A
Report
on

Early Detection of Alzheimer's Disease using 2D Brain MRI Modality

Submitted in partial fulfillment for

Mini-Project III

Submitted by

Group 15 & 20

Under the guidance of

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DECLARATION

I, hereby declare that the dissertation report entitled **"Early Detection of Alzheimer's Disease using Brain MRI Modality"** submitted by Group 20 to **Walchand College of Engineering, Sangli** in fulfillment of the requirement for the award of the degree of **B. Tech** in **Information Technology** is a record of bonafide project work carried out by me under the guidance of **Prof. M. B. Narnaware.**

I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university. I declare that this dissertation report reflects my thoughts about the subject in my own words. I have sufficiently cited and referenced the original sources, referred or considered in this work. I have not misrepresented or fabricated or falsified any idea/data/fact/source in this my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute.

Acknowledgement

We, Group 15 and 20 like to express our sincere gratitude to **Prof. M.B. Narnaware** for his guidance and his continuous support, encouragement, help extended at every stage of this project work.

We, Group 20 feel immense pleasure in submitting this Project report entitled "***Early Detection of Alzheimer's Disease using Brain MRI Modality***". We are also thankful to Dr. P.K. Kharat for their valuable feedback during the completion of the project. We would like to thank all faculty members and staff of the Department of Information Technology for their generous help in various ways for the completion of this thesis. We would like to thank all our friends and especially our classmates for all the thoughtful and mind stimulating discussions we had, which prompted us to think beyond the obvious.

CERTIFICATE

This is to certify that the project/mini-project/dissertation work entitled

"Early Alzheimer's disease detection using 2D brain MRI modality"

submitted by

Group 15 & 20

In partial fulfillment of the requirement for the degree of

Bachelor of Technology

in

INFORMATION TECHNOLOGY

From

Walchand College of Engineering, Sangli

(An Autonomous Institute)

Affiliated to Shivaji University, Kolhapur

This project/mini-project/dissertation work is a record of student's own work carried out by him under my supervision and guidance during the session 2022-23.

Guide	HOD

External Examiner

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1. Introduction

Alzheimer's disease is the most common type of dementia. In this disease, it is observed that it progressive and begins with mild memory loss and possibly leading to loss of the ability to carry on a conversation and respond to the environment. Alzheimer's disease involves parts of the brain that control thought, memory, and language.

How Alzheimer's Disease get caused?

Alzheimer's disease is thought to be caused by the abnormal build-up of proteins in and around brain cells.

One of the proteins involved is called **amyloid**, deposits of which form **plaques** around brain cells.

The other protein is called tau, deposits of which form tangles within brain cells.

Although it is not known exactly what causes this process to begin, scientists now know that it begins many years before symptoms appear.

As brain cells become affected, there is also a **decrease in chemical messengers** (called neurotransmitters) involved in sending messages, or signals, between brain cells.

Levels of one neurotransmitter, acetylcholine, are particularly low in the brains of people with Alzheimer's disease.

Over time, different areas of the brain shrink. The first areas usually affected are responsible for memories.

In more unusual forms of Alzheimer's disease, different areas of the brain are affected.

The first symptoms may be problems with vision or language rather than memory.

As this is the commonly observed disease among the aged people and no much accurate/precise and early detection is there, due to this we have undertaken this as our project and we aim at building the model which can detect the disease at early stage with high accuracy.

2. Relevance/Importance of proposed work

This deep learning architecture is completely built up with well-defined parameters.

Due to which it is more simplified and efficient.

Also, the accuracy of this model is too good as compare to the complex architectures of deep learning involving handcrafted feature extractors.

This model will be helpful for accurate prediction of current stage of Alzheimer's disease in body.

3. Scope of the work/Problem formulation

As Alzheimer's disease is common in India (Because nearly about 80% peoples having age above 60 are surviving through this dementia.) the accurate and precise diagnosis is required.

The healthcare sector of India is too good, but they are good in curing the disease. But if such a deep learning architecture will help healthcare department to diagnose the disease properly then automatically our doctors will get a special reach in healthcare.

The model is too simplified so that every Alzheimer's disease diagnostics center can implement this model.

Due to this, early detection will be possible and ultimately patient will get correct treatment at its early stage.

4. Problem Statement

Early detection of Alzheimer's disease using 2D brain MRI modality.

In which the CNN (Convolutional Neural Network) architecture is developed based on certain parameters.

Here we will be also handling the overfitting condition.

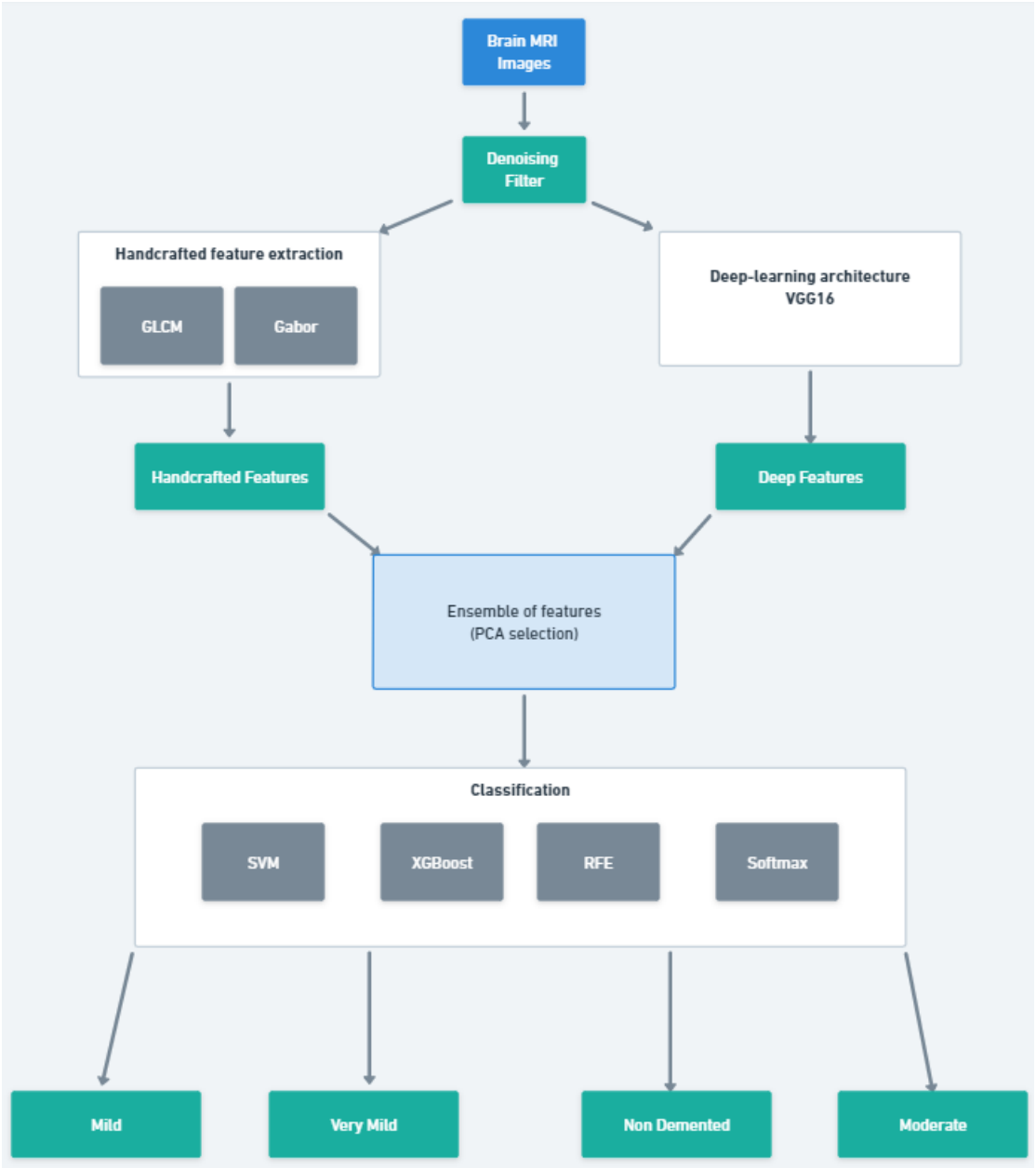
The model will be completely based on 2D CNN network, max pooling layer, dense layer and SoftMax.

5. Objectives

- To build the computer vision-based model which, given an MRI of a patient, points out the stage of disease.
- It should be simplified and accurate to diagnose the disease properly.
- To achieve this, we will be using CNN model with specific parameters.

6. Methodology/Planning of study

Approach 1:



- **Denoising Filter:**

  Total variation denoising, also known as total variation regularization or total variation filtering, is a noise removal process. It is based on the principle that signals with excessive and possibly spurious detail have high total variation.

  The basic idea behind wavelet denoising, or wavelet thresholding, is that the wavelet transforms lead to a sparse representation for many real-world signals and images. What this means is that the wavelet transforms concentrates signal and image features in a few large-magnitude wavelet coefficients.

  A bilateral filter is a non-linear, edge-preserving, and noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels.

- **GLCM:**

  The Gray. Level Concurrence Matrix (GLCM) method is a way of extracting second order statistical texture features.

  The approach has been used in a few applications, Third and higher order textures consider the relationships among three or more pixels.

  Texture Analysis Using the Gray-Level Co-Occurrence Matrix (GLCM) A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix.

- **Deep-Learning Architecture (VGG16):**

  A convolutional neural network is also known as a Convent, which is a kind of artificial neural network.

  A convolutional neural network has an input layer, an output layer, and various hidden layers. VGG16 is a type of CNN (Convolutional Neural Network) that is one of the best computer vision models to date.

  The creators of this model evaluated the networks and increased the depth using an architecture with very small (3 × 3) convolution filters, which showed a significant improvement on the prior-art configurations. They pushed the depth to 16–19 weight layers making it approx. — 138 trainable parameters.

- **PCA:**

  The Principal Component Analysis is a popular unsupervised learning technique for reducing the dimensionality of data. It increases interpretability yet, at the same time, it minimizes information loss. It helps to find the most significant features in a dataset and makes the data easy for plotting in 2D and 3D. PCA helps in finding a sequence of linear combinations of variables.

- **SVM:**

  The Principal Component Analysis is a popular unsupervised learning technique for reducing the dimensionality of data. It increases interpretability yet, at the same time, it minimizes information loss. It helps to find the most significant features in a dataset and makes the data easy for plotting in 2D and 3D. PCA helps in finding a sequence of linear combinations of variables.

- **XGBoost:**

XGBoost is a popular and efficient open-source implementation of the gradient boosted trees algorithm. Gradient boosting is a supervised learning algorithm, which attempts to accurately predict a target variable by combining the estimates of a set of simpler, weaker models.

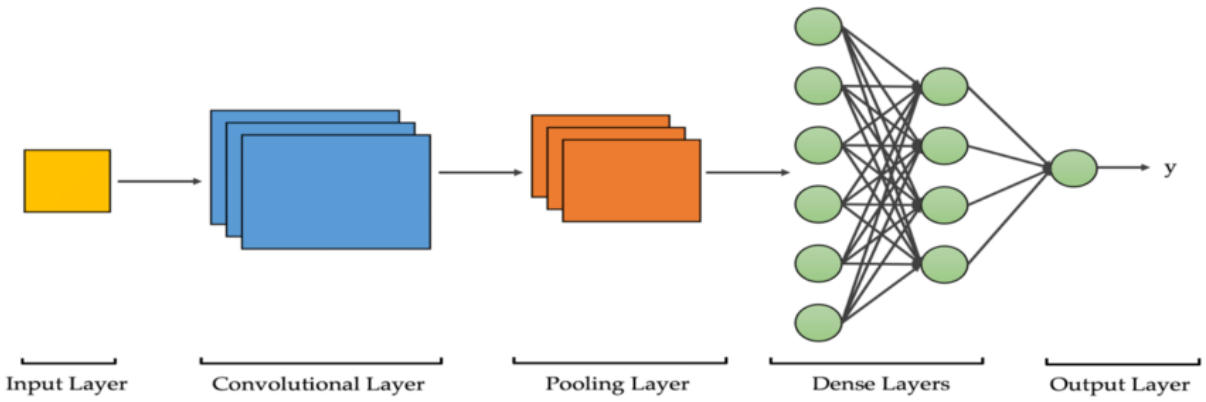
- **RFE (Recursive Feature Elimination):**
  Recursive feature elimination (RFE) is a feature selection method that fits a model and removes the weakest feature (or features) until the specified number of features is reached.

- **SoftMax:**
  Most of the time the SoftMax Function is related to the Cross Entropy Function. In CNN, after the application of the SoftMax Function, is to test the reliability of the model using as Loss Function the Cross Entropy Function, in order to maximize the performance of our neural network.

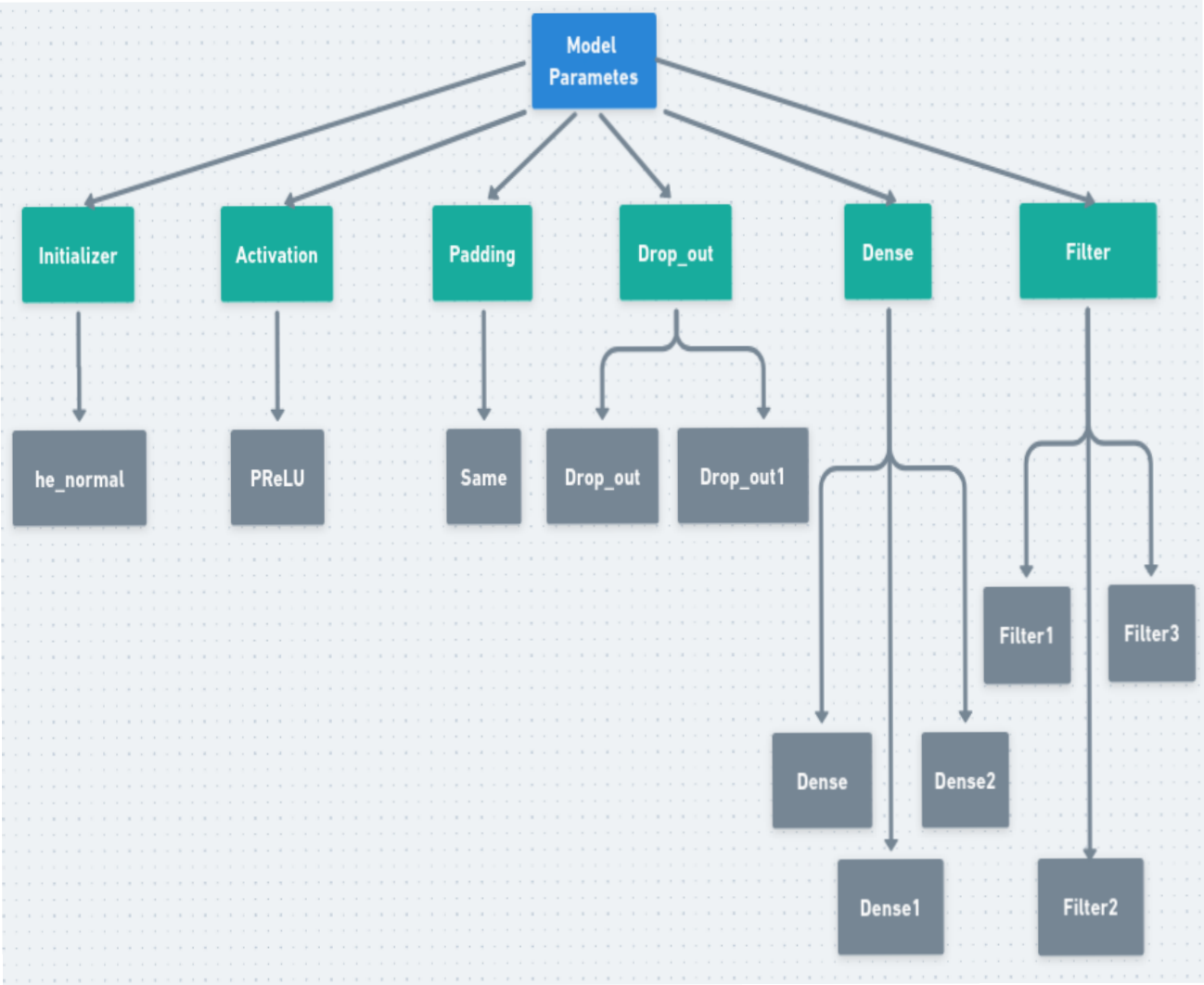
But this approach was not giving us the expected results or accuracy. Because during this we was applying a lot many handcrafted feature extractors, due to which we were losing out our features of MRI images and it was resulting into the less accuracy as our model prediction was not as like ground level labels associated with those images.

Approach 2:

Basic CNN architecture:



Parameters Used:



1.He-normal initializer: It considers a particular part of the data having maximum standard deviation in a normal distribution.

2.**PReLU Activation Function**: It is Parametric Rectified Linear Unit. If the input to the PReLU activation function is positive, then the neuron passes the same input to the next layer. If the input to the PReLU activation function is negative, then the neuron passes the input multiplied with a parameter.

3.Padding: In a CNN, the filter traverses over the input image. The pixels in the corner column do not get much importance as they do not get considered after each traversal. So, to give more importance to these corner column pixels, padding of value 0 is added to the input image.

4.Drop Out: The Dropout layer is a mask that nullifies the contribution of some neurons towards the next layer and leaves unmodified all others. To avoid overfeeding condition, drop out is done.

5.Dense Layer: Dense Layer is simple layer of neurons in which each neuron receives input from all the neurons of previous layer. Output of CNN is applied to dense layer to get feature classification.

6.Filters: A filter acts as a single pattern, which, when convolved across the input, finds similarities between the stored template & different locations/regions in the input image. The filter is traversed on the input image and performs the convolution operation.

Defined Parameters are like:

```
initializer = 'he_normal'
# It draws samples from a truncated normal distribution centered on 0 with stddev = sqrt(2 / fan_in)
# where fan_in is the number of input units in the weight tensor.
act = 'PReLU'
# In a neural network, the activation function is responsible for transforming the
# summed weighted input from the node into the activation of the node or output for that input.
# The rectified linear activation function or ReLU for short is a piecewise linear
# function that will output the input directly if it is positive,
# otherwise, it will output zero. It has become the default activation function
# for many types of neural networks because a model that uses it is
# easier to train and often achieves better performance.
padd = 'same'
# 'SAME' ensures that the filter is applied to all the elements of the input.
# Normally, padding is set to "SAME" while training the model.
Drop_out = .2
# Dropout is a regularization technique for neural network models
# “Dropout: A Simple Way to Prevent Neural Networks from Overfitting”
Drop_out1 = .25
Dense = 64
Dense1 = 32
Dense2 = 4
filters1 = 16
filters2 = 32
filters3 = 64
```

Defined Model is like:

```
model = keras.models.Sequential()
model.add(keras.layers.experimental.preprocessing.Rescaling(1./255, input_shape=(IMG_HEIGHT,IMG_WIDTH, 3)))
model.add(keras.layers.Conv2D(filters=16,kernel_size=(3,3),padding= padd,activation=act,kernel_initializer=initializer))
model.add(keras.layers.MaxPooling2D(pool_size=(2,2)))


model.add(keras.layers.Conv2D(filters=32,kernel_size=(3,3),padding= padd,activation=act,kernel_initializer=initializer))
model.add(keras.layers.MaxPooling2D(pool_size=(2,2)))

model.add(keras.layers.Dropout(Drop_out))

model.add(keras.layers.Conv2D(filters=64,kernel_size=(3,3),padding= padd,activation=act,kernel_initializer=initializer))
model.add(keras.layers.MaxPooling2D(pool_size=(2,2)))

model.add(keras.layers.Dropout(Drop_out1))
model.add(keras.layers.Flatten())
model.add(keras.layers.Dense(Dense,activation=act,kernel_initializer=initializer))
model.add(keras.layers.Dense(Dense1,act))
x = model
print(type(x))
model.add(keras.layers.Dense(Dense2,"softmax"))
```

7. Technology Required

1. **Keras on the top of TensorFlow**
2. **CNN Algorithm**
3. **Python – NumPy, Pandas**
4. **Platform: Google Colab**

8. References

1] Documentation | Automated Detection of Alzheimer's Disease and Mild cognitive Impairment Using Whole Brain MRI - IEEE Access https://drive.google.com/drive/u/1/folders/1Lc6iAw89gVhDrDvD74h-s0D6GggXBKw1

2] Course (Udacity)

https://drive.google.com/drive/u/1/folders/1uTJDPMeD3xZoNB__paAMEFB0fVSTralL

3] Course (NPETL)

https://youtube.com/playlist?list=PLEAYkSg4uSQ1r-2XrJ_GBzzS6I-f8yfRU

4]Dataset from Kaggle:-

https://www.kaggle.com/datasets/tourist55/alzheimers-dataset-4-class-of-images