TITLE: Advancements in Neuroimaging: Detection of Alzheimer's, Parkinson's, and Brain Tumor using Convolutional Neural Network

Alzheimer's (AD) disease is a high-risk and atrophic neurological illness that slowly and gradually destroys brain cells, On the other hand Parkinson’s disease is a neurological disorder with more than 6 million people worldwide suffering from it.It is commonly diagnosed using clinical assessments and progression scale which usually depends on the medical practitioner’s expertise ,and accuracy varies greatly between various examiners which also takes a long time to accurately diagnose (i.e. neurons) whereas, Brain Tumors could lead to life threatening conditions. Therefore, the early detection of AD and other brain related plays a crucial role in preventing and controlling its progression. For classification of AD, Parkinson’s and Brain Tumour in the early stage, classification systems and computer-aided diagnostic techniques have been developed. Previously, machine learning approaches were applied to develop diagnostic systems by extracting features from neural images. Currently, deep learning approaches have been used in many real-time medical imaging applications

The main objective is to design an end-to-end framework for early detection of Alzheimer’s, Parkinson’s disease and Brain Tumor and medical image classification for varies stages. A deep learning approach, specifically convolutional neural networks (CNN), is used in this work. Four stages of the AD spectrum are multi-classified along with initial and stages of Parkinson’s disease. Furthermore, separate binary medical image classifications are implemented between all three neurological disorders Different methods are used to classify the medical images and detect AD, Parkinson’s disease and Brain Tumour respectively. The first method uses simple CNN architectures that deal with 2D and 3D structural brain scans from the such diseases Neuroimaging Initiative (ADPP) dataset based on 2D and 3D convolution. The second method applies the transfer learning principle to take advantage of the pre-trained models for medical image classifications.

In this study, we suggest an AI model that aids in the recognition of various disorders through the classification of images. We seek to construct a very reliable and accurate model for the early phase detection of these diseases by merging the different datasets, applying the sophisticated image processing techniques, and ML algorithms. Our initiatives will be more significant and could lead to advancements in patient diagnostics and the healthcare industry. If this model is developed successfully, it will significantly alter how medical sciences have evolved in the future and pave the way for diagnosis.

The images present in the dataset have varying brightness, colour and noise, to remove these unwanted elements from our training and testing images, we apply image filtering operations and histogram equalisation for contrast enhancement, for better identifiable features.

Several brain slides are included in the MRI dataset's images, and different studies may have used slides of varying thickness. In this study, we use a custom CNN for automatically differentiating SN in image and no SN in image. The SN region is the most influential region of the brain in the detection of Parkinson's disease. We localise the SN region to classify between pd and no pd. To improve the accuracy of the localization, we separate the images containing the SN region.

METHODOLOGY:

- **CNN:** The first method is based on simple CNN architectures that deal with 2D and 3D structural brain MRI. These architectures are based on 2D and 3D convolution. Feature extraction, feature reduction, and classification are three essential stages where traditional machine learning methods are composed. All these stages are then combined in standard CNN. By using CNN, there is no need to make the feature extraction process manually. Its initial layers' weights serve as feature extractors, and their values are improved by iterative learning. The activation function, that we are using here is 'softmax' function, as it is a multi-class sigmoid function. The Optimizer, we use here is 'adam'.The loss function, we use here is 'SparseCategoricalcrossentropy' function. CNN gives higher performance than other classifiers.
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- **Transfer Learning Model:** Transfer learning is a deep learning procedure whereby a neural network model is first trained on a problem similar to the issue being solved. Transfer learning's key benefit is that it benefits from the pre-trained weights resulting from the training of millions of images from the ImageNet database. It decreases the training time for a learning model. Its ability to reduce generalization errors.
- **Masking of the MRI images:** Any remaining non-brain regions can be eliminated from the image by applying a binary mask. The image can then be divided into several parts of interest for additional analysis using this mask. To further the mask and guarantee that only the pertinent portions of the image are included in the study, we can also employ methods like morphological operations or clustering algorithms. A correct masking MRI scan will be the end result, which can then be processed and analysed further using our AI disease prediction system. Compared to manual masking, automated thresholding techniques are quicker and more effective, but they might not be as accurate, particularly when the contrast between the lesion and the surrounding tissue is not clearly defined.

WORK ARCHITECTURE:

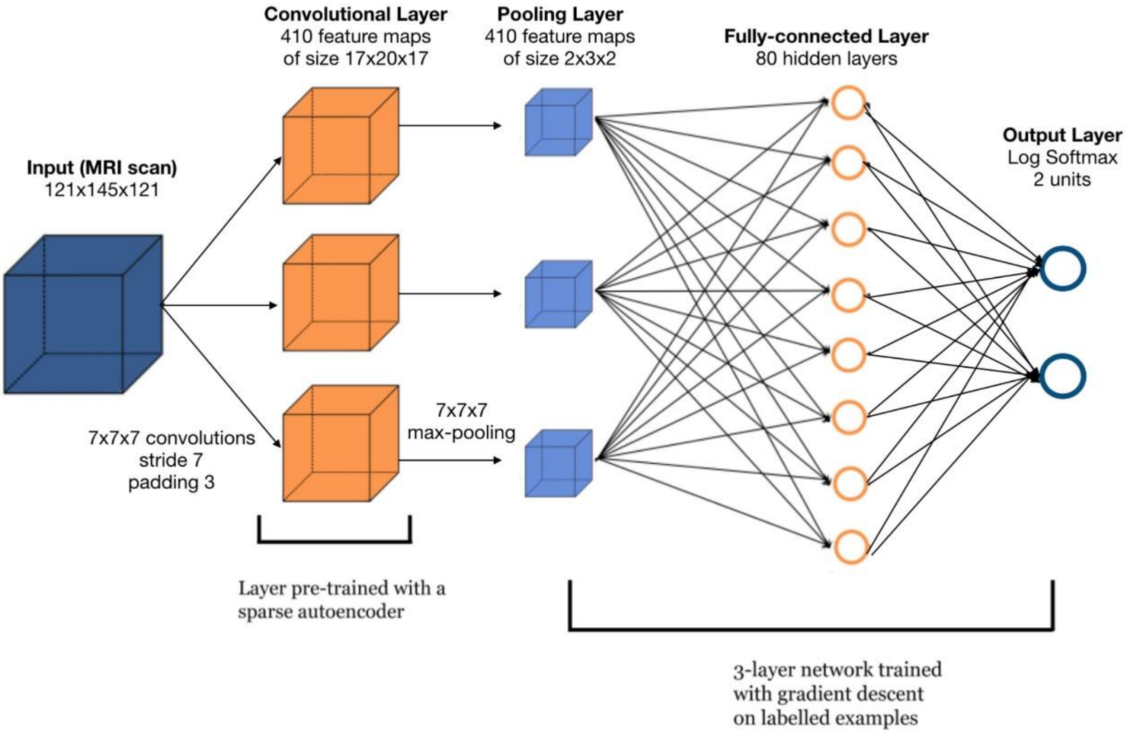
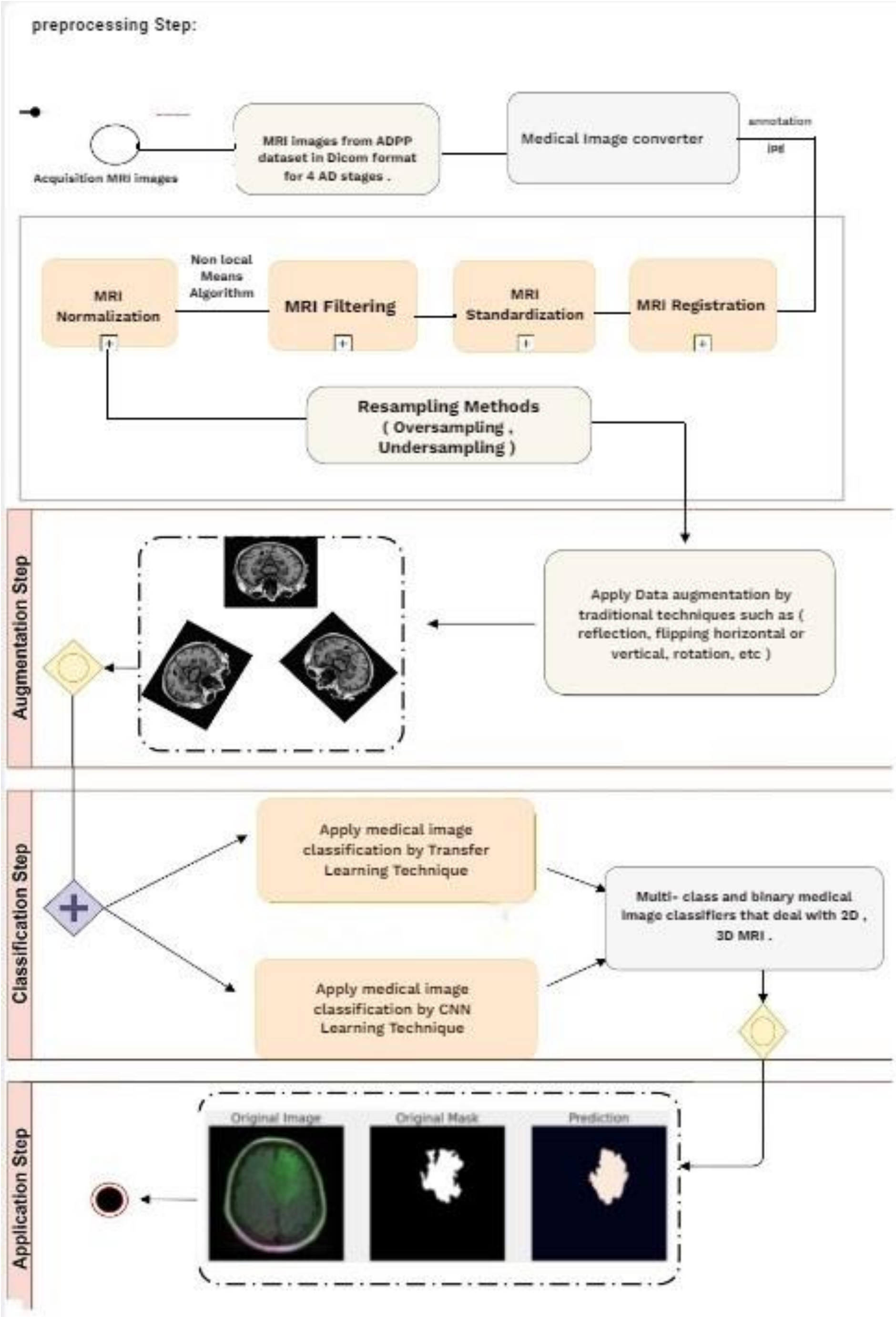


Figure 2: The Architecture of the neural network used for 2-way classification.



preprocessing Step:
Acquisition MRI images
MRI images from ADPP dataset in Dicom format for 4 AD stages .
Medical Image converter
annotation
jpg
MRI Normalization
Non local Means Algorithm
MRI Filtering
MRI Standardization
MRI Registration
Resampling Methods (Oversampling , Undersampling)
Augmentation Step
Apply Data augmentation by traditional techniques such as (reflection, flipping horizontal or vertical, rotation, etc)
Classification Step
Apply medical image classification by Transfer Learning Technique
Apply medical image classification by CNN Learning Technique
Multi- class and binary medical image classifiers that deal with 2D , 3D MRI .
Application Step
Original Image
Original Mask
Prediction