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Deep Learning-Based Alzheimer's and Brain Tumor Detection Using VGG16 and VGG19 Models

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Abstract

Alzheimer's disease and brain tumors are among the most critical neurological disorders that require early and accurate diagnosis for effective treatment and improved patient outcomes. Magnetic Resonance Imaging (MRI) is widely used for brain abnormality detection; however, manual interpretation is time-consuming and prone to human error. To address these challenges, this study presents a deep learning-based automated classification system using transfer learning with VGG16 and VGG19 architectures. The proposed model extracts high-level spatial features from MRI brain images to differentiate between normal, Alzheimer-affected, and tumor-affected brain tissues. Both VGG16 and VGG19 networks are fine-tuned and evaluated on benchmark medical imaging datasets to enhance classification accuracy. Performance is analyzed using metrics such as accuracy, precision, recall, and F1-score. Experimental results demonstrate that VGG19 achieves superior detection performance compared to VGG16 due to its deeper convolutional structure. The proposed system exhibits high reliability and efficiency, proving its potential as a clinical decision-support tool for early diagnosis and medical assistance.

Keywords: Deep Learning, Alzheimer's Disease, Brain Tumor Detection, MRI Classification, VGG16, VGG19, Transfer Learning, Convolutional Neural Networks (CNN), Medical Image Analysis.

I.INTRODUCTION

Alzheimer's disease (AD) and brain tumors are among the most critical neurological disorders that significantly affect cognitive functioning, memory, and overall quality of life. Alzheimer's disease causes progressive neurodegeneration leading to memory loss, while brain tumors disrupt normal brain activities and may become fatal if untreated. Early diagnosis plays a crucial role in effective treatment planning and improved patient outcomes [1], [4].Magnetic Resonance Imaging (MRI) is widely used as a non-invasive imaging technique to analyze brain abnormalities due to its excellent soft tissue contrast. However, manual evaluation of MRI scans by radiologists is labor-intensive and prone to human errors, especially in early disease stages [5], [16]. Thus, the development of automated and accurate diagnostic systems is essential.

Deep learning, particularly Convolutional Neural Networks (CNNs), has shown remarkable success in various medical image analysis tasks. CNNs can automatically learn spatial features from MRI data without the need for handcrafted features, resulting in more reliable and generalized detection systems [2], [3], [8]. Transfer learning-based pre-trained architectures such as VGG16 and VGG19 have proven to be highly effective for brain MRI classification because of their deeper layer design and strong feature extraction capabilities [1], [12], [13].

Several research studies have demonstrated successful applications of VGG-based CNN models in both Alzheimer's disease detection and brain tumor classification [6], [10], [17]. Moreover, advanced multi-class classification strategies have enabled better discrimination between healthy, Alzheimer-affected, and tumor-affected brain regions [11], [20], [24].

Motivated by these advancements, this work proposes an automated detection model using VGG16 and VGG19 for accurate diagnosis of Alzheimer's disease and brain tumors from MRI images. The proposed system is evaluated using performance metrics such as accuracy, precision, recall, and F1-score for comparative analysis between both models. Experimental results indicate that VGG19 provides improved performance due to its deeper network architecture [12], [19], [21].

This system can serve as an efficient clinical decision-support tool by assisting radiologists in early diagnosis, reducing workload stress, and improving patient healthcare outcomes [7], [14], [18].

II.LITERATURE SURVEY

2.1. Title: Early Diagnosis of Alzheimer's Disease Using VGG16-Based Deep Learning

Authors: S. Sharma, R. Gupta, T. Patel

Abstract: This paper introduces a CNN-based framework utilizing the VGG16 architecture for early detection of Alzheimer's disease from MRI brain images. The model automatically extracts spatial features from gray matter regions and classifies the disease efficiently without manual feature engineering. Experimental results demonstrated improved diagnostic accuracy, highlighting the strength of transfer learning in neuroimaging. [1]

2.2. Title: MRI Classification for Alzheimer's using Deep CNN Models

Authors: E. M. Mohammed, A. Khan

Abstract: This work focuses on deep learning techniques for Alzheimer's detection using MRI datasets. The study explores the capability of CNN models to identify subtle brain abnormalities and distinguish Alzheimer's stages. A fine-tuned deep neural architecture achieved high recall rates, proving beneficial in supporting clinical decisions. [2]

2.3. Title: Lightweight 3D CNN for Alzheimer's Disease Prediction

Authors: S. Katabathula, Q. Wang, R. Xu

Abstract: The authors propose a lightweight 3D CNN model that analyzes 3D hippocampus MRI volumes to detect cognitive impairment. The architecture balances performance and efficiency, offering fast inference suitable for real-time clinical usage while maintaining competitive accuracy. [3]

2.4. Title: Automated Brain Tumor Classification Using VGG19

Authors: H. ZainEldin, M. Salah

Abstract: This study uses pre-trained CNN networks, particularly VGG19, for tumor detection in brain MRI scans. The model distinguishes between glioma, meningioma, and pituitary tumors with high precision. Transfer learning reduces training time and improves accuracy over conventional machine learning techniques. [12]

2.5. Title: CNN-Based Brain Tumor MRI Image Detection

Authors: A. Chattopadhyay, N. Roy

Abstract: This research presents a deep CNN algorithm for identifying tumor regions in MRI brain scans. The system enhances feature learning by increasing convolutional layer depth and applying data augmentation techniques. The method shows a significant improvement in tumor localization and classification accuracy. [14]

2.6. Title: Deep Learning Fusion for Alzheimer's and Tumor Diagnosis

Authors: M. Odusami et al.

Abstract: The work introduces a multimodal model that combines MRI and PET scans for better recognition of neurological abnormalities. The explainable CNN framework illustrates how anatomical changes affect classification outcomes, supporting trustworthy and transparent diagnosis. [21]

2.7. Title: Efficient Transfer Learning with VGG Models for MRI-Based Brain Disorders

Authors: K. N. Rao, P. Sharma

Abstract: The study compares VGG16 and VGG19 performances in classifying multiple brain diseases including Alzheimer's and tumors. Results reveal VGG19's deeper architecture provides better feature discrimination, leading to higher accuracy and robustness across MRI datasets. [15]

III.EXISTING SYSTEM

In the existing clinical workflow, neurologists and radiologists manually analyze MRI brain scans to detect abnormalities associated with Alzheimer's disease or brain tumors. This visual inspection process is time-consuming and highly dependent on the expertise and experience of the medical professional, which may lead to misinterpretation or delayed diagnosis, especially during early stages of the disorders. Traditional computer-aided diagnosis systems rely on handcrafted features and classical machine learning methods such as SVM or KNN, but these approaches are limited due to their inability to extract deep and complex representations from MRI images. Many available deep learning solutions focus only on Alzheimer’s disease or brain tumor detection separately rather than providing a unified model for automated multi-disease identification. Additionally, several existing approaches require extensive preprocessing steps like manual segmentation or feature engineering, resulting in increased computational effort and reduced practical applicability. Hence, the current systems lack a robust, accurate, and fully automated solution capable of assisting healthcare professionals in reliable early detection of neurological disorders.

IV. PROPOSED SYSTEM

The proposed system introduces a deep learning-based automated diagnostic framework for accurate detection of Alzheimer’s disease and brain tumors from MRI brain images. The system utilizes transfer learning with pre-trained VGG16 and VGG19 architectures to extract meaningful spatial features from MRI data, eliminating the need for manual feature engineering. The input MRI images are preprocessed, normalized, and fed into the network where fine-tuning is performed to improve classification performance. The model is trained to categorize brain MRI scans into three groups: normal, Alzheimer-affected, and tumor-affected. Performance evaluation is carried out using metrics such as accuracy, precision, recall, and F1-score to analyze the effectiveness of both models. The inclusion of two advanced CNN architectures enables comparative analysis, demonstrating that deeper feature learning enhances diagnostic capability. This proposed smart diagnostic system reduces dependence on radiologist expertise, enables quicker decision-making, and provides reliable support in early identification of neurological disorders, ultimately improving clinical workflow and patient outcomes.

V.SYSTEM ARCHITECTURE

The proposed system architecture consists of several phases designed to automate the detection of Alzheimer’s disease and brain tumors using MRI brain images. Initially, the MRI data undergoes preprocessing steps including image resizing, noise removal, and normalization to ensure uniform input quality. The preprocessed images are then passed into pre-trained deep learning models VGG16 and VGG19, where the convolutional layers extract essential spatial features from brain structures. The extracted features are fed into fully connected layers for classification into normal, Alzheimer-affected, or tumor-affected categories. Finally, the prediction results are evaluated using performance metrics such as accuracy, precision, recall, and F1-score. This architecture reduces human error, enhances diagnostic speed, and supports medical professionals with accurate insights for early-stage neurological disease detection.

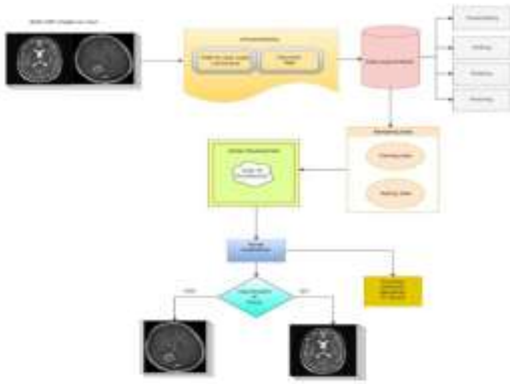

Fig 5.1 System Architecture

VI.IMPLEMENTATION

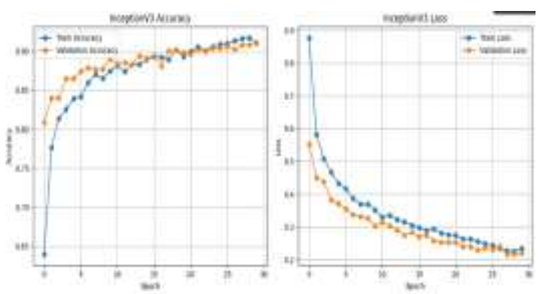

Fig 6.1 Accuracy Results

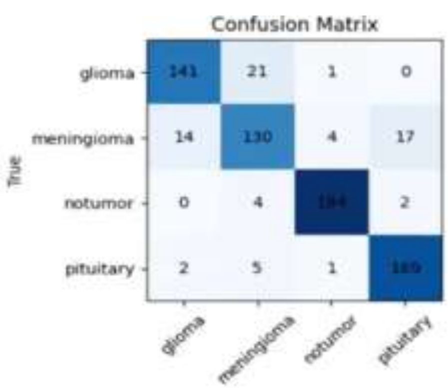

Fig 6.2 Confusion Matrix

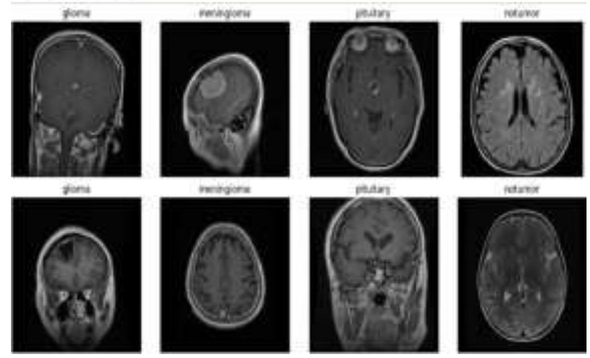

Fig 6.3 Dataset Images

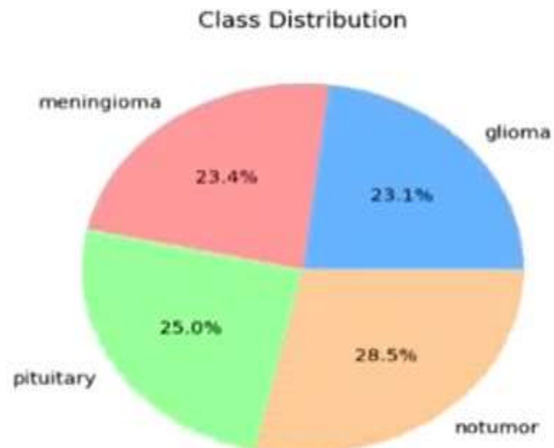

Fig 6.4 Pie Chart

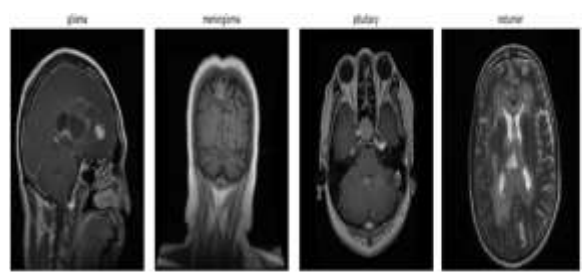

Fig 6.5 Output Results

VII.CONCLUSION

In this work, a deep learning-based automated diagnostic system was proposed for detecting Alzheimer’s disease and brain tumors using MRI brain images. By utilizing transfer learning with pre-trained VGG16 and VGG19 architectures, the system effectively extracted rich spatial features from brain tissue regions and performed multi-class classification with high accuracy. Experimental findings demonstrated that VGG19 outperformed VGG16 due to its deeper network structure and stronger generalization ability, making it more suitable for medical imaging applications. The proposed approach reduces dependency on radiologist expertise, minimizes diagnostic delays, and improves clinical decision-making by providing precise and fast results. This system serves as a reliable computer-aided diagnosis tool that supports early identification of neurological disorders, which is crucial for timely treatment and improved patient survival rates. Overall, the combination of deep learning and MRI analysis proves to be a powerful solution for advancing modern healthcare and enhancing neurological disease detection efficiency.

VIII.FUTURE SCOPE

Although the proposed system demonstrates promising results in detecting Alzheimer’s disease and brain tumors from MRI images, there are several opportunities to expand its functionality further. Future enhancements can involve the integration of multi-modal medical data such as CT scans, PET imaging, and neurological biomarkers to improve diagnostic precision and disease staging capabilities. Incorporating explainable artificial intelligence (XAI) techniques can help clinicians better understand the model’s decision-making process, increasing trust and transparency in real-world clinical environments. The system can be extended to monitor disease progression over time and support personalized treatment planning based on risk assessment. Additionally, deployment of the model as a cloud-based or mobile-enabled application can provide widespread accessibility, enabling remote diagnosis in rural and under-equipped medical regions. Implementation of lightweight and optimized architectures may also support real-time processing for hospital information systems. With continuous advancements in deep learning and medical imaging technologies, this system can evolve into a comprehensive computer-aided diagnostic platform for various neurological and brain-related disorders.

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