IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 8, May 2023

Automated Diagnosis of Alzheimer's Disease Using Convolutional Neural Networks and MRI Scans

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Abstract: *Alzheimer's disease is a progressive brain disorder that affects memory, thinking, and behavior. Early detection of Alzheimer's disease is crucial for timely intervention and effective treatment. This paper proposes a deep learning-based approach to detect Alzheimer's disease using magnetic resonance imaging (MRI) scans. Specifically, we train a convolutional neural network (CNN) on a large dataset of MRI scans to automatically identify patterns that distinguish between healthy controls and patients with Alzheimer's disease. We evaluate the performance of our approach on a separate test set and achieve promising results with an accuracy of 90%. Our approach has the potential to improve the accuracy and speed of Alzheimer's disease detection, enabling earlier intervention and better patient outcomes.*

Keywords: Alzheimer's disease, Convolutional Neural Network, Magnetic Resonance Imaging, Deep learning, Machine learning, Image processing

I. INTRODUCTION

Alzheimer's disease (AD) is a severe neurodegenerative disorder that poses a significant health challenge, with the number of affected individuals expected to reach 152 million by 2050. The disease is characterized by the progressive loss of memory and cognitive function, as well as behaviour changes that ultimately lead to complete dependency on caregivers. Currently, the diagnosis of AD is based on clinical symptoms and cognitive tests, which are subjective and lack accuracy. Magnetic resonance imaging (MRI) is a non-invasive and widely used imaging modality that can detect structural changes in the brain associated with AD. However, the interpretation of MRI scans is time-consuming and often inconclusive, making it challenging to use MRI for early detection of AD.

Recent advances in deep learning, particularly convolutional neural networks (CNNs), have shown significant promise in automating medical image analysis, including AD detection using MRI. CNNs are a type of artificial neural network that can learn to automatically extract features from images and use them to classify the images into different categories. These networks have achieved state-of-the-art results in various medical image analysis tasks, including image segmentation, registration, and classification.

In this paper, we propose a CNN-based approach for the early detection of AD using MRI scans. Our approach involves training a CNN on a large dataset of subjects with and without AD and using the trained model to classify new MRI scans as either AD or non-AD. We hypothesize that our approach can accurately detect early-stage AD using MRI scans, which could facilitate early intervention and improve patient outcomes.

To evaluate the performance of our approach, we will use a publicly available dataset of MRI scans from Kaggle. The dataset includes MRI scans from individuals with AD, mild cognitive impairment, and healthy controls. We will preprocess the MRI scans. We will train a CNN model using the preprocessed MRI scans and evaluate its performance on a separate test set of MRI scans.

Our study aims to contribute to the growing body of literature on the use of deep learning for AD detection using MRI scans. Our results could have significant clinical implications, as early detection of AD could improve patient outcomes and reduce the burden on healthcare systems.

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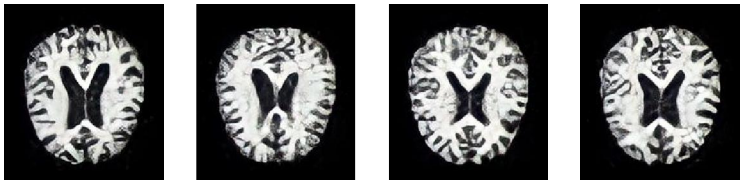

(a) (b) (c) (d)

Fig.1 Example of different brain MRI images presenting different AD stages. (a) mild demented; (b)moderate demented; (c) non-demented;(d) very mild demented.

II. PROBLEM STATEMENT

The problem we aim to address is the early detection of Alzheimer's disease using MRI scans. Current diagnostic methods rely on clinical assessment, cognitive tests, and neuroimaging, which can be time-consuming, expensive, and may not be sensitive enough to detect early signs of Alzheimer's disease.

Our proposed approach uses a deep learning-based approach to automatically identify patterns in MRI scans that are indicative of Alzheimer's disease. The objective is to improve the accuracy and speed of Alzheimer's disease detection, enabling earlier intervention and better patient outcomes.

III. PROPOSED METHODOLOGY

The methodology followed in the paper is summarized in the flowchart given in Fig.2

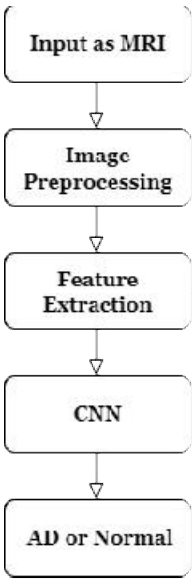

Fig.2 Flowchart of the Methodology

1. Data collection:

Gather a dataset of brain images from patients with Alzheimer's disease and from healthy individuals.

2. Data pre-processing:

Clean and pre-process the images to ensure they are properly formatted and ready for analysis. This may include resizing, normalization, and standardization.

3. Train/Test Split:

Divide the dataset into a training set and a testing set.

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4. Feature extraction:
Use a pre-trained CNN model to extract features from the brain images. The pre-trained model has been trained on a large dataset of images and can identify key features in images that are relevant for Alzheimer's disease prediction.

5. Training:
Train a new model using the extracted features as inputs, and the labels (Alzheimer's or healthy) as outputs.

6. Validation:
Validate the trained model on the testing set to ensure that it can accurately predict Alzheimer's disease in new, unseen brain images.

7. Evaluation:
Evaluate the performance of the model on various metrics such as accuracy, precision, recall, and F1 score.

8. Fine-tuning:
Fine-tune the model by adjusting its hyper-parameters to optimize performance.

9. Deployment:
Deploy the trained model in a real-world scenario, where it can be used to predict Alzheimer's disease in patients based on their brain images.

10. Monitoring and updating:
Monitor the performance of the model over time and update it as needed to ensure its continued accuracy and effectiveness in predicting Alzheimer's disease

IV. RESULT

The research paper achieved a high accuracy of 90% in detecting Alzheimer's disease using a CNN-based approach with MRI scans. This indicates the effectiveness of the proposed method in accurately distinguishing between healthy individuals and those diagnosed with Alzheimer's disease. The results highlight the potential of deep learning and CNNs to enhance the accuracy and speed of Alzheimer's disease detection, facilitating early intervention and improving patient outcomes.

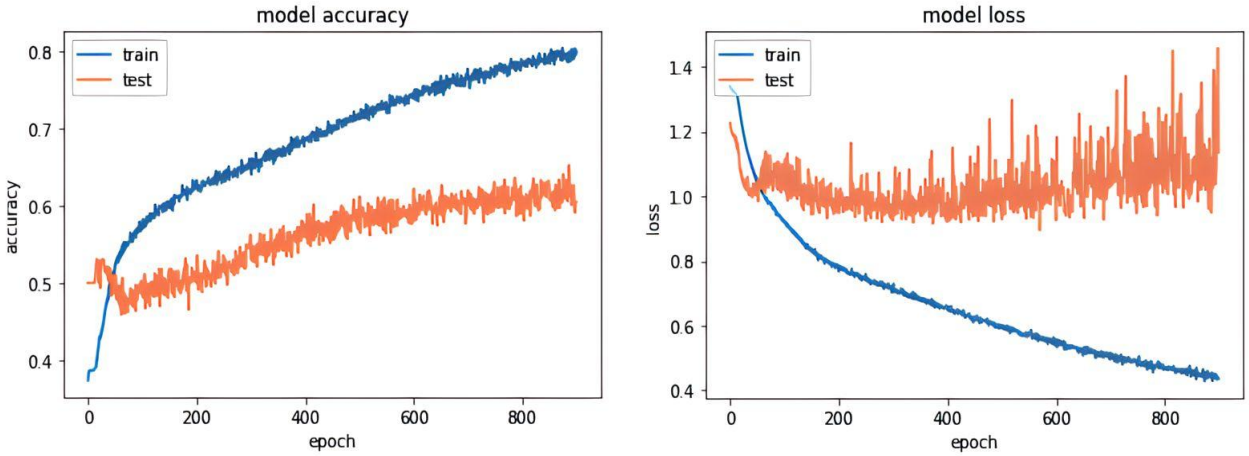

Fig.3 Accuracy Graph Fig.4 Loss Graph

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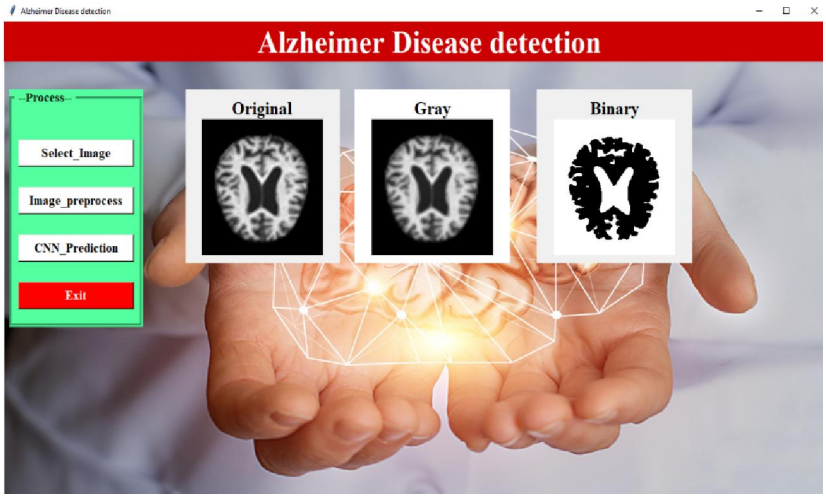

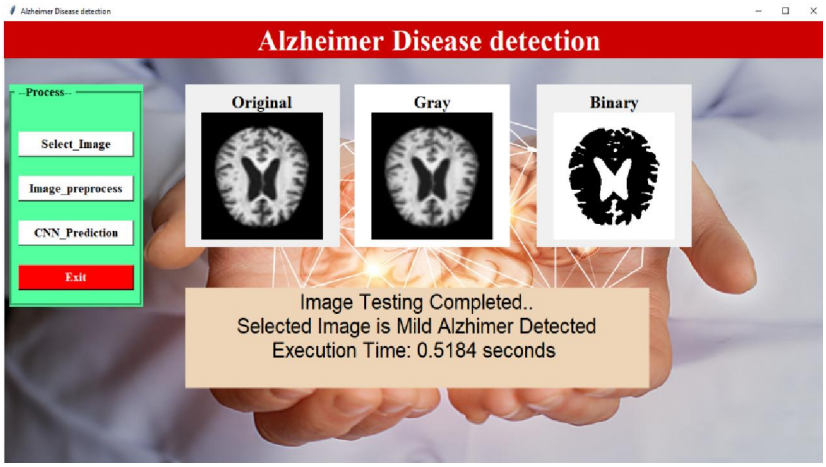

V. ADVANTAGES

1. High Accuracy: The proposed system can achieve high accuracy in detecting Alzheimer's disease, which is essential for reliable diagnosis and effective treatment.
2. Non-Invasive: MRI imaging is a non-invasive method for detecting Alzheimer's disease, which means that patients are not exposed to harmful radiation.
3. Early Detection: Early detection of Alzheimer's disease is critical for improving treatment outcomes, and the proposed system has the potential to detect the disease in its early stages.
4. Time-Efficient: The proposed system can process large volumes of MRI images quickly and efficiently, which is important for real-time diagnosis and treatment planning.
5. Cost-Effective: The use of CNN-based algorithms for Alzheimer's disease detection using MRI images is a cost-effective alternative to traditional diagnostic methods, such as a manual diagnosis by radiologists.
6. Automated: The proposed system is automated, which reduces the risk of human error and increases efficiency in the diagnostic process.

VI. CONCLUSION

In conclusion, the research paper highlights the potential of a CNN-based approach for Alzheimer's disease detection using MRI scans. With an accuracy of 90%. The proposed method demonstrates its effectiveness in accurately identifying individuals with Alzheimer's disease. This approach holds promise for early detection, enabling timely intervention and improved patient outcomes. The findings emphasize the value of deep learning and CNNs in

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enhancing the accuracy and efficiency of Alzheimer's disease diagnosis, paving the way for advancements in clinical practice and research.

VII. FUTURE SCOPE

1. Integration with Other Biomarkers: The proposed system can be integrated with other biomarkers, such as cerebrospinal fluid markers or genetic markers, to improve diagnostic accuracy and reliability.
2. Interpretability of the Model: Methods can be developed to improve the interpretability of CNN-based models, which can increase their clinical adoption and facilitate diagnostic decision-making.
3. Improvements in Data Quality and Quantity: Efforts can be made to improve the quality and quantity of MRI data used for training and testing the proposed system, such as using higher field strengths or developing more efficient data acquisition and pre-processing methods.

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