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Alzheimer and Parkinson Disease Prediction using MRI Images

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ABSTRACT: Neurodegenerative disorders like Alzheimer's disease (AD) and Parkinson's disease (PD) present significant diagnostic challenges due to overlapping symptoms and progressive nature. This project develops an automated deep learning-based system for classifying brain MRI images into three categories: Alzheimer's, Parkinson's, or healthy control. Using a Convolutional Neural Network (CNN) trained on a publicly available Kaggle dataset, the model incorporates pre-processing techniques including grayscale conversion, noise reduction, normalization, and data augmentation. The architecture consists of convolutional layers, max-pooling, ReLU activation, dropout, and batch normalization to extract discriminative features from MRI scans. The trained model achieved approximately 82% accuracy and was deployed through a Stream lit web application for real-time predictions. This system demonstrates the potential of AI-powered medical imaging in enhancing early diagnosis and supporting clinical decision-making for neurodegenerative diseases. Future improvements include dataset expansion, multimodal data integration, and implementation of explainable AI techniques like Grad-CAM.

KEYWORDS: Convolutional Neural Network (CNN), Multi-class Classification, MRI Brain Images, Neurodegenerative Diseases.

I. INTRODUCTION

Alzheimer's disease (AD) and Parkinson's disease (PD) are progressive disorders of the nervous system that gradually damage its structure and functions. Patients often experience difficulties in movement, speech, and memory. Global health statistics indicate that dementia affects nearly 57 million people, with AD contributing to about two-thirds of these cases [1]. Alzheimer's is strongly linked to memory decline, especially among individuals older than 65. In contrast, PD is primarily associated with motor impairments such as tremors, stiffness, and slowed movements, often accompanied by emotional challenges like anxiety and chronic pain. While PD is generally not fatal, it significantly impacts daily living and independence, affecting more than 11 million people worldwide. Since both conditions share overlapping symptoms and can lead to dementia, they are frequently misdiagnosed. Therefore, early and reliable detection is vital for better treatment and patient outcomes.

A. Alzheimer's Disease

Alzheimer's disease is the most prevalent type of dementia and usually affects individuals over the age of 65 [2]. It is caused by the abnormal accumulation of proteins specifically amyloid plaques and tau tangles that interfere with neuron communication and eventually lead to cell death. Symptoms usually begin with memory lapses, confusion, and challenges in daily activities, but as the condition advances, patients may lose the ability to recognize familiar people, communicate effectively, or manage basic self-care. Although there is currently no cure, early detection and supportive interventions can slow progression and help maintain quality of life.

B. Parkinson's Disease

Parkinson's disease is a progressive neurological disorder that results from the gradual decline of dopamine-producing neurons in the substantia nigra region of the brain. This dopamine loss leads to difficulties in motor control, with

hallmark symptoms such as tremors, muscle stiffness, slowed movements, and balance issues [3]. Beyond motor challenges, PD patients may also experience non-motor problems including depression, sleep disturbances, and in some cases, mild cognitive impairment. Unlike Alzheimer’s, PD is rarely life-threatening, but its impact on mobility and independence makes it a life-altering condition requiring long-term management

C. Overlapping Clinical and Pathological Features

Although AD and PD are distinct diseases, they share several clinical and pathological similarities that complicate diagnosis. Both involve gradual cognitive decline, memory issues, and emotional disturbances like depression and anxiety. Pathologically, abnormal protein deposits are common in both disorders: beta-amyloid plaques in AD and alpha-synuclein aggregates in PD [4]. Such overlaps contribute to frequent misdiagnosis and highlight the need for advanced diagnostic methods. Brain imaging combined with deep learning models has recently gained attention as a promising approach for addressing these challenges.

Clinical Domain	Common Symptoms in AD and PD		
	Alzheimer Disease (AD)	Parkinson Disease (PD)	Overlap Explanation
Cognitive Decline	Memory loss, disorientation, impaired judgment	Slower thinking, memory issues (especially in later stages)	Both involve a decline in cognitive functions, especially executive function and memory
Mood & Psychiatric Issues	Depression, apathy, anxiety	Depression, anxiety, hallucinations (esp. with dementia)	Emotional and psychiatric symptoms often co-occur, affecting diagnosis and care
Sleep Disturbances	Sleep fragmentation, insomnia	REM sleep behavior disorder, insomnia	Sleep disruptions are common and affect brain health and disease progression
Impact on Daily Life	Memory, language, and spatial navigation issues	Motor symptoms + cognitive decline in some cases	Both eventually impair independent functioning and quality of life

Fig. 1.1

D. Existing approaches for detecting or predicting these diseases

Machine Learning (ML) and Deep Learning (DL) models have been widely applied in healthcare for detecting neurological diseases such as Alzheimer’s and Parkinson’s. Existing methods include traditional approaches like Linear Discriminant Analysis (LDA) and Multilayer Perceptron (MLP), as well as advanced deep learning techniques such as Convolutional Neural Networks (CNNs), patch-based CNNs, and hybrid CNN-LSTM models. Recent developments also explore the integration of multi-modal data, such as sensor inputs from functional mobility tests, and the use of recommendation engines to support personalized treatment planning.

E. Review of ML/DL models used in healthcare

Machine Learning (ML) and Deep Learning (DL) methods have become increasingly important in healthcare, especially for the early detection of neurological diseases such as Alzheimer’s and Parkinson’s. Traditional ML approaches, including Linear Discriminant Analysis (LDA) and Multilayer Perceptrons (MLP), have been applied in the past, but these models often struggle to capture the complex spatial features present in MRI scans, which limits their accuracy [5].

By contrast, deep learning models, particularly Convolutional Neural Networks (CNNs), have shown significant promise for medical image analysis. CNNs are able to automatically learn hierarchical features from MRI data, making them well suited for distinguishing between subtle patterns in different brain conditions. Extensions such as patch-based CNNs and hybrid architectures like CNN-LSTM models have further improved classification performance by capturing both spatial and temporal patterns in medical data [6]. Recent studies have also explored the use of multimodal data, where MRI scans are combined with additional patient information such as clinical test results or sensor-based mobility data. This integration has been shown to boost diagnostic accuracy and provide a more comprehensive view of patient health. Another emerging direction is the use of recommendation systems alongside diagnostic models, offering personalized treatment options based on predicted disease progression [7].

Despite these advancements, significant challenges remain. Most existing studies rely on relatively small or imbalanced datasets, which raises concerns about overfitting and reduces the generalizability of results. In addition, many of these models are not yet incorporated into clinical workflows, limiting their practical utility in real-world healthcare environments.

II. PROPOSED METHODOLOGY

A. Flowchart

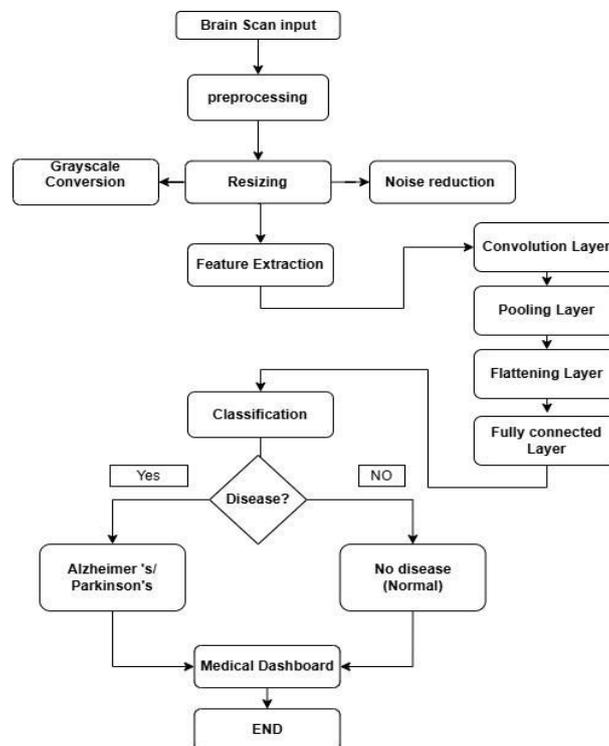


Fig. 2.1

B. Comparison with other studies

In the study by Balaji et al. (referenced in the MDPI paper), a hybrid CNN-LSTM architecture was developed to classify MRI scans into categories of Alzheimer's and Parkinson's disease. While the model demonstrated promising results with an accuracy of 80.5%, it faced significant limitations due to the small dataset size of only 450 images. This constraint led to issues of overfitting and limited the model's generalizability to new, unseen data. Additionally, the study did not include a user interface, making the model less accessible for practical clinical use.

In contrast, our proposed model is trained on a larger and more balanced dataset containing over 8,000 MRI images categorized into Alzheimer's, Parkinson's, and Healthy (Control) classes, reducing the risk of overfitting and improving generalization. We utilize a custom CNN-based architecture optimized for performance and robustness in medical image classification. Moreover, our model is integrated into a Streamlit-based web application, enabling real-time predictions through an intuitive interface. This makes the system not only more accurate but also more user-friendly and readily deployable in real-world healthcare environments. Hence, our model bridges the gap between deep learning advancements and their practical application in neurological disease diagnosis.

III. IMPLEMENTATION**A. Model Overview**

The proposed system applies a Convolutional Neural Network (CNN) for the multi-class classification of brain MRI scans into three categories: Alzheimer's disease, Parkinson's disease, and healthy (control). CNNs are particularly effective for image-related tasks because they automatically extract spatial features through convolutional layers. Our model was implemented using TensorFlow and trained on a labelled dataset of MRI images.

The architecture consists of multiple convolution and pooling layers that capture both low-level and high-level image patterns. To improve generalization, the design incorporates techniques such as batch normalization and dropout. The extracted features are passed to fully connected layers, followed by a SoftMax classifier that produces the probability distribution across the three classes. Training was carried out using categorical cross-entropy loss, optimized with the Adam optimizer, which adapts learning rates for efficient convergence.

B. Dataset Description

The dataset used in this study was sourced from a publicly available collection on Kaggle [8]. It includes MRI scans of patients diagnosed with Alzheimer's disease, Parkinson's disease, as well as healthy individuals. The dataset is organized into training and testing subsets, each containing three folders corresponding to the respective classes. Training set: 4,105 images (639 Alzheimer's, 906 Parkinson's, 2,560 Control) and Testing set: 5,750 images (639 Alzheimer's, 61 Parkinson's, 3,050 Control). This organization supports supervised learning, allowing the model to learn distinct class patterns and then be evaluated on unseen samples. The class imbalance, particularly in Parkinson's images, was addressed through data augmentation techniques such as resizing, grayscale conversion, and random transformations, which help improve model robustness.

C. Deployment Framework

To ensure practical usability, the trained CNN was integrated into a web-based application built with Streamlit. This interface enables healthcare professionals and researchers to upload MRI scans and instantly receive predictions regarding the likelihood of Alzheimer's, Parkinson's, or no disease. The deployment step bridges the gap between research and clinical use, making the model accessible to non-technical users while maintaining reliability.

IV. RESULT AND DISCUSSION

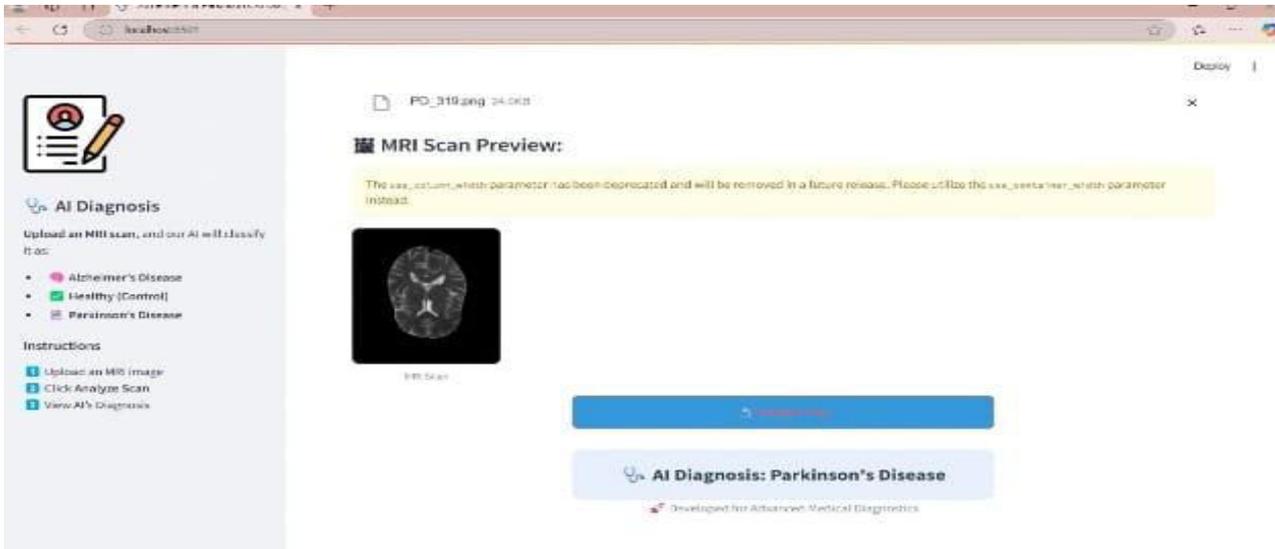


Fig. 4.1 Parkinson Disease Prediction

As shown in Figure 4.1, our model took an MRI brain image as input has analysed the given MRI image and detected it as Parkinson's disease (PD). The AI-powered model processes the uploaded image using deep learning techniques, identifying patterns and abnormalities associated with Parkinson's.

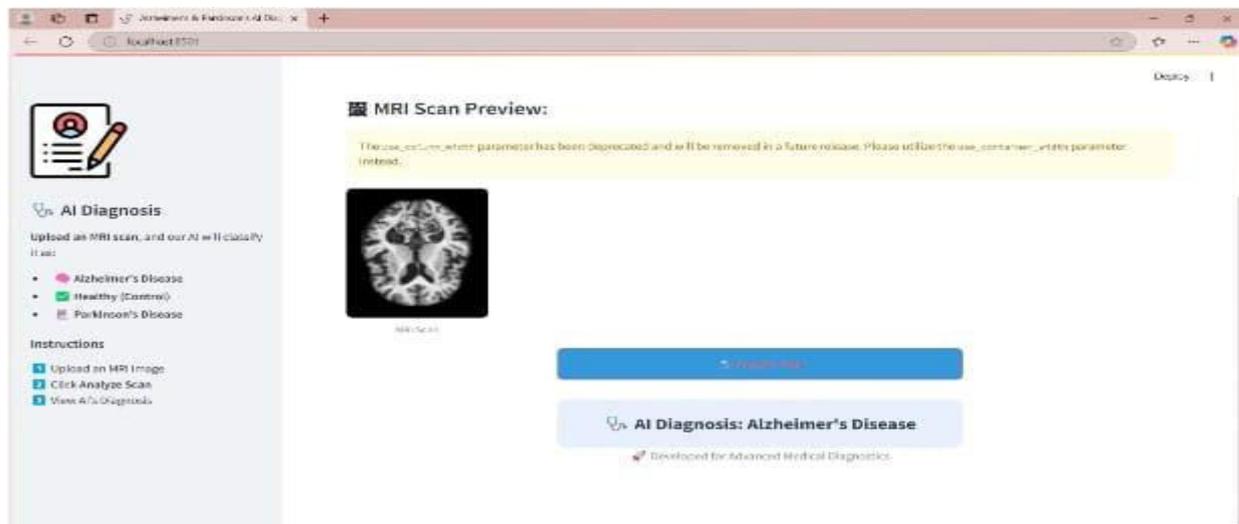


Fig. 4.2 Alzheimer Disease Prediction

In the fig. 4.2, the system analysed the MRI image and predicted the presence of Alzheimer's disease (AD). The deep learning model successfully identified the characteristics of Alzheimer's in the brain scan. Our model has achieved an overall accuracy of 82 percent, making it a reliable tool for assisting in early disease detection. The user-friendly interface ensures seamless interaction, providing accurate and quick results to support early diagnosis and medical decision making.

The proposed CNN model was evaluated on the test set of brain MRI images to classify patients into three categories: Alzheimer's disease, Parkinson's disease, and healthy control. The system allows users to upload MRI scans through

the deployed interface and instantly obtain predictions. Along with the predicted label, the interface can also display the uploaded MRI for better visualization of the output. In terms of performance, the CNN achieved an accuracy of above 82%, which is consistent across multiple evaluation metrics such as precision, recall, and F1-score. These results demonstrate that the model is effective in distinguishing between overlapping neurological conditions. The lowest loss values were observed with the CNN configuration, highlighting its robustness compared to alternative approaches. Although the results are promising, certain limitations remain. The relatively small number of Parkinson's disease images in the dataset may have influenced model generalization for that class. Nevertheless, data augmentation helped reduce imbalance to some extent. Future work can address this by using larger and more balanced datasets to further enhance classification performance.

V. CONCLUSION

This study presented a deep learning-based system for the early detection of Alzheimer's and Parkinson's diseases using brain MRI scans. A custom CNN architecture was developed and trained on a publicly available dataset to classify images into three categories: Alzheimer's, Parkinson's, and healthy. The model achieved strong accuracy and evaluation metrics, demonstrating its potential as a reliable diagnostic aid. To make the system practical for real-world use, the model was integrated into a Streamlit-based application that enables healthcare professionals and researchers to easily upload MRI images and receive instant predictions. This feature makes the system both accessible and user-friendly. In the future, the work can be extended by incorporating multimodal data such as patient history, genetic markers, or cognitive test results. Additionally, sequential MRI data could be used to track disease progression over time, enabling continuous monitoring and personalized treatment planning. Such enhancements would not only improve diagnostic accuracy but also increase the system's clinical value.

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