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A Synopsis
On

Detection and Classification of Alzheimer's disease stages using Deep learning approach.

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ABSTRACT

Alzheimer's disease (AD) is a progressive and irreversible brain degenerative disorder. Worldwide around 50 million people have dementia and there are nearly 10 million new cases every year. There is no treatment currently available to cure dementia, but it can be treated only if it is identified in the early stages. Thus, the need for a computer aided system for early diagnosis of AD. Here in our project we are trying to identify and classify the stage of AD by using deep learning techniques. We are using OASIS dataset to train our model. Initially we use data augmentation to increase the amount of data to increase the size of the dataset and increase variability in the dataset. The MRI images are pre-processed to remove noise and enhance the quality of image. Furthermore it is subjected to segmentation and feature extraction by using relevant algorithms and techniques for better results. Deep learning algorithms are flexible for complex problems and non-linear solutions. This is the main reason to choose DNN instead of Machine Learning algorithms.

INTRODUCTION

Dementia is a syndrome in which there is deterioration in memory, thinking, behaviour and the ability to perform everyday activities. It mainly affects old people but it is not a normal part of aging. Usually it starts slowly and worsens over time. AD is expected to affect 131.5 million people in the world by the year 2050. The cost of treatment of AD patients is also high. The complexity associated with brain structure and functions makes the early diagnosis of this disease a challenging task. Thus, there is a need for a computer aided system for early diagnosis of AD. There are various stages of AD that can be termed as Mild demented, Moderate demented, Non-demented, Very Mild demented. MRI is used to analyse brain structure due to its high spatial resonance ability to contrast soft tissue. The segmentation of MRI taken at different angles also used to measure structural changes in the brain. Abnormal tissues of the brain in the patients with AD can be segmented in MRI. Large amounts of data is required for more accurate diagnosis. Manual analysis of brain MRI is time consuming and vulnerable to errors. However, the extraction of the imaging features for such segmentation requires elaborate Engineering techniques.

LITERATURE SURVEY

Alzheimer’s disease detection has a significant role in a patient's quality of life, especially detection in its early stages. As a result, there have been several studies trying to predict AD and prodromal AD (early stage of AD) using MRI scans.

Liu, M [1] et al., developed a multi-model deep learning framework based on CNN which is used for learning hippocampus segmentation and disease classification. It is evaluated on baseline T1-weighted structural data collected from Alzheimer’s disease Neuroimaging (ADMI) database. The results based on ADNI dataset have demonstrated the approach has promising performance for AD and MCI diagnosis.

I. Beheshti [3] et al., used a Histogram-Based feature extraction (CAD system) for AD classification. It is composed of five stages. The stages include pre-processing and a novel statistical feature-generation process. The proposed feature-generation method compresses the statistical information of high-dimensional similarity matrices with different sizes into fixed size and lower-dimensional vectors.

Maqsood, M [12] et al., adopted a system which not only classifies dementia patients but also identifies the four progressing stages of dementia. The system they proposed works on an ancient technique of utilizing transfer learning to classify the images by fine-tuning a pre-trained convolutional network, AlexNet. The architecture is trained and tested over the pre-processed segmented (Grey Matter, White Matter, and Cerebral Spinal Fluid) and un-segmented images for both binary and multi-class classification.

Jun Yu [9] et al., used Deep Learning to study segmentation and classification of the human brain. Here it is discussed how brain MRI segmentation improves AD classification, describes the state of the art approaches and summarizes their results using publicly available datasets. To overcome difficulties, various methods for segmentation have been proposed with varying complexities. The segmentation of the brain structure and classification of AD using deep learning approaches has gained attention due to the ability to provide efficacious results over a large scale data set as well as to learn and make decisions on its own.

PROBLEM DEFINITION

Drawbacks of the existing system

- Classifying different stages of AD is a challenging task due to overlapping of features in different stages of AD.
- Legitimate datasets are hard to acquire due to restricted availability.
- Proper segmentation of the hippocampus is difficult due to its irregular shape and blurred boundaries in MRI scans.

Motivation:

Around 50 million people in the world have dementia and there are 10 million new cases each year. Every 3 seconds someone in the world develops dementia. AD is the most common form dementia which constitutes to 60-70% of cases. AD is a growing epidemic which changes the lives of families forever. With our project we plan to classify different stages and early detection of AD so that people with AD can receive treatment faster. There is still no cure for AD, although there is medication available that can temporarily seize the symptoms. Medical image analysis has benefited from the development of deep neural networks, which are used for various tasks of classification and segmentation.

Objectives:

- MRI images acquisition from various sources and database creation.
- Pre-process the MRI data and perform segmentation on the pre-processed data.
- Feature extraction and classification of AD using deep learning and its performance analysis.

METHODOLOGY

The overall block diagram of the diagnosis of AD usually adopted in conventional methods is depicted in Figure 1. The workflow includes two phases, the training phase where data acquisition, pre-processing, segmentation, feature extraction and training the deep learning model takes place and the testing phase where Classifier predicts the output based on the trained model and analysis of the performance takes place.

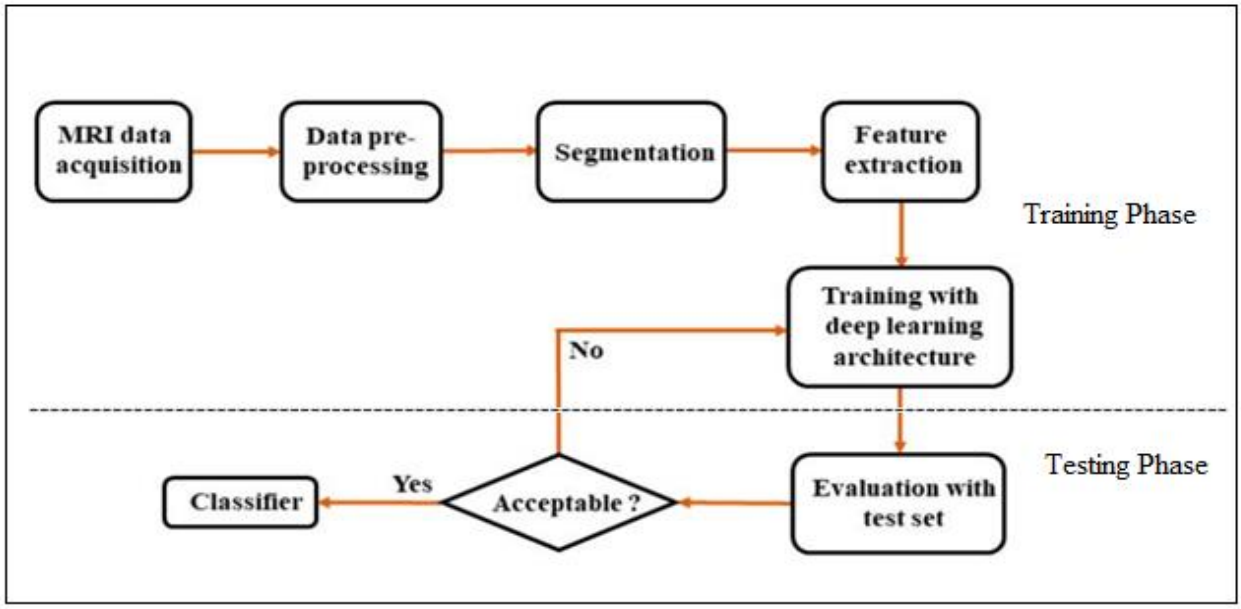

Figure 1. The overall block diagram of AD diagnosis

MRI data acquisition:

Generally, real-time images collected from scan centres and simulated images collected from publicly available databases are used for image classification and segmentation. These are raw images which are unsuitable for analysis due to the various types of noises present in the images. Hence the acquired images has to undergo pre-processing.

Data Pre-processing:

Brain MRI pre-processing often involves skull-stripping, and enhancement based on image thresholding and filtering. But the dataset we found doesn't contain any skull elements in it, so we directly perform image filtering on the MRI data. Under image filtering we undergo Bias field correction, Brain extraction and Noise reduction using various image processing algorithms which helps to normalize the data for further stages.

Segmentation:

The goal of image segmentation is to divide an image into a set of semantically meaningful, homogeneous, and non-overlapping regions of similar attributes such as intensity, depth, colour, or texture. The segmentation result is either an image of labels identifying each homogeneous region or a set of contours which describe the region boundaries. The segmentation of brain MRI is carried out to eliminate unnecessary details and to locate relevant objects from the processed images.

Feature Extraction:

The purpose of feature extraction is to reduce the original data set by measuring certain properties or features that distinguish one input pattern from another pattern. The extracted feature should provide the characteristics of the input type to the classifier by considering the description of the relevant properties of the image into a feature space. Feature extraction stage is a very crucial stage wherein the different algorithms and techniques play a major role in identifying various sets of features that describe the visual texture of an image.

Training with Deep learning architecture:

Once the input data has been processed and analysed, the information is ready to be computed by a neural network. The neural network will be in charge of learning from these data to be able to make predictions on new input data in the future. The creation of structure of the neural network is based on a Sequential model, which can be defined as a stack of layers. Different layers will be added specifying their activation functions, number of neurons and input data. When the structure is created, the model will be compiled.

Classification:

There are many different machine learning paradigms to design a classifier: logistic regression, decision trees or support vector machines. Deep learning solutions provide a more powerful and flexible framework for supervised learning problems. By adding more layers and more units within a layer, a deep network can represent functions of increasing complexity which depends on a huge number of features. This flexibility on working with complex problems and non-linear situations, will be one of the main points to choose a DNN solution rather than traditional ML algorithms.

SOFTWARE REQUIREMENTS

Programming language: Python.

Programming Environment: Google Collaborator (Colab), Jupyter Notebook.

Python Libraries: Tensorflow, Keras, PIL.

Expected Output:

Classification of the Alzheimer's disease stages with good accuracy and faster execution time.

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