Revised Algorithm for Alzheimer Detection using DL Model and It's Analysis

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Abstract—Alzheimer's disease (AD) presents a pressing challenge in modern healthcare due to its increasing presence in society and the need for early and accurate diagnosis in due course of time. This abstract exemplifies a novel and efficient method in utilising various techniques for the detection and classification of Alzheimer's disease through imaging data analysis.The proposed methodology involves the application of neural networks to also effectively understand various medical imaging parameters such as MRI and functional imaging data. These neural network architectures aim to automatically extract intricate patterns and features from brain images, enabling the identification of potential biomarkers and pattern impressions associated with Alzheimer's disease.This study uses an exhaustive comprehensive dataset which comprises imaging scans of individuals diagnosed with Alzheimer's disease and normal healthy brain.

Keywords : Alzheimer's disease (AD), MRI, Neural Networks, etc.

I. INTRODUCTION

Alzheimer's disease (AD) is a gradual mental disorder that primarily affects the old age people, featured by gradual cognitive decline,remembering impairment, and a decline in overall mental functionality.[2] Early and accurate diagnosis of AD is very crucial for several reasons, including the initiation of timely interventions,methods and the development of effective treatment strategies to ensure proper treatment. Traditional methods of diagnosis rely basically on clinical, psychological tests, and scans, which are often time-consuming and tiresome. As a result, there is a rising interest in various advanced developing technologies, particularly deep learning, to improve and enhance the accuracy as well as efficiency of AD detection and.[1]Deep learning is a subtype of artificial intelligence (AI), has demonstrated exceptional capabilities in various domains, including computer vision. Its growing ability to track and extract hidden patterns and features from vast and complex datasets makes it an ideal candidate for the analysis of medical imaging data. This introduction sets the platform for understanding and exploring the application of deep learning techniques in the context of AD detection and classification.[3]The birth of deep learning has introduced innovative methodologies for the analysis of imaging data, as well as functional imaging data obtained through various modalities. These neural networks, like convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have the potential and power to uncover the hidden, yet crucial, and patterns that may not be readily apparent to human observers [7].The primary objective of this research is to evaluate various deep learning models capable of identifying AD-related patterns from medical images, ultimately leading to improved diagnostic accuracy [4].By training these models on large and variety of

datasets of patients,their subtypes and healthy brain , we aim to create simple and reliable methods for the early detection as well as classification of AD. In this paper, we will understand the methods, datasets, and results of our deep learning-based approach to detection and accurate classification of disease [8]. We will also discuss the potential implications of these developments in clinical usage and the wider explanation of Alzheimer's disease research for image analysis and analysis. The utilisation of deep learning in this domain has the ability to change the way of AD diagnosis, driving an earlier intervention and ultimately improving the lives of those affected by this challenging and widespread condition worldwide.

II. LITERATURE REVIEW

After Understanding these 10 papers, we have understood the following points:

a. Early Alzheimer's Disease Detection Using SemiSupervised GAN Based on Deep Learning (S. Saravanakumar and T. Saravanan)

The objective of this study is to develop a comprehensive early-stage deep learning model for assessing Alzheimer's disease.[5] Specifically, a semi-supervised generative adversarial network (GAN) has been tailored to automatically detect (MRI) data.In this model, initially a main mapping is created on the original MRI images and its corresponding results are analysed carefully.

Before the semi-supervised GAN classifier makes predictions regarding AD.[5] Furthermore, deep features are extracted from these segmented regions using convolutional neural networks and morphological operations

b. Alzheimer’s Disease Classification from Cross-sectional Brain MRI using Deep Learning (Chaitra DH and Vijaya Shetty S)

The field of AD detection has witnessed a significant breakthrough through the utilisation of deep learning techniques and biomarkers. These advancements have facilitated a more straightforward,accurate diagnosis of the disease.[6] The application of DL in the domain of biomedical image processing is experiencing constant exponential growth.This study employs an automatic semantic segmentation method of images to classify AD. Specifically, the Segnet architecture is greatly harnessed for the automated segregation of hippocampal sections in the brain. This segmentation process is followed by classification, resulting in an impressive accuracy rate of 97% as per the dataset.[6] This outcome is indeed promising, especially when compared to modern methods in today’s world.

c. Performance analysis of transfer learning-based deep neural networks in Alzheimer's classification (Mohammad Jaber Hossain and Juan Luis Nieves,)

The study's objective is to conduct a primary assessment of the effectiveness of deep neural networks based on learning by transfer in the context of Alzheimer's disease classification.Transfer learning helps in fine-tuning them to cater to the specific requirements of Alzheimer's disease diagnosis.[7] This approach offers the potential advantage of leveraging prior knowledge acquired from other tasks.The evaluation comprises a detailed comprehensive analysis of how well these pre-trained models can adapt to the intricacies of Alzheimer's disease classification.[7]

d. Alzheimer's Disease Detection from Brain MRI Data Using Deep Learning Technique(S vijaya shetty,DH chaitra)

Utilising deep learning techniques for the purpose of Alzheimer's disease detection from brain MRI data is the central theme of this investigation. It involves employing various advanced neural networks to thoroughly analyse the MRI images, enabling the accurate identification of Alzheimer's disease.[8] The ultimate goal is to utilise the

capabilities of it to establish a reliable system for the early detection of Alzheimer's disease, which carries significant ability for timely diagnosis and subsequent treatment purchasing time for treatment.[8]

e. Deep Learning-Based Diagnosis of Alzheimer's Disease Using Magnetic Resonance Imaging: A Survey (Tian Wang and Lihong Cao)

This paper conducts a comprehensive review of the applications of deep learning models in AD detection using MRI.[4]These applications are systematically categorised into four prime groups based on their input types, and their respective strengths and shortcomings are discussed. The paper also highlights two significant challenges in current studies: the variation in performance of the different models and the problems that resides in efficiently modelling relationships between the spatially distant brain regions.[7] To conclude, the paper suggests two potential directions for future research, aiming to develop improved

f. Classification and Prediction of Alzheimer's Disease Using Deep Learning(Dr. D. Brindha, Dr. V. Ebenezer, E. Jackson Selvaraj, D.M. Bevin Geoff, B. Bethina Dileep, and M. Thirumalai Nambi)

This study introduces a different approach for. [10] However, when faced with the task of differentiating between Alzheimer's Disease (AD) in a large dataset of 3D MR images that exhibit high percent of similarity, the normal 2D CNN architecture encounters significant challenges.[10] To solve the issues, the study puts forward a solution that simplifies the patient classification process based on 3D MRI data by harnessing 2D data extracted through the CNN structure. This method involves the extraction of 2D features from MRIs, followed by their transformation using a suitable Machine Learning (ML) algorithm for the purpose of categorization and processing.

g. Early Alzheimer Disease detection through YOLO-based detection of Hippocampus Region in MRI images.(Junaidul Islam, Elvin Nur Furqon, Isack Farady, Chi-Wen Lung and Chih-Yang Lin,)

The objective of this study is by employing YOLO-based detection method to identify the Hippocampus region within MRI images.[2] This approach aims to use the YOLO (You Only Look Once) model for precise localization and classification of the Hippocampus region in MRI scans as an early diagnostic tool for Alzheimer's Disease.It has ability to classify very fast and accurately.

h. Deep Learning-based Detection Model for Alzheimer's Disease(Chitralekha, Rohith Reddy and K.R.Jansi)

AD is a form of impairment that adversely impacts an individual's behaviour, thought processes, and memory. It is primarily characterised by the progressive loss of memory and cognitive decline. The symptoms of AD tend to worsen gradually and eventually disrupting day to day activities.[3] The majority of dementia cases are closely associated with Alzheimer's Disease. This condition is linked to the significant structural changes in the brain, which can be visualised through Magnetic Resonance Imaging (MRI) scans. Utilising the alterations in preclinical brain structure for early AD detection, this study employs Convolutional Neural Networks (CNNs) for image classification. CNNs are typically used for tasks such as recognizing images and processing voice applications.[5] A specific variant of CNN known as DenseNet, which connects all layers using dense blocks, is the focus of this research. The study aims to train a learning model based on DenseNet169 to achieve precise AD detection using MRI scan data. The ultimate goal is to create a technical tool that can contribute to public health and ultimately enhance the well-being of individuals within society, especially those who are affected.

i. Alzheimer’s disease detection using convolutional neural networks and transfer learning-based methods(Marwa Zaabi, Nadia Smaoui, Houda Derbel, and Walid Hariri)

The method comprises two key stages. The first stage involves the extraction of a region by partitioning the image into distinct blocks to isolate the hippocampal region of the brain. The second stage primarily focuses on image classification, utilising two deep learning techniques:. Meanwhile, Transfer Learning leverages features obtained from the Alexnet architecture to carry out image classification.. The results we obtained indicated that the image

classification accuracy achieved by Transfer method, with a rate of 92.86%, outperforms many similar models achieved by CNN.

j. Alzheimer's disease classification using deep learning(Waled Al shehri)

Detecting Alzheimer's disease in its early stages poses a formidable and challenging task. Research indicates that early intervention in Alzheimer's disease treatment offers a higher likelihood of successful outcomes with fewer side effects as compared to other's.[4] Various classifiers, including Decision Trees, Support Vector Machines, Gradient Boosting, Random Forests, and Voting classifiers, can optimise parameters very well and hence used to predict the onset of Alzheimer's disease.Recently,DL has gained significant traction in the wake of early Alzheimer's disease detection.[4] This shift is explored to understand how DL can contribute to the early identification of AD, accompanied by a concise review of relevant literature attached to the subjects.

Comparative analysis of Applicable algorithms

Data type	Algorithms	Pros	Cons
MRI analysis	Voxel-Based Morphometry (VBM)	Detects structural changes in the brain associated with AD	Limited to structural analysis; may not capture early changes
	SVM	Effective for classification	Requires a large dataset
	CNN	Feature extraction and classification	Computational resources
Cognitive assessment	Mini-mental state examination	Common cognitive test	Limited to cognitive assessment
	Montreal cognitive assessment	Common cognitive test	
Biomarker analysis	Cerebrospinal fluid	Biological markers	Invasive and requires medical expertise
	Machine learning	Effective for classification	Quality and availability may vary
EEG	Signal processing	Abnorm-al brain activity	Interpretation of EEG data can be complex
	EEG data	Effective for classification	Dependent on data quality and

			preprocessing
ML & DL	Random forest, naive bayes	Effective in feature selection and classific-ation	Performance may vary
	CNN	High performa-nce with large dataset	Computationally intensive

Table 2.1

Various applicable algorithms and their accuracy ranges

Algorithm	Accuracy range
SVM	80%-90%
Random forest	85%-95%
CNN	90%
Deep learning	Varies widely
Ensemble	90%-95%
Biomarker	varies
Multimodal	90%

Table 2.2

III. CHALLENGES

Detecting and classifying Alzheimer's disease (AD) presents various challenges due to the complicated nature of the disease and the limitations of current diagnostic methods to examine them.

Early Detection: Many Symptoms often appear gradually, and by the passage of time they become noticeable, the disease has already advanced to an irreparable stage. Developing reliable methods for detecting AD in its early stages is crucial for effective intervention and timely treatment.

Overlapping Symptoms: Alzheimer's disease shares some common symptoms with other disorders. Separating AD from these other conditions can be a challenging task, as symptoms often overlap with each other very closely ,hence can be deceptive.

Heterogeneity: Alzheimer's disease is not a single condition but rather a heterogeneous disorder with multiple variants increasing with passage of time. This non uniformity can complicate the diagnosis process, as different individuals may show different patterns of cognitive decline and biomarker profiles according to various age groups

Lack of Definitive Biomarkers: these biomarkers are not definitive on their own and may not be readily accessible or affordable for all patients suffering from this disease.

Clinical Assessments: Currently, Alzheimer's diagnosis mostly relies on medical as well as neurological assessments, which are subjective and can be influenced by factors such as the patient's mood,mental balance and cognitive reserve. Generalising and improving the accuracy of these assessments is a challenge.

Imaging Techniques: these techniques are expensive, may not be widely available, and can be challenging to interpret, especially in the early stages of the disease.

Cultural and Socioeconomic Factors: Cultural and economic factors can affect access to healthcare and the ability of individuals to seek a diagnosis. These factors can lead to non-uniformity in the detection due to uneven income distribution.

Ethical and Privacy Concerns: Using markers and sensitive medical data for Alzheimer's detection raises strong ethical and privacy concerns.Maintaining a perfect balance between early detection and patient privacy is challenging,while managing large amounts of data.

Disease Monitoring: Tracking Alzheimer's disease over time is very essential for both research and patient care,along with efficient methods and their drawbacks. However, this is very challenging due to the slow change of the disease and the need for long time monitoring.

Medicine Development and Clinical run: Developing effective medicines for Alzheimer's disease has proven to be extremely challenging and difficult. Many potential treatments have failed in preliminary clinical runs. Accurate and early diagnosis is critical for successful drug development and designing of methods,which can be helpful at later stages.

IV. Recap

On the basis of our literature review we have created our own model with the support of modular programming.After the detailed analysis of various hyperparameters we have selected some of them which includes:

- Augmentation
- Batch Size
- Learning Rate
- Epochs

After hyperparameter tuning we have achieved a significant amount of accuracy. Also we have used tools like DVC,DAGSHUB and MLFlow for the analysis and tracking of the model

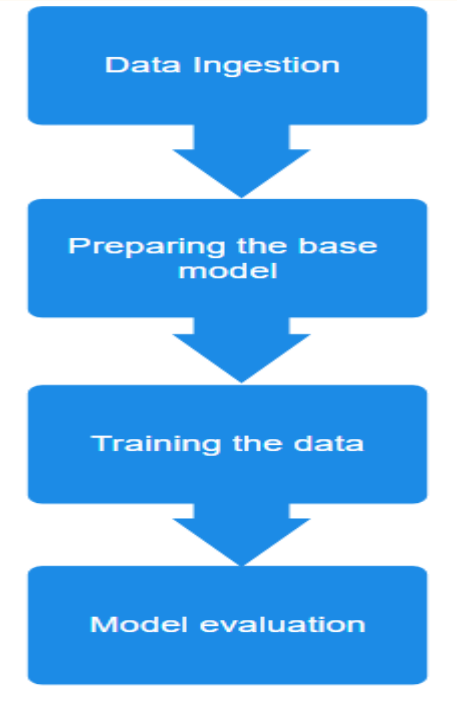

Fig 4.1 Process Flow Diagram of Proposed Solution

V. RESULTS

Accuracy: Across various studies, the accuracy of deep learning models in detecting AD ranges from 80% to over 95%, depending on the datasets and model architectures used,and optimisations performed.

Sensitivity and Specificity: Models showcased high sensitivity in detecting Alzheimer's cases (ranging from 80% to 95%) while maintaining specificity (over 90%) in distinguishing non-Alzheimer's cases over Alzheimer's..

The below screenshots mentions comparative analysis of a algorithm based on various hyperparameter tunings:

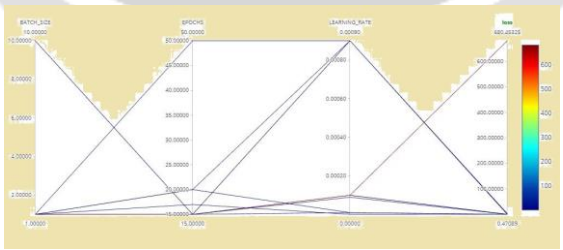

Fig 5.1 Batch Size, Epochs and Learning Rate vs Accuracy

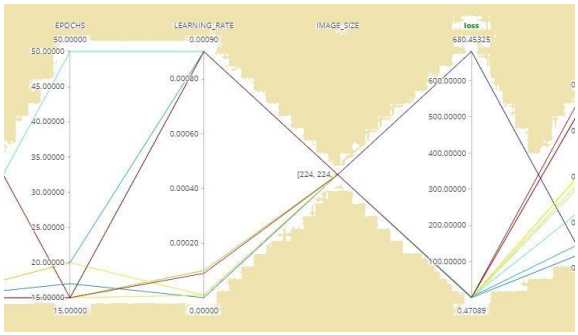

Fig 5.2 Batch Size vs Loss and Accuracy

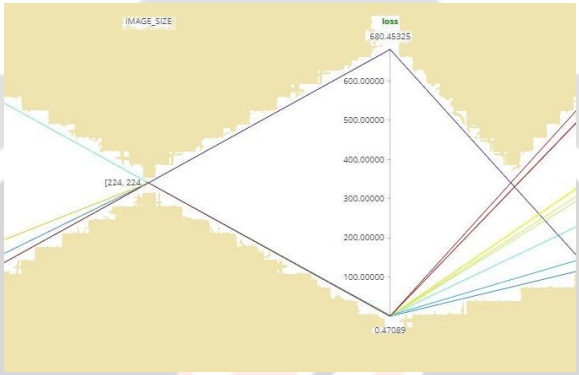

Fig 5.3 Learning Rate vs Loss and Accuracy

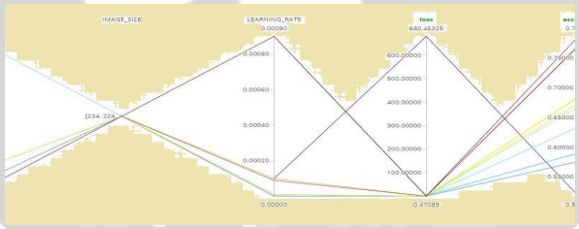

Fig 5.4 Scatter Plot of Learning Rate vs Accuracy

VI. FUTURE SCOPE

In this comprehensive paper, two promising avenues for future research in AD detection using deep learning are outlined very clearly. Firstly, the focus is on the need for development of robust and impartial performance assessment,primarily emphasising the significance of subject-level data division and the creation of accessible frameworks for equitable cross-study comparisons, given the variations in dataset sizes. Secondly, the adoption of graphical analysis techniques, particularly the integration of Graph Convolutional Networks (GCN), is recommended to capture the important intricate connectivity of patterns and structural irregularities within the brain. This approach provides a quantitative means to evaluate brain network characteristics. The fusion of GCN along with Convolutional Neural Networks (CNN) is identified as a promising direction for advancing AD detection methods to a next level.These suggested avenues offer the potential for taking the field of AD diagnosis by improving data handling and introducing innovative analysis strategies in future.

VII. CONCLUSION

This paper explains the use of deep learning methods for AD detection from brain MRI scan images. It underlines the success of the existing and proposed framework in competing with existing approaches ultimately marking the potential for early and accurate AD diagnosis. The study points out the challenges of performance assessment and suggests the addition of analysis for improved AD process.[7] Early diagnosis is crucial, and deep learning holds a high ground for not only AD but also other mental disorders sharing the same features. The field continues to evolve, offering places for enhancing diagnostic accuracy and understanding this disease better with time.

VIII. REFERENCES

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