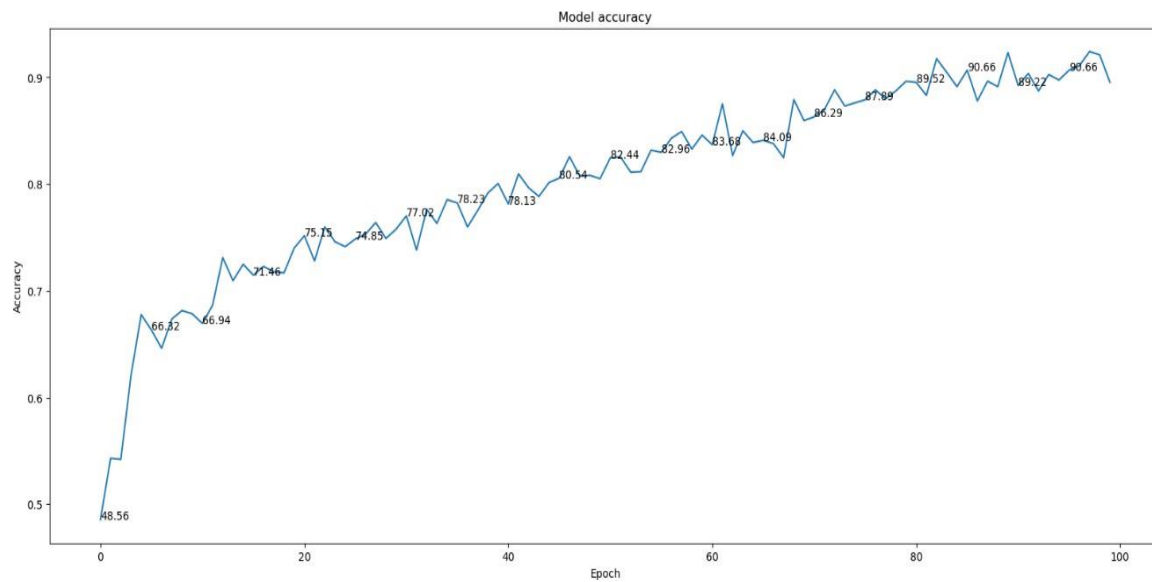


Fig:5.1.1: CNN model accuracy

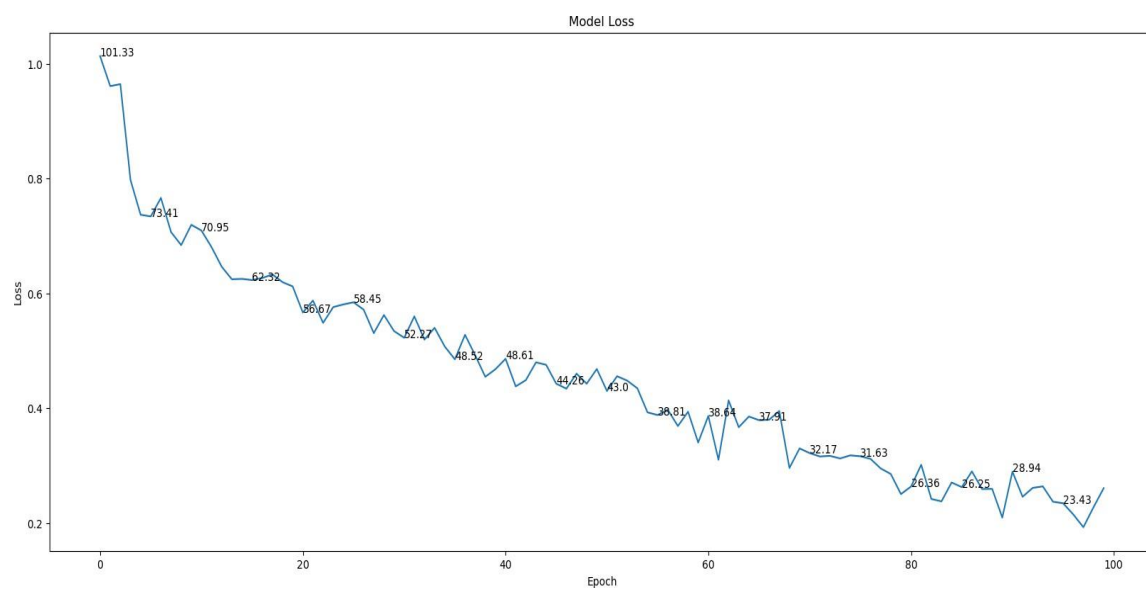


Fig:5.1.2: CNN model loss values

5.2 Landing page:

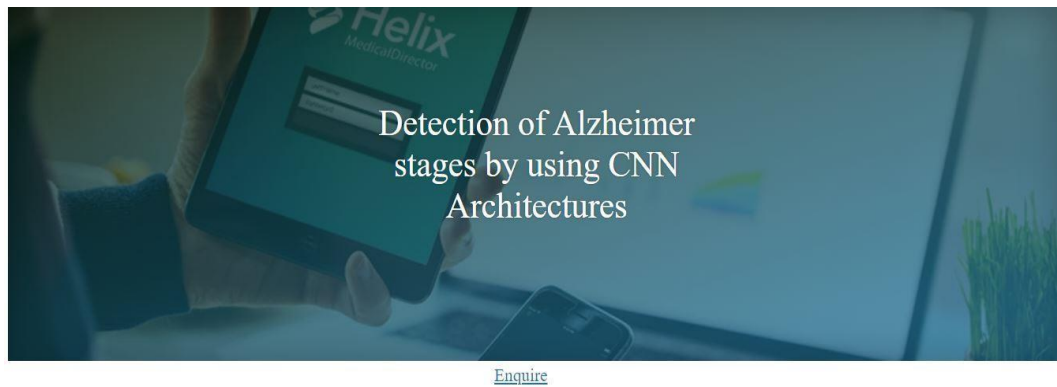


Fig:5.2: Landing Page

5.3 Home page:



Fig:5.3: Home Page

5.4 Image upload page:

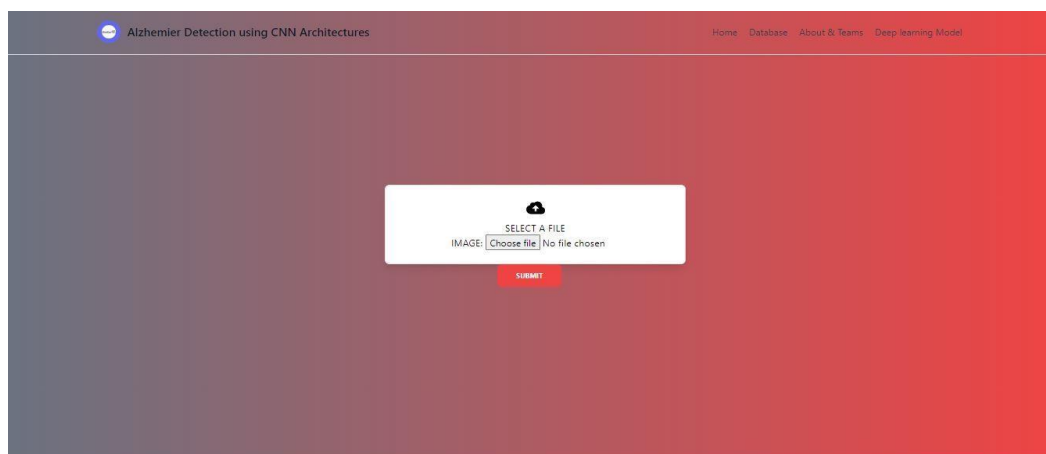


Fig:5.4: Image Upload Page

5.5 Output pages:

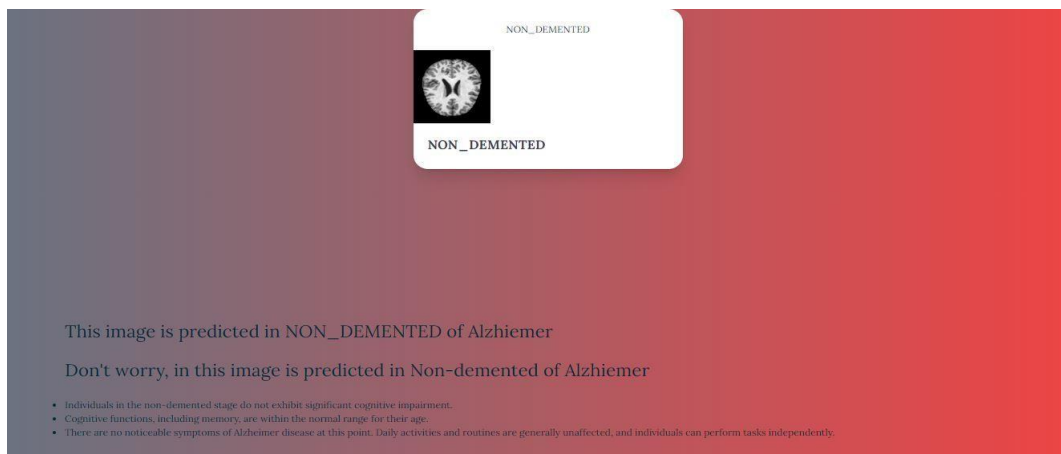


Fig.5.5.1: Image Prediction on Non-Demented of Alzheimer and Analysis

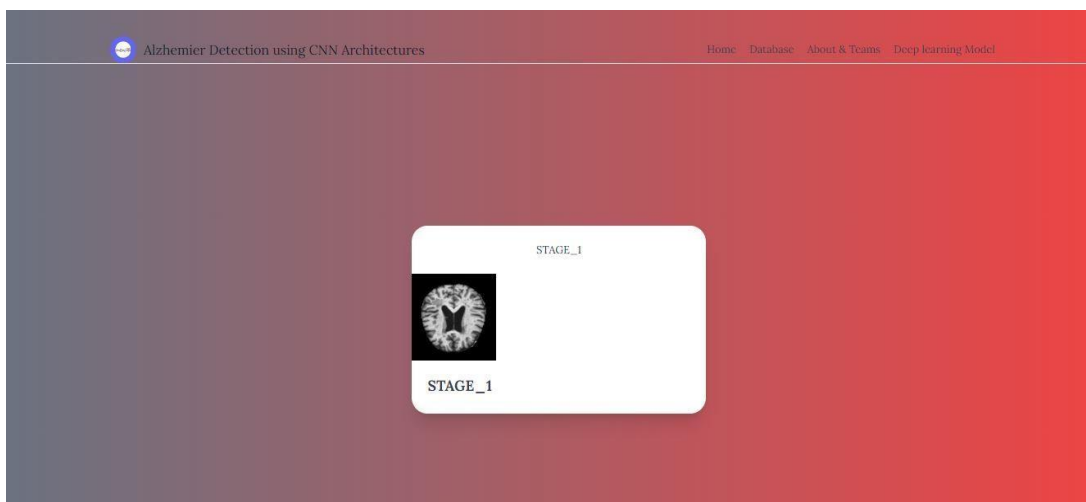


Fig.5.5.2: Image Prediction on Stage 1 of Alzheimer

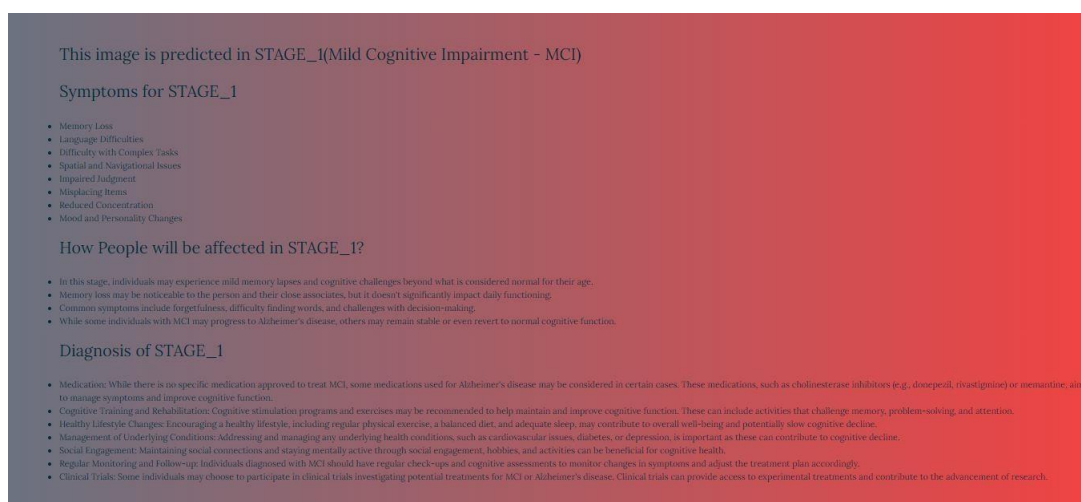


Fig:5.5.3: Stage 1 Image Analysis

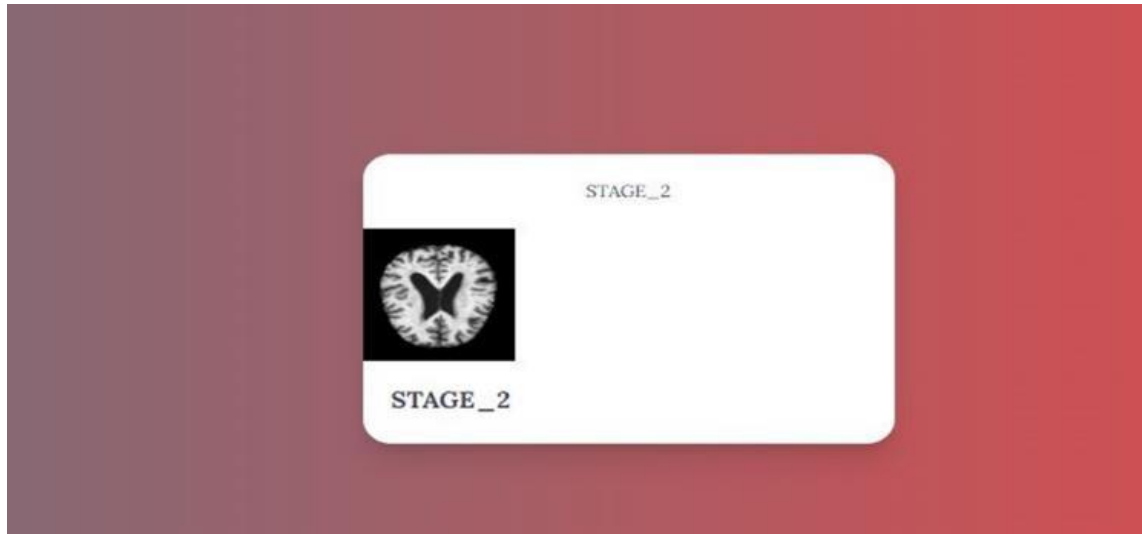


Fig.5.5.4: Image Prediction on Stage 2 of Alzheimer

This image is predicted in STAGE_2 (Mild Alzheimer Disease)

Symptoms for STAGE_2

- Increased Memory Loss
- Confusion and Disorientation
- Difficulty with Everyday Tasks
- Language and Communication Challenges
- Impaired Judgment
- Personality and Behavior Changes
- Reduced Initiative

How People will be affected in STAGE_2?

- Symptoms become more pronounced in this stage, with noticeable memory loss, confusion, and difficulty with problem-solving.
- Individuals may struggle with tasks they previously handled easily, such as managing finances or following a familiar recipe.
- While they may still be able to perform daily activities independently, cognitive decline is evident during assessments.
- Communication may be affected, leading to difficulties in expressing thoughts or following and joining in on a conversation.
- Personality and behavior changes may become noticeable, and individuals may become more withdrawn or anxious.

Diagnosis of STAGE_2

- Medication: Cholinesterase inhibitors (e.g., donepezil, rivastigmine, galantamine) and memantine are commonly prescribed medications for managing cognitive symptoms in Alzheimer's disease. These medications may help improve or stabilize cognitive function and manage behavioral symptoms.
- Behavioral and Environmental Interventions: Creating a structured and supportive environment can help individuals with Alzheimer's disease. This may include establishing routines, minimizing distractions, and ensuring safety at home.
- Cognitive Stimulation: Engaging in activities that stimulate the mind, such as puzzles, games, and reminiscence therapy, can help maintain cognitive function and provide a sense of accomplishment.
- Physical Exercise: Regular physical activity has been associated with potential cognitive benefits. It can improve overall health, mood, and sleep patterns.
- Nutrition and Hydration: A well-balanced diet that includes nutrients essential for brain health is important. Adequate hydration is also crucial.
- Support for Caregivers: Providing support for caregivers is vital. Caregivers may benefit from education, counseling, and respite care to manage the challenges associated with caregiving.
- Social Engagement: Maintaining social connections is important for emotional well-being. Social activities and interactions can provide stimulation and reduce feelings of isolation.

Fig.5.5.5: Stage 2 Image Analysis

5.6 Database:

DATABASE	
image	label
	NON_DEMENTED
	NON_DEMENTED
	STAGE_1
	STAGE_2
	NON_DEMENTED
	STAGE_1
	STAGE_2

Fig:5.6: Database

In our work, CNN gained an accuracy of 92.40%, which is better than the state of the result obtained so far. Our CNN based model will help the doctors to detect Alzheimer's Disease in MRI images accurately, so that the speed in treatment will increase a lot.

CHAPTER 6

SUMMARY AND CONCLUSIONS

It focused how image from given dataset (trained dataset) and past data set used to predict the pattern of Alzheimer diseases using CNN model. This brings some of the following insights about Alzheimer disease prediction. The major benefit of the CNN classification framework is the ability to classify images automatically. Alzheimer's disease is a brain disorder that slowly destroys memory and thinking skills and often can't be remedied because the patients are diagnosed too late with the diseases. In this study, we have discussed the overview of methodologies for detecting the abnormalities in Alzheimer images which includes collection of Alzheimer image data set, preprocessing techniques, feature extraction techniques and classification schemes. The model we presented on 2 Stages of Alzheimer's Disease for early Diagnosis showed an accuracy rate of 92.40% with precision percentage 93.13. By this work it is possible to identify people with Alzheimer's Disease through MRI scans and help doctors to diagnose with non-invasive methods for examining inside the body.

REFERENCE

Atri A. The Alzheimer's disease clinical spectrum: diagnosis and management. *Medical Clinics*. 2019 Mar 1;103(2):263-93.

Bringas S, Salomón S, Duque R, Lage C, Montaña JL. Alzheimer's disease stage identification using deep learning models. *Journal of Biomedical Informatics*. 2020 Sep 1;109:103514.

Ding Y, Sohn JH, Kawczynski MG, Trivedi H, Harnish R, Jenkins NW, Lituiev D, Copeland TP, Aboian MS, Mari Aparici C, Behr SC. A deep learning model to predict a diagnosis of Alzheimer disease by using 18F-FDG PET of the brain. *Radiology*. 2019 Feb;290(2):456-64.

Dutta P, Upadhyay P, De M, Khalkar RG. Medical image analysis using deep convolutional neural networks: CNN architectures and transfer learning. In 2020 International Conference on Inventive Computation Technologies (ICICT) 2020 Feb 26 (pp. 175-180). IEEE.

Ebrahimighahnavieh MA, Luo S, Chiong R. Deep learning to detect Alzheimer's disease from neuroimaging: A systematic literature review. *Computer methods and programs in biomedicine*. 2020 Apr 1;187:105242.

Grossberg GT. Cholinesterase inhibitors for the treatment of Alzheimer's disease:: getting on and staying on. *Current Therapeutic Research*. 2003 Apr 1;64(4):216-35.

Hoozemans JJ, Rozemuller JM, Van Haastert ES, Veerhuis R, Eikelenboom P. Cyclooxygenase-1 and-2 in the different stages of Alzheimer's disease pathology. *Current pharmaceutical design*. 2008 May 1;14(14):1419-27.

Islam J, Zhang Y. A novel deep learning based multi-class classification method for Alzheimer's disease detection using brain MRI data. In *Brain Informatics: International Conference, BI 2017, Beijing, China, November 16-18, 2017, Proceedings 2017* (pp. 213-222). Springer International Publishing.

Porsteinsson AP, Isaacson RS, Knox S, Sabbagh MN, Rubino I. Diagnosis of early Alzheimer's disease: clinical practice in 2021. *The journal of prevention of Alzheimer's disease*. 2021 Mar;8:371-86.

Rossi PJ, Gunduz A, Judy J, Wilson L, Machado A, Giordano JJ, Elias WJ, Rossi MA, Butson CL, Fox MD, McIntyre CC. Proceedings of the third annual deep brain stimulation think tank: a review of emerging issues and technologies. *Frontiers in neuroscience*. 2016 Apr 6;10:119.

Salehi AW, Khan S, Gupta G, Alabduallah BI, Almjally A, Alsolai H, Siddiqui T, Mellit A. A study of CNN and transfer learning in medical imaging: Advantages, challenges, future scope. *Sustainability*. 2023 Mar 29;15(7):5930.

Scheltens P, De Strooper B, Kivipelto M, Holstege H, Chételat G, Teunissen CE, Cummings J, van der Flier WM. Alzheimer's disease. *The Lancet*. 2021 Apr 24;397(10284):1577-90.

Spector A, Woods B, Orrell M. Cognitive stimulation for the treatment of Alzheimer's disease. *Expert Review of Neurotherapeutics*. 2008 May 1;8(5):751-7.

Suzuki K. Overview of deep learning in medical imaging. *Radiological physics and technology*. 2017 Sep;10(3):257-73.

Tang X. The role of artificial intelligence in medical imaging research. *BJR| Open*. 2019 Nov 21;2(1):20190031.

