

Enhanced transfer learning technique for the diagnosis of Alzheimer's disease through mri image analysis

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Abstract—This paper presents a comprehensive study on cognitive analysis techniques and the implementation of machine learning models to detect Alzheimer's Disease (AD) at an early stage. With the increasing prevalence of AD globally, early detection has become crucial to managing the disease progression effectively. The proposed methodology leverages neuroimaging datasets and cognitive metrics with a refined preprocessing pipeline, enabling better model accuracy. Various existing systems are reviewed, and a novel system design is proposed using a hybrid learning model. The results indicate substantial improvements in detection precision, demonstrating the potential of AI-driven approaches in the medical diagnostic domain.

Index Terms—Alzheimer's Disease Detection, Cognitive Assessment, Machine Learning in Healthcare, Deep Learning Models, VGG-19 Architecture, Neuroimaging Analysis, MRI-Based Classification, Hybrid Learning Model

I. INTRODUCTION

Alzheimer's Disease is a chronic neurodegenerative condition that affects memory, thinking skills, and the ability to carry out simple tasks. It is the most common cause of dementia and is currently incurable. Early diagnosis can significantly slow down the progression of the disease and improve the quality of life of patients. The emergence of artificial intelligence, particularly machine learning (ML), in healthcare has opened new avenues for disease detection and monitoring. Cognitive tests, neuroimaging, and genetic data provide rich sources of information, which, when processed appropriately, can offer critical insights into early AD detection. This

study explores the application of ML techniques in AD diagnosis. We analyze multiple systems and propose a novel architecture aimed at improving detection rates using optimized data preprocessing and a hybrid model approach. Memory is the most basic thing in everyday life. The ability to think, learn or recall information will be dependent on memory. Dementia is the loss of the ability to recall things. This often happens with aging but not to the level of forgetting everything. This condition of declining cognitive function is called Dementia. Alzheimer's disease (AD) is a neurological illness with a protracted incubation period that is frequently seen in older persons. The patient's memory and cognitive functions steadily deteriorate as the disease progresses over time, his or her neurons are gradually destroyed, and the patient finally passes away [1]. In most cases, the disease is late onset type symptoms that do not present until a person is in their mid-60s. Due to Alzheimer's, some symptoms are arising such as memory loss and increased confusion, inability to pick up new skills, Language difficulties and writing, numbers and reading, having trouble thinking logically and arranging your thoughts, and Difficulties adjusting to novel circumstances. According to hypotheses, the abnormal protein builds up in and around brain cells causing Alzheimer's disease. One implicated protein is amyloid, and deposits form plaques surrounding the brain cells. Within the brain cells, tau, the other protein, produces tangles. In the brain age-related changes, along with genetic, environmental, and lifestyle factors, are

likely contributing factors to this disorder. Each element's importance depends on how likely an individual is to develop Alzheimer's disease.



Fig. 1. home page for sign up

The entorhinal hippocampus, cortex, and initially, memory-related brain areas suffer damage. Later, it impacts the cerebral cortex's language, thinking, and social behavior. Gradually, numerous additional brain regions suffer damage. For those with Alzheimer's, some prevention needs to be taken, such as stopping smoking, not taking alcohol, balancing their diet, eating healthy, and consuming a few vegetables and five portions of plants daily. Every week exercise for a minimum of 150 minutes by doing an aerobic activity with moderate intensity like fast walking or cycling or any other exercise that you can do regularly. Other preventions like mental stimulation, stress management, social engagement, quality sleep, a healthy diet and vascular health are needed.

Identifying if a person has Alzheimer's disease in the existing system is challenging. They use only the patient's clinical history and knowledge of any inherited disorders to determine this. To detect the disease a few times, it is possible that the doctor may not be able to diagnose. Alzheimer's disease is a kind of dementia defined by advancing cognitive and behavioural issues that begin in old or middle age. In daily life, the symptoms usually develop slowly and get severe enough. Although age is the leading risk factor, AD is not just an old condition. Early memory loss is moderate. However, subsequent memory loss significantly impairs the patient's ability to answer questions and carry on a conversation. While Alzheimer's disease (AD) cannot currently be cured, early detection can lessen the illness's effects and improve the standard of living for patients. According to reports, lots of people impacted by AD will quadruple in the next 20 years, reaching 1 out of 85 people by 2050. Therefore, a proper diagnosis is crucial; especially early in the development of AD. The purpose of the project is to create a model for predicting the disease at an early stage possible, so that the disease can be cured and can save many lives, to give a reliable tool. This tool is developed using VGG classifier.

II. LITERATURE REVIEW

Using a machine learning algorithm many authors are working on finding the prediction of Alzheimer's disease. Due to the extra time and complexity of Alzheimer's disease, more authors are working to find the prediction for that disease. Many authors give a prediction for Alzheimer's disease by using various classifiers and machine learning. Emotional deficits characterise the clinical pathology of dementia. Dynamic and functional deficits represent the clinical disease dementia. Deterioration in memory, judgement, language and perceptual interpretation are typical symptoms that impact everyday life and quality of life. The most common kind of dementia (62 percentage of cases) is Alzheimer's disease (AD), which primarily affects older adults. Specific combinations of these symptoms distinguish different kinds of dementia. However, the reported numbers are also rising globally and in the UK among those under 65. Two of the earliest symptoms of AD that patients can recognize are loss difficulties learning new material and episodic memory[1].

Automatic detection of Alzheimer's disease : Using various methods, we can automatically detect the Alzheimer's disease. In this paper we use machine learning algorithm (SVM, DT) to predict Alzheimer's disease. History of ML for brain related diseases: The diagnosis of Alzheimer's can be confirmed or ruled out using brain scans; brain scans should be performed using magnetic resonance imaging (MRI), positron emission tomography (PET), or computed tomography (CT). There are various diseases related to brain such as Alzheimer's disease, brain malformations, brain tumours, concussion, Cerebellar disorders, dementia and so on. Previously doctors need lots of time to predict whether the people have Alzheimer's disease or not? And that process is very complex. Now machine learning is the technique from where we can easily predict the Alzheimer's disease. First, we want to upload the dataset means the age, group, MMSE and other data of the patient for the prediction of Alzheimer's disease. The dementia type that is most common is Alzheimer's disease (AD), which has a complex aetiology that makes treatment largely ineffective. In order to find alternative disease-modifying medicines that can stop the progression of the disease, a thorough understanding of the main pathogenic pathways and new biomarkers is required. Due to its possible neuro toxic effect, iron, a key component of brain metabolism, is linked to neurodegeneration.[2]

Application of ML for brain related disease . Here in this project, we study the brain related disease is Alzheimer's disease. Using machine learning we can easily predict the Alzheimer's disease because of that doctors can save their time and easily they can detect the disease. We explicitly show why machine learning

in brain disorders is grabbing the interest of academics and clinicians by focusing on three critical applications: prediction of sickness onset, assistance with diagnosis, and prediction of longitudinal outcomes. Machine learning approaches can help researchers address a variety of issues, including those in neurology, by identifying[3].

Methods on the basis of Cognitive AD Screening :On cognition is the process through which someone uses knowledge they have already gathered to guide their behaviour. Although there are many domains of cognition, these studies focus on those that are impacted by Alzheimer's disease. Six cognition domains were identified by the American Psychiatric Association as being compromised by AD.Complex attention: sustained, selective attention, divided i.e., the ability to keep one's attention on a stimulus while focused on two at once or on a single stimulus when other stimuli are competing for it. Executive function, which includes mental flexibility, responding to feedback, working memory,decision-making, and planning.Memory and learning: short-term, long-term, and extremely long-term. Autobiographical memory is a part of both very long-term memory and recent.Understanding and expression in language.Perceptual-motor skills include the ability to recognize faces or objects by their faces or by their shapes or colours. Social cognition: the capacity to recognise the emotions of others.[4]

Methods on the basis of Problem-Solving Tasks:The most widely used techniques that test individuals' cognition to look for a cognitive impairment are those based on questions and problem-solving activities. Doctors most frequently employ these techniques. In a comparison of these techniques, Cordell et al. present the MMSE,Saint Louis University Mental Status (SLUMS), or Mini-Cog test.One among the most recognisable and often utilised tests is the Mini Mental State Examination (MMSE). Attention; registration, computation, Orientation, memory, name, repetition, comprehension, writing, and building are among the ten domains covered by the MMSE's twenty problems. The two that matter the most out of these are direction and attentiveness.[5].

Methods on the basis of Visual or Auditory Tasks:Visualizing visuals is necessary for the Visual Association Test (VAT), which tests memory for connected objects. The participants then had to remember which thing or animal was absent from a new set of six photographs. The Dichotic Listening Test (DLT) measures the frequency of the right ear when individuals with Alzheimer's disease memorise sounds.Two single-digit numbers, such as 1 on the right and 8 on the left, are simultaneously played in each participant's ear to achieve this goal. The participants must then remember every number after this process is carried out six times with new numbers. Both ears are often equally remem-

bered by healthy people, however right ear dominance is seen in AD patients.[6]

Methods on the basis of Emotional and Social Tasks:Changes in attitude or behaviour, a decline in empathy, or a reduced capacity for facial expression recognition are examples of associated symptoms. The relationship between the decline in older persons' capacity for emotion perception and their degree of cognitive impairment was examined by Virtanen et al.Aged 35 to 55; their participant group must complete the Facial Emotion Recognition Test(FERT) and MMSE. The most recent asks participants to name six fundamental emotions. There are three levels of intensity for each emotion, with the exception of neutral. The participants are shown a total of 160 photos. A significant association between MMSE and the FERT's accuracy in identifying emotions was shown [7].

Challenges in machine learning to select classifier:There are various machine learning classifiers Decision Tree, Naive Bayes, Perceptron,Support vector machine, and so on. But to predict Alzheimer's disease, we get less accuracy for perceptron, decision tree classifier, and naive Bayes. In this paper we are using the classifier decision tree and support vector machine. We get a more accuracy for support vector machine, so we are used it in this paper. With the other classifier we are facing the complexity, time and accuracy[8].

a)Complexity:With the various classifier's it is very complex to detect Alzheimer's disease. So in this paper we use VGG19 classifier so that the process will make easy.b)Time : Previously we see that for prediction of Alzheimer's disease it takes lots of time. For the doctor to predict disease it is very time taking and complex procedure.c)Accuracy: We have to get more accuracy for Support Vector machine classifier comparing with other classifier.For the recommendation of Alzheimer's disease there are various techniques[9].

By using C,C++, Java, Python, MATLAB we can predict a Alzheimer's disease. But the process is complex so we use python for this paper. Python is easy to understand, free and open source, easy to code and all its libraries are easily available.Virtual Environment on the basis of AD Screening Methods Due to recent advancements in Virtual Environments (VES), computer technology, have begun to be used in diagnostic procedures and rehabilitation treatments. To assist in the use of virtual reality for neuro psychological testing, numerous strategies have been presented. In the authors test healthy controls' learning and memory skills while they move using a head-mounted VR system about a virtual environment.[10].

The brain considered the link between cholesterol molecules and oxidized Alzheimer's disease from a previous study. Limited data on the relationship between

Alzheimer's disease and oxidized cholesterol in the brain is available. For Alzheimer's and dementia disease, a high-cholesterol diet and its oxidized forms have been linked to hyper cholesterolemia, one of the significant risk factors. Increased inflammation and endogenous oxidative processes can result from oxidized cholesterol since it can be absorbed in the small intestine and pass the blood-brain barrier. Foods made from animals are sources of oxidized cholesterol, which starts to happen right after the animal is killed and continues at the time of processing and storage. Key messages: The number of oxidized cholesterol compounds may be significantly increased by high-heat food preparation and refrigerator storage of prepared foods before reheating[11].

As a result, the most preventive diet is high in plants with antioxidant qualities and low in cholesterol oxidation products. This diet should be adopted as soon as feasible. Older adults with moderate cognitive impairment (MCI) must have their risk of acquiring Alzheimer's disease (AD) properly anticipated for societal and therapeutic reasons. Recently, we created a polygenic hazard score (PHS) that went above and beyond APOE to indicate the age of AD onset. With data from the Alzheimer's disease neuroimaging initiative (ADNI), we looked into PHS's possible clinical relevance in predicting AD onset in older people with MCI[12].

We looked into the ability of PHS, both alone and in combination with baseline structural magnetic resonance imaging (MRI) data, to predict performance on the Mini-Mental State Examination (MMSE). In survival studies, PHS considerably outperformed APOE alone in predicting the time it would take for MCI to develop into an AD over 120 months. When compared to models without PHS, the addition of baseline MMSE and brain atrophy scores to PHS significantly improved prediction. PHS increased the prediction model's area under the curve, accuracy, and sensitivity compared to just using MMSE and atrophy score. These results show the clinical potential of PHS in predicting the risk of AD development in MCI patients, both on its own and in combination with other prodromal disease-related clinical measures, such as evaluations of regional brain atrophy and cognitive function[13].

In a previous study, we developed a machine learning method to predict the three-year conversion to Alzheimer's disease (AD) in people with pre-mild cognitive impairment and mild cognitive impairment. This method is therapeutically practical and incredibly effective (MCI). The actual training process is necessary when applied to issues not used to demonstrate its accuracy for these further tests. We sought to offer preliminary proof of this in our work through a transfer learning approach. To retrain the system to distinguish between persons with AD ($n = 75$) and participants with normal

cognition ($n = 197$), we initially used the same baseline data and machine learning technique in our prior work. The algorithm was then utilized to complete the initial objective of forecasting the three-year conversion to AD in the earlier work in the sample of 61 MCI participants that we used. Results: In the MCI sample the algorithm showed a significant prediction performance even after retraining[14].

These findings offer the first indirect proof that, when applied to new MCI cases, our original approach can also make pertinent generalized, generalized predictions. Those drives further work to improve the algorithm in research and clinical settings to levels of dependability and optimization that will permit its use. We discuss the references above for the prediction of Alzheimer's disease using various machine learning classifiers. In the above, we discuss how the authors recommend a prediction for Alzheimer's disease, which classifier is used and how machine learning is better than the doctors. Alzheimer's is a degenerative neurologic condition that causes the brain to shrink and brain cells to die. The most common form of dementia, Alzheimer's disease affects a person's ability to operate independently and its characterized by a continuous deterioration in social, behavioral, and cognitive capacities[15].

III. METHODOLOGY

A feature selection and extraction technique is used to predict Alzheimer's disease using machine learning techniques, and the classification is done using the basis longitudinal dataset. A brief overview of the various methods used to analyze brain images in order to detect brain illnesses. We take the data from the oasis longitudinal.csv.

We discuss data selection, pre-processing, transformation, Modelling, and evaluation in the proposed methodology. In the health care business, machine learning plays an important role. The healthcare industry has produced a large amount of data that can be used to create a sophisticated and scientific approach to early disease diagnosis. Therefore, specific machine learning algorithms are utilized here to predict Alzheimer's disease and to select the process with the highest accuracy. The algorithm is the Support vector machine and Decision Tree. Python code is used for the implementation

a) Data Selection

For predicting Alzheimer's disease, the selection is a necessary step. In the dataset, we have the age, visits, MMSE scores, group, MRI ID, CDR, ASF, patient educational level, and many other factors of people taken for pre processing. With that values and using the above dataset, we are training VGG-19 algorithms and then comparing their performance in terms of accuracy.

The collection includes longitudinal MRI data from 150 patients, ranging in age from 60 to 96. The dataset for Alzheimer's disease is gathered from and made available on their oasis longitudinal.csv website.

b) Data Pre-processing

Using this module, we will read dataset and then encode non-numeric values in above dataset to numeric and then replace missing values with 0 and then split dataset into train and test part where application used for training 80 percentage dataset and for testing 20 percentage The pre-processing operations required to process the input dataset are all included in this stage. To avoid the curse of dimensionality, we first divide the data into train and test data files and then apply some pre-processing, such as normalization. Few exploratory data analysis is carried out, such as response missing value checks or variable distribution and null

c)

Data Transformation

Memory dysfunction is the most prevalent cognitive sign of early-stage Alzheimer's disease; a person may have trouble recalling material they have just learned. For instance, a person may find it difficult to recall the specifics of a discussion they have just had after a little delay of a few minutes. We will train VGG19 Using this module with 80 percentage training data and then calculate its accuracy by predicting 20 percentage test data. We will train decision tree using this module with 80 percentage training data and then calculate its accuracy by predicting 20 percentage test data.

d) Modelling

Predicted	Actual value	
	Normal Transaction	Fraud Transaction
Normal Transaction	True Negative	False Negative
Fraud Transaction	False Positive	True Positive

TABLE I

CONFUSION MATRIX FOR EVALUATING CLASSIFICATION

Confusion matrix is displayed in the above table and has four values: true positive. True negative, false positive, and, false negative, We investigate accuracy in the model for machine learning. We utilize a confusion matrix because we need accuracy as well as proper classification. A confusion matrix is a NxN matrix that aids in determining how well the machine learning model performs when applied to the classification issue. The confusion matrix comes in four different forms. TP, TN, FP, FN. For categorization by using the confusion matrix, we discuss the precision of the machine learning algorithm. We must generate four alternatives for the confusion matrix.

For categorization by using the confusion matrix, we discuss the precision of the machine learning algorithm.

We must generate four alternatives for the confusion matrix.:

- If the predicted transaction is fraudulent and the actual transaction is fraudulent as well, our accuracy rises..
- If the predicted transaction is fraud but the actual transaction is not, we receive reduced accuracy.
- If the predicted transaction is fraudulent but the actual transaction is not fraudulent, the accuracy falls..
- **Accuracy:**Accuracy is calculated as follows using confusion matrix .

$$\text{Accuracy} = \frac{TP}{TP + FR} \quad (1)$$

- **Precision:**Precision is the ratio of the number of TP classes to the total of FP classes plus TP classes

$$\text{Recall} = \frac{TP}{TP + FN} \quad (2)$$

- **F Score:**is a performance metric used in classification problems, especially when the dataset is imbalanced.

$$F1 = 2 \times \frac{TP}{2TP + FP + FN} \quad (3)$$

d) Existing System

On account of head ways in profound learning and clinical imaging advances, numerous analysts currently use convolutional neural networks (CNNs) to extricate profound level qualities from clinical pictures to all the more precisely order Alzheimer's sickness (AD) and conjecture clinical scores. A minimized profound learning network known as PCANet basically utilizes principal component analysis (PCA) to supply staggered channel banks for the concentrated learning of tests. Blockwise histograms are made to get picture attributes following binarization. The components of the recovered PCANet highlights can move toward many thousands or even many thousands, restricting PCANet's flexibility, and the making of the multifacet channel banks is reliant upon test information.

- **DISADVANTAGES OF EXISTING SYSTEM:**Sample data is required for the creation of multilayer filter banks, which limits PCANet's versatility

IMPLEMENTATION

AD Diagnosis, Deep Learning Techniques:The goal of machine learning, a branch of artificial intelligence, is to provide methods that let machines learn. Machine learning techniques could be used to use data from tests tasks and tests or medical data and

their related classifications, such as healthy or non-healthy subjects, to uncover relationships between data and labels. For instance, VGG19 classifiers can distinguish between the handwriting of Parkinson's patients and healthy individuals. Despite the merits of employing these techniques, cognitive tests continue to be the most popular approach for detecting AD.

- **Data exploration:** This module will be used to load data into the system. Processing: We will pursue information utilizing the module and interact with it. Splitting data into train test Information will be isolated into train and test utilizing this module
- **Model generation:** VGG-19, A convolutional neural network is used for feature extraction and classifying the result. User Register login By using this module, you may register and log in.
- **Train model:** This module produces confusion matrix and performance metrics like accuracy, precision, recall, f-score Prediction: displayed, the ultimate prediction
- **Algorithms:** VGG19 is a deep convolutional neural network (CNN) architecture developed by the Visual Geometry Group (VGG) at the University of Oxford. It is an extended version of VGG16, with 19 layers, including 16 convolutional layers, 3 fully connected layers, and 5 max-pooling layers. VGG19 follows a simple and uniform design, using small 3x3 convolutional filters stacked multiple times to extract hierarchical features from images. This deep architecture enables high accuracy in image classification, object detection, and other computer vision tasks. VGG19 is widely used in transfer learning due to its ability to generalize well across various datasets. It is pre-trained on ImageNet, which allows it to recognize a broad range of objects with high precision. The network is commonly applied in medical image analysis, facial recognition, autonomous vehicles, and artistic style transfer. Despite its effectiveness, VGG19 is computationally expensive due to its large number of parameters (143 million), requiring significant memory and processing power.

RESULTS AND EVALUATION

sign up process with his details first. Then it will show a window it will ask basic details



Fig. 2. home page for sign up

- then you need to login after the sign up with your details



Fig. 3. log in page

- after the login it will show a convolution matrix for the algorithm



Fig. 4. convolution matrix

- it will show the accuracy, precision, recall and f score parameter for measuring performance



Fig. 5. performance metrics

- VGG19 is giving almost 99percentage accuracy which will we use for prediction of Alzheimer disease

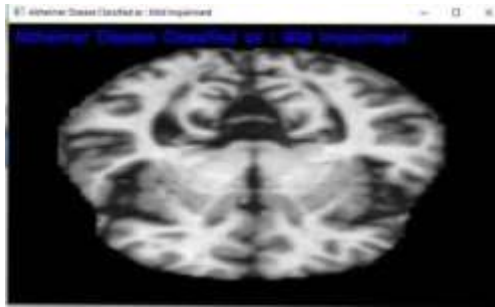


Fig. 6. performance metrics

IV. CONCLUSION

In conclusion, the implementation of VGG19 for Alzheimer's Disease Classification demonstrates the effectiveness of deep learning in medical image analysis. By leveraging convolutional layers and max-pooling, the model extracts complex patterns from brain scan images, aiding in accurate disease detection. The integration of Django for web deployment allows for real-time predictions, making the system user-friendly and accessible. Although VGG19 is computationally intensive, its high accuracy and feature extraction capabilities make it a valuable tool in healthcare applications.

The future scope of this study includes enhancing the VGG19-based Alzheimer's Disease Classification by integrating transfer learning and optimizing computational efficiency. Implementing lightweight architectures like MobileNet or EfficientNet can improve processing speed without compromising accuracy. Additionally, real-time deployment using cloud-based frameworks will enhance accessibility for medical professionals. Future advancements may also explore multi-modal data fusion, incorporating genetic and clinical data to improve diagnostic precision. Furthermore, integrating explainable AI (XAI) techniques will provide better interpretability, ensuring trust and reliability in healthcare applications

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