A SYSTEMATIC REVIEW ON ALZHEIMER’S DISEASE DETECTION USING ARTIFICIAL INTELLIGENCE

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1. ABSTRACT

The most prevalent type of dementia, Alzheimer's disease, affects a disproportionately high percentage of elderly people (AD). Given the prevalence of metabolic diseases like Alzheimer's and Diabetes, it is not surprising that researchers are investigating the use of machine learning to diagnose these conditions. The fact that they are happening more frequently each year is alarming. The underlying cause of Alzheimer's disease is neurodegeneration, which causes changes in brain structure and function. The financial, social, and economic repercussions will be devastating. Experts in the field of sickness prediction agree on one thing: the prognosis of Alzheimer's disease is notoriously difficult to forecast. Researchers have found that administering Alzheimer's disease medication early on in the disease's course yields better results and fewer side effects later on. Numerous methods have been applied to the issue of parameter optimization for Alzheimer's disease prediction. These techniques include Gradient Boosting, Support Vector Machine, Random Forest, and Decision Tree. With this study, we aimed to take stock of the current state of deep learning AD detection techniques. We present the most recent findings and developments in this domain based on a thorough literature review of over a hundred articles. In this article, we discuss single-modality and multi-modality neuroimaging data, as well as valuable biomarkers and features, pre-processing methods, and varied techniques to dealing with neuroimaging data. A comprehensive analysis of the performance of deep models is provided. For all of deep learning's success in Alzheimer's disease diagnosis, there are still substantial limitations, notably in terms of dataset availability and training techniques.

2. INTRODUCTION

Alzheimer's disease is most recognized by the decline in mental faculties that it causes. Experts estimate that this contributes to as much as 80% of all cases of dementia in the elderly. Despite an increase in public knowledge of the disease in recent years, there is currently no cure for Alzheimer's. Since dementia is one of Alzheimer's disease's symptoms and is frequently misdiagnosed, a diagnosis may take a long time. Mild cognitive impairment (MCI) is a term used to describe people who have Alzheimer's disease (AD) in its early stages; however, only 30–40% of people with MCI will go on to acquire AD. Patients have structural abnormalities in the brain that are indicative of AD before cognitive decline begins, such as atrophy of the hippocampus and amygdala and enlargement of the lateral ventricles. Brain atrophy is a common finding in research looking for Alzheimer's disease biomarkers. This emphasizes the significance of a timely and accurate diagnosis of Alzheimer's disease.[1]

Despite the challenges, computer-aided technologies that classify medical images have greatly improved clinical diagnosis. Computerized Tomography (CT) is Used (CT),[2] Using Structural MRI for Imaging (MRI), [3] joint use with positron emission tomography (PET) [4] When trying to diagnose neurodegenerative diseases, MRI and CT scans are the imaging gold standards (PET). Scanning using a CT scanner doesn't take long, and the produced image is of high quality. It can help doctors diagnose a variety of conditions. However, MCI is frequently misinterpreted or disregarded as a normal component of aging due to the poor resolution of the middle lobe. Pet uses transmission scanning technology to improve sensitivity and resolution while also eliminating the effect of tissue attenuation on the final image. MRI scans provide you a glimpse into the inner workings of the human body. Rapidly fluctuating gradient magnetic fields allow for faster MRI scans, higher resolution in soft tissues, and shielding from dangerous ionizing radiation. A necessary initial step in the process of classifying images is to extract relevant characteristics. Normal investigations necessitate researchers purposefully exclude AD components like the hippocampus and amygdala, even though frontotemporal lobe atrophy is a prominent diagnostic marker of AD. Personal inspection of the hippocampus was employed by De Flores and La Joie to differentiate between healthy old and those with intermediate Alzheimer's disease. Although voxel-based morphometric (VBM) has been found to be more accurate than ROI-based approaches in predicting hippocampal volume, it is still challenging to achieve an optimal amount of inter-voxel interaction. The need for physical labor introduces constraints and error potential.

As AI has advanced, researchers have begun to focus more on using computer vision for AD diagnosis. If you're looking for a solution to the issues plaguing conventional approaches, go no further than deep learning, the most prominent subfield of machine learning. A more recent advancement is the automatic feature extraction from medical photos using deep learning to identify Alzheimer's disease.[5]

ALZHEIMER’S DISEASE

Kraepelin described a group of persons with exceptionally severe cellular abnormalities in the ninth edition of Clinical Psychiatry: A Textbook for Students and Physicians (1910). Large areas of the brain's cortex were removed, and they were replaced by bands of neurofibrillary tangles in various colours. In these cases, an abnormally high number of plaques was seen.[6] Kraepelin first used the term "Alzheimer's disease" to characterise the condition in the early stages of Alzheimer's disease (AD) diagnosis. The first case of August Deter illness was documented by German physician Alois Alzheimer in 1906, however the initial diagnosis was not entirely accurate. However, it wasn't until much later that plausible theories to explain AD's clinical description emerged. Dr. Alois Alzheimer first described Alzheimer's disease in 1907, and later, in 1909, Proskin described the characteristic "senile plaques" and "neurofibrillary sections" of the disease. [7] Arteriosclerosis was thought to be a part of the patient's diagnosis, but when a clinical study of the brain was conducted, no major symptoms of arteriosclerosis were identified. In 1998, scientists from the Max Planck Institute for Neurobiology in Martinsried and the University of Munich presented a study demonstrating the distinct danger posed to specific regions of the brain by neuro fibrillary cramping and amyloid plaques.[8] The findings of this study are now recognized as the first documented instance of AD, and the patient in question matches the diagnostic criteria for the disease as it is now understood.

F. Johan's brain tissue, preserved in histology wax, was studied by Dr. Gerber and his colleagues at the Max Planck Institute of Neurobiology in 1997, after it had lain undisturbed for almost 90 years. According to the study, this was only the second documented instance of AD. Multiple amyloid plaques were seen in the wounds. Based on what we already know, it should be possible to do mutational analysis on archived brain tissue. Dr. Alzheimer's major discovery has been reiterated on the occasion of its centennial. In Figure 1, we can see side-by-side images of the normal brain and the AD brain.

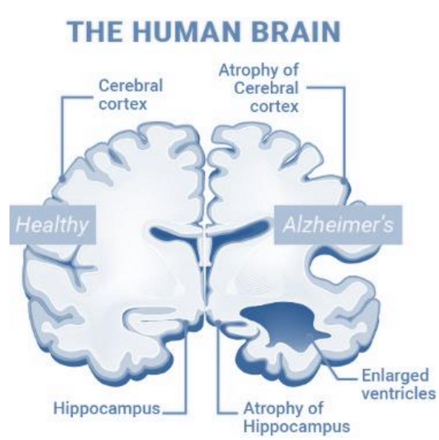

Figure 1.comparision of normal brain and AD brain.

According to recent data, AD is the sixth most common cause of mortality in the United States. Recent research suggests this condition may be the third biggest cause of mortality in the elderly, just behind cardiovascular disease and cancer. [9] It's obvious that slowing or stopping AD's development from the beginning would be a huge benefit to society. Multiple medical exams and massive amounts of multivariate heterogeneous data are needed for a proper diagnosis of AD. Nonetheless, due to the variety of medical tests available, manual comparison, visualization, and interpretation of data is challenging and time-consuming. MRI scan classification is an effective method for predicting brain diseases with high accuracy, but it is also a difficult undertaking. However, new methods for Alzheimer's early diagnosis have been proposed. One such application is the classification of brain MRI data using convolutional neural networks for accurate label propagation (CNNs) .[10] The Alzheimer's Association has voiced disappointment on the lack of development toward a treatment for Alzheimer's disease by the year 2019. In the US, there are more than 5 million people who have Alzheimer's.[11] And among them, over 200,000 are under the age of 65. By 2050, 10 million people, mostly in their 60s, are projected to have AD, according to the research. The paper also states that every 67 seconds, a new case of AD is diagnosed. [12] Medicare and Medicaid are expected to spend a combined total of $36 billion (Figure 2) on Alzheimer's care and treatment over the next 50 years.

STORY OF ALZHEIMER DISEASE

This section gives a brief history of AD by compiling data from Google Scholar results for works on AD. Only the most current publications published between 2008 and 2019 were considered. Our main source of knowledge when trying to comprehend Alzheimer's disease and its precursor, mild cognitive impairment, was data that had previously been gathered from databases (MCI). Academics evaluated the efficiency of tried-and-true methods .[13]

MACHINE LEARNING TECHNIQUES

Before diving into an in-depth exploration of machine learning methods, it is important to define machine learning and identify the specific machine learning techniques that are typically used in AD diagnosis. Machine learning is a subfield of AI that uses a variety of methods to extrapolate mathematical and statistical findings from seemingly chaotic data. The system utilizes training data to make predictions about untrained events. When compared to more traditional statistical methods, machine learning's efficacy shines. Accurate results can only be achieved in machine learning if both the problem at hand and the algorithms' limits are fully grasped. This means that if the experiment is carried out appropriately, the right kind of training is used, and the results are rigorously confirmed, there is a strong likelihood that it will be successful. Further, every every algorithm and technique used in machine learning is unique in some way. Some approaches, for instance, are built on presumptions or intended for a certain kind of data, making them unsuitable for other kinds of data. This is why it is important to use many machine learning techniques on the same set of training data.

The three main categories of learning algorithms in machine learning are: Observed instruction 1 Second, the concept of "unsupervised learning." Lastly, we have reinforcement learning. During supervised learning, a set of training data is provided while the algorithm attempts to infer the necessary parameters to produce the desired result. The unsupervised algorithms use unlabeled and unclassified data to learn on their own. Multiple supervised learning methods are utilized in the AD diagnostic and prognostic processes. Some illustrations include linear discriminant analysis, genetic algorithms, decision trees, and synthetic neural networks.[14]

Commonly employed approaches include support vector machines, anomaly detection mining, and ensemble methods. The support vector machine (SVM) is a relatively recent method, however it is now a well-known machine learning approach throughout the world. Despite this, it continues to be largely unrecognized in the field of AD diagnosis. K-Nearest Neighbors (KNN) and decision trees (DT) are two alternative approaches, however they are rarely utilized in AD forecasts. Despite the fact that a large number of reliable resources were used in this analysis. However, nearly all of them were either not double-checked, overtrained with an excessive amount of features, or lacked a well-defined standard against which results could be evaluated, or all of the above. [15]

3. LITERATURE OF REVIEW

(Rekha & Shashi Rekha et.al, 2020) [16] Alzheimer's disease (AD), a fatal degenerative brain disorder, is characterized by dementia, forgetfulness, and mortality. Alzheimer's disease is a degenerative neurological ailment that is characterized by severe memory loss and an absolute inability to perform daily duties. For Alzheimer's disease to be successfully treated, early diagnosis is essential. Diagnosing Alzheimer's disease takes time, and it's not easy to do without a report from brain imaging and human expertise. The current gold standard for diagnosing Alzheimer's disease is costly and error-prone. This work investigates a different approach that is quick, inexpensive, and reliable. With the help of AI, medical care and therapies may be improved significantly. Human diagnostic performance declines as a result of fatigue, cognitive biases, broken systems, and distractions. However, AI-based diagnostics solutions mitigate human error and safeguard doctors at every stage of the diagnosis and treatment process. We offer a novel and remarkably accurate method for identifying dementia in its early stages, including Alzheimer's disease, using a standardized screening battery (AD). Through structural MRI scans, the presented architecture may be exploited for Alzheimer's disease early diagnosis. The ability to predict whether or not a patient with MCI would subsequently develop Alzheimer's disease has significant implications for both clinical care and the caliber of clinical research. In this work, we classify AD in its early stages using a number of criteria, including outcomes from the Mini-Mental State Examination (MMSE) and MRI (MRI).

(Kumari, 2021) [17] Memory and other cognitive faculties are particularly vulnerable to the debilitating effects of Alzheimer's disease, a progressive neurodegenerative ailment. At the moment, there isn't a surefire way to identify this sickness. It is not possible to tell whether or not a person is actually experiencing a certain mental state just by verifying that they claim to be. The doctor has concluded that the patient has Alzheimer's disease after interviewing the patient's loved ones about their social behavior and reading the patient's medical records. Using AI and ML techniques, perhaps this model might be adjusted. Since the data comes from so many different places and is likely to continue growing due to the complexity of the underlying conditions, processing it on a massive scale is essential. The percentage of patients who get the disease as a result of exposure will be used as proof of the disease's impact and its absence. With a data mining lens, the proposed architecture becomes clear as a massive processing model. An Alzheimer's disease rate and characteristics framework was constructed in this study utilizing a number of machine learning methods, and classifiers were applied to the resulting data. Studies have revealed that the Support Vector Machine classifier is insufficient for use in Alzheimer's disease prognosis. Therefore, there is obviously room for improved precision. In order to speed up the diagnosis of the aforementioned disease, this study gives several data categorization algorithms, the most effective of which is the Support Vector Machine with a linear kernel model.

(Roobaea Alroobaea, n.d.) [18] About 5% of dementia cases in the elderly population are caused by Alzheimer's disease. Regrettably, no one can afford the price tag associated with providing care for a loved one who has a long-term condition. Alzheimer's disease is a significant factor in the high death rate among the elderly, which is already a problem. By improving diagnosis procedures, the death rate from Alzheimer's disease can be reduced. As a result, medical experts have been working diligently to perfect techniques for Alzheimer's disease early diagnosis. The two main goals of the study are to (1) build an AI-based system for diagnosing Alzheimer's disease and (2) evaluate the method's practical utility. Data for this review was given by the Open Access Series of Imaging Studies (OASIS) and the Alzheimer's Disease Neuroimaging Initiative (ADNI) (ADNI). In an effort to automate the diagnosis of Alzheimer's disease, researchers have turned to well-established supervised machine learning algorithms due to the intricacy of the problem. Methods such as linear discriminant analysis, SVMs, forests, and logistic regression fall under this umbrella. Our results show that on the OASIS dataset, both logistic regression and random forest are 84.33 percent accurate, whereas on the ADNI dataset, support vector machine is 99.43 percent accurate and logistic regression is 84.33 percent accurate.

(Lucia Billeci, 2020) [19] The prevalence of Alzheimer's disease as a major contributor to dementia has increased as the population as a whole has aged. Despite its pervasiveness, nothing is known about its beginnings or how it evolved. Neuroimaging techniques have come a long way in recent years, with some suggesting that they can be utilized for both diagnosis and early detection because to developments like diffusion Magnetic Resonance (MR). Machine learning, which is defined as a collection of computer algorithms that may change their output to suit a particular purpose, is a topic of great interest to educators since it can be challenging to comprehend huge collections of medical images. Diffusion tensor imaging using machine learning has been applied in recent Alzheimer's disease investigations. This study provides an in-depth analysis of these programs, outlining their main features and offering commentary on how well they function. Minor cognitive impairment is included in some of the evaluated studies, and structural magnetic resonance imaging (MRI) data is integrated with diffusion data in others (multimodal analysis). The rediscovered research indicates that machine learning might be used to evaluate helpful classification properties like fractional anisotropy, and that it might even be able to perform on several visual modalities with increased accuracy.

(Vrashikesh Patil, 2021) [20] The risk of having Alzheimer's disease increases with age, particularly around age 65. Protein fragments called amyloid beta (A) aggregate in the synapses of affected brain cells, leading to symptoms of Alzheimer's disease. Hypothesized to be smaller in those without dementia and greater in those with Alzheimer's, the ventricular space and total brain size are the primary focus of this study. The Region of interest (ROI) technique, which uses image processing for classification, is evaluated for its ability to diagnose Alzheimer's disease. And an approach to MRI scan classification that makes use of machine learning (ML) and image processing. After the input images were processed to increase contrast and decrease noise, the algorithm employed a criteria based on the ratio of ventricular gaps in Alzheimer's and non-images Alzheimer's. Alzheimer's sufferers will have larger ventricular volumes than healthy people, and this will be a determining factor. The present approach has been tested with a confusion matrix and has shown to be 95% accurate. The best results that have been achieved by other methods using a comparable Region of interest (ROI) based technique are just 84%. This technique has the potential to help in the medical community's identification of a wide range of conditions.

(Devasana, 2020) [21] There are many forms of dementia, but Alzheimer's disease affects more individuals than all of them together. These symptoms typically show up quite subtly at first. However, they increase swiftly and become quite severe. The majority of people who develop dementia do so because of Alzheimer's disease. Managing this sickness on a daily basis is extremely difficult because there is currently no cure. In the presence of severe impairment, medical professionals may suspect this condition. Illness prognosis research may lead to earlier diagnosis, more effective therapy, or even disease prevention. In this article, machine learning algorithms are employed in conjunction with patient demographic information (such as age, number of office visits, MMSE score, and education level) to predict the likelihood that a patient would develop Alzheimer's disease.

(Abdullah, 2019) [22] Alzheimer's disease, which leads to memory loss and other cognitive issues, is the most prevalent form of neurodegenerative illness (AD). Alzheimer's disease can be stopped before irreversible damage to brain tissue occurs if diagnosed and treated early on. The current state of medical diagnostics is insensitive, wasteful (in terms of both time and accuracy), and misses numerous possible warning signs. Basic data pre-processing, feature identification, and the evaluation of the effectiveness of five suggested supervised machine learning algorithms are all required to increase prediction accuracy. All information gaps were filled up before processing because of the poor overall coverage (5.63 percent). It has been demonstrated that the Boruta algorithm considers factors including the Atlas Scaling Factor, normalized whole-brain volume, the mini-mental state test, and clinical dementia scores. Despite the small size of the OASIS-2 longitudinal MRI dataset, the Random Forest Grid Search Cross Validation (RF GSCV) model outperformed 11 other models that used the Boruta method, reaching 94.39% accuracy, 88.24% sensitivity, 100.00% specificity, and 94.44% AUC. Finally, using the 216 processed imaging sessions from the OASIS-1 cross-sectional MRI dataset, we evaluated our proprietary GUI prediction tool. Prediction accuracy was improved by combining a dementia diagnosis with the OASIS cross-sectional data fact sheet.

(Taeho Jo, 2019) [23] When it comes to uncovering fine-grained patterns in high-dimensional, complicated data, modern machine learning techniques like deep learning have made tremendous strides. This proliferation of neuroimaging data has reignited research into using deep learning to problems like early Alzheimer's disease detection and automated classification (AD). Cognitive MRI data was analyzed using deep learning techniques with the goal of making a diagnosis of Alzheimer's disease. We looked through articles about deep learning and AD that were released between January 2013 and July 2018 in Pub Med and Google Scholar. Together, the data from each study was assessed, rated, and organized according to algorithm and neuro imaging type. Twelve of the accepted research employed exclusively deep learning while the other four used a hybrid approach that included both deep learning and more traditional machine learning techniques. When we employed stacked auto-encoder (SAE) for feature selection, patients with moderate cognitive impairment were properly predicted to develop to Alzheimer's disease at an accuracy of 83.7%. (MCI). Without any prior preparation for feature selection, sending neuro imaging data directly into a convolutional neural network (CNN) or recurrent neural network (RNN) increased the accuracy rates for AD classification and MCI conversion prediction to 96.0 and 84.2 percent, respectively. Multimodal brain imaging in conjunction with fluid biomarkers yielded the most accurate classification results. The categorization of Alzheimer's disease diagnoses using multimodal neuro imaging data is a problem well suited for deep learning systems. The incorporation of additional hybrid data types, such as -omics data, may enhance performance and increase transparency if explainable approaches are utilized that combine understanding of certain disease-related features and mechanisms. The potential of deep learning to improve Alzheimer's disease analysis has only barely been scratched.

(Doaa Ahmed Arafa, 2022) [24] Alzheimer's disease is characterized by memory loss and other forms of cognitive impairment (AD) Because people with the condition frequently see remarkable improvements and because there are no precise diagnostic procedures, early detection and classification of Alzheimer's disease are interesting research topics. The main goal of research towards preventing or slowing the progression of Alzheimer's disease has been to improve methods of early diagnosis. To do this, we performed a thorough literature review of research that attempted to use cutting-edge deep learning techniques to detect and classify early-stage Alzheimer's disease. Techniques like as imaging, preprocessing, learning, and classification are broken down and described in layman's terms. Imaging strategies for Alzheimer's disease: structural, functional, and molecular imaging methods are discussed in detail. Procedures for structural and functional magnetic resonance imaging as well as positron emission tomography are being considered as diagnostic medical imaging techniques (PET; for assessment of both cerebral metabolism and amyloid). As a means of guaranteeing the efficacy of the processing at hand, it checks each preceding step. We will also discuss the most popular deep learning methods now employed by the classification industry. To be sure, deep learning with picture preprocessing has surpassed the performance of competing approaches, but there are still challenges to overcome. It will also examine a wide range of studies to dissect the difficulties and triumphs of image classification and preprocessing.

(Debabrata Sahoo, 2022) [25] The neurodegenerative brain ailment known as Alzheimer's disease (AD) causes a gradual decline in mental capacity and, finally, death. Nearly half of all cases of dementia in the older population can be attributed to Alzheimer's disease. Memory, focus, and judgment all weaken and eventually disappear in people with dementia, along with other cognitive and behavioral abilities. The medical sector makes extensive use of image processing for the purpose of disease diagnosis and to aid doctors in making decisions based on clinical observations. The main goal of the research is to create a trustworthy approach for diagnosing Alzheimer's disease early, before any permanent brain damage occurs. Recently created machine learning and deep learning technologies have made MRI image classification extremely accurate. In the medical industry, however, classification tasks must adhere to a stringent set of rules. A mistake of seemingly minor importance might have devastating consequences for the patient's health. We proposed a method for identifying injured regions in MRI scans of the brain collected in the coronal, axial, and sagittal planes with a 99.5% degree of accuracy by using a Deep Learning-based Image classifier to these images. Our suggestion holds up well when compared to other, more cutting-edge models.

(G.-R. K. et. a. Fazal Ur Rehman Faisal, 2022) [26] Early detection of Alzheimer's disease by neuroimaging has showed potential, which may eventually lead to more treatment options (AD). This study aims to develop a deep learning-based autonomous classification system that can discriminate between brain pictures indicative of mild cognitive impairment (MCI), Alzheimer's disease (AD), and normal cognitive function (CN).We trained and tweaked convolutional neural networks (CNNs) to assess sMRI brain pictures using the publically accessible ADNI datasets. Our proposed technique for transforming the MRI images hierarchically combines data from various layers to provide more condensed, high-level features. Reduced computing complexity is a major advantage of the suggested method. We propose a new convolution operation that greatly outperforms prior approaches for AD classification, and we demonstrate that this is the main reason for our method's success on a variety of benchmarking criteria (such as accuracy, area under the ROC curve, etc.).

(Ambily Francis, 2021) [27] Alzheimer's disease, a neurological condition that causes memory loss over time as a result of brain cell death, is characterized by dementia. For a very long time, the automatic early identification of Alzheimer's disease (AD), a neurodegenerative ailment, has mainly depended on a machine's ability to discern between different degrees of dementia. Alzheimer's disease, mild cognitive impairment nonconvertible, and mild cognitive impairment convertible are all different types of dementia (AD).Memory difficulties are shared by MCI and MCInc, as seen by this comparison. Aging brings on MCInc; it's inevitable. Age-related memory loss is inevitable. However, MCIc is a kind of AD that will eventually manifest itself. Alzheimer's disease begins with MCIc, the earliest form of the illness. Meditating regularly has been shown to reduce the course of memory loss in those with mild cognitive impairment who have been detected at an early stage. In our research, we take into account both the cognitively healthy and the cognitively impaired stages of dementia. To increase the accuracy of our CN and MCIc categorizations, we specifically use an ensemble model. Two pre-trained network models, Xception and Mobile Net, make up the ensemble model. Pre-trained and ensemble models are commonly validated using the ADNI dataset. Doctors need to be able to distinguish between CN and MCIc in order to identify Alzheimer's disease at an early stage. To that end, we compare the Xception and Mobile Net models and find that they are able to classify MCIc and CN with 89.23% and 89.89% accuracy, respectively. The accuracy of the proposed method is so high, at 91.3%, that it is very impressive. The results demonstrate that the proposed ensemble model successfully separates MCIc and CN phases.

(A. S. A. M. Et.al, 2021) [28] The slow death of brain cells is a hallmark of Alzheimer's disease. If this illness is identified and treated early, more harm can be avoided. The development of convolution neural networks has greatly benefited computer-aided detection systems in addressing this problem. Here, we offer a technique for identifying Alzheimer's illness that makes use of segmentation and convolution. Here, we use recursive thresholding to an MRI of the brain to isolate the brain's tissue. Images depicting what seems to be a failing brain over time are the result of this segmentation. Deterioration is identified by means of convolutional neural networks, and an index reflecting the development of Alzheimer's disease is subsequently provided.

(R. M. M. A. A. Et.al, 2021) [29] Brain cell death in Alzheimer's disease (AD) causes memory loss and cognitive decline. In spite of the fact that many neuroimaging methods have been created in an effort to identify Alzheimer's disease, magnetic resonance imaging (MRI) has emerged as the most reliable tool (MRI). Before, a team of highly skilled radiologists had to visually assess brain MRI scans to make the diagnosis of Alzheimer's disease. This process, however, has recently been greatly mechanized because to advancements in deep learning for medical picture processing. Modern architectures frequently use Regions of interest as the foundation for feature extraction to perform human-level classification of AD images against Normal Control (NC) images. The incorporation of human intellect into the design already poses difficulties, and this additional aspect further adds to those difficulties. Here, we showed that a 14-layer Neural network architecture may be used to detect AD without requiring any preexisting brain information. The network attained an accuracy of 87.06% (AUC=0.93) while being evaluated on ADNI-1, the de facto MRI dataset for AD research.

(Fatemah H. Alghamedy, 2022) [30] Progressive neuro degeneration characterizes Alzheimer's disease. The situation is bearable at first, but it worsens over time. In a nutshell, Alzheimer's disease is a neurodegenerative condition that causes brain cell loss and dysfunction. Hackers may access our memories with extreme ease. One of the early signs of Alzheimer's disease is memory loss. As the illness worsens and more brain cells are lost, new symptoms start to appear. Processing images taken of a patient's body aids in both diagnosis and treatment. For the first time, this research proposes a machine learning-based multi-model computing strategy to image categorization and diagnosis in Alzheimer's disease. Snap some photos as a starting point. Unfortunately, MRI scans have a number of drawbacks, the most significant of which are noise and poor contrast. In order to get the pictures ready for viewing, CLAHE is utilized. An improved visual product is the eventual outcome. When comparing CLAHE to other methods, it is clear that CLAHE is the best option for enhancing the look of mammography's finer features. Marks of damage are more noticeable on a white background. Even while the method does a better job of isolating signal from noise, the final images still have a grainy appearance. The k-means method is used for this purpose to segment pictures into individual regions. By segmenting the images, it's possible to zero down on a specific area of interest. In order to extract useful features, PCA is often employed. Finally, the machine learning methods are used to classify the pictures.

(G.-R. K. Fazal Ur Rehman Faisal, 2022) [31] Neuroimaging offers the ability to diagnose Alzheimer's disease early, which could potentially lead to more treatment options (AD). This study aims to develop a deep learning-based autonomous classification system that can discriminate between brain pictures indicative of mild cognitive impairment (MCI), Alzheimer's disease (AD), and normal cognitive function (CN).We trained and tweaked convolutional neural networks (CNNs) to assess sMRI brain pictures using the publically accessible ADNI datasets. Our proposed technique for transforming the MRI images hierarchically combines data from various layers to provide more condensed, high-level features. The proposed method's main benefit is that it requires less computational work. For AD classification, we present a new convolution operation that significantly outperforms previous methods, and we show that this is the primary cause for our method's performance on a number of benchmarking criteria (such as accuracy, area under the ROC curve, etc.).

(Nickson Mwamsojo, 2022) [32] There has never been a better moment for ANNs to be used in information processing applications like image identification and time series prediction. Using bigger and bigger datasets for training and the resulting complexity increases appear to be the main drivers of advancement. For some applications, though, a lack of training data may make things challenging. The likelihood of over-fitting and poor generalization in complicated models increases with insufficient training data. When compared to models with fewer trainable parameters, those with many more are more challenging to train and optimize. It is our belief that our proposed use of ANNs to the classification of ES-AD from handwriting samples is a first of its kind (HW). We recommend the Reservoir Computing (RC) framework for building Recurrent Neural Networks (RNNs), which simplifies training by concentrating on the optimization of the network's output layer, and we demonstrate its efficacy both numerically and experimentally. Compare the results of CNN and BiLSTM models. When weighing the accuracy-efficiency trade-off, we take into account not only the precision but also the energy expenditures associated with achieving that precision. Our numerical and experimental findings show that although incurring significantly lower inference costs, RC obtains a classification accuracy that is 3% lower than BiLSTM but 2% higher than CNN. Our research was conducted with the hope that it would start a conversation about how various models balance accuracy and efficiency in the context of initiatives to reduce neural networks' negative environmental impact (ANNs).

(Yusera Farooq Khan, Baijnath Kaushik, 2022) [33] The Alzheimer's disease (AD) symptoms of forgetfulness and disorientation are caused by the illness's attack on the cortex, the protective tissue of the brain. Early identification of Alzheimer's disease may be aided by training oneself to distinguish between normal and impaired linguistic and cognitive functioning. Convolutional neural networks (CNNs) are used in this study for text categorization and predicting the prognosis of Alzheimer's disease (AD), and we develop the idea of a stacked deep dense neural network (SDDN) that combines CNN and Bidirectional Long-Short Term Memory (LSTM) (SDDNN).The full Dementia Bank clinical transcript dataset was used to train the models. Meetings between doctors and patients with Alzheimer's disease to discuss care are documented in these transcripts. Different model configurations were tested, including random initialization and Glove embedding. Furthermore, Grid Search was utilized to refine hyper parameters, which improved learning model design and forecast accuracy. Area under the curve, specificity, accuracy, F1 score, and recall were the metrics used to assess and compare each variable (AUC). We evaluated the accuracy of our classifications using a 10-fold cross-validation approach to ensure performance generalization. Through Glove embedding and hyper parameter tuning, the proposed model's performance and classification accuracy were significantly increased, reaching 93.31%. The results of this study will be very helpful to clinical professionals who focus on the early detection of AD.

(Mohammad Amin Shayegan, 2021) [34] Due to the high expense of care and therapy, the lack of predictability in present medications, and the dismal prognosis for the patient's future, early detection of Alzheimer's disease (AD) would appear vital. Researchers in this study looked at the potential of using AI techniques in tandem with MRI scans for the diagnosis of AD. Here, we detail a computer-assisted method for detecting Alzheimer's disease early on (AD). A deep neural network and a conditional random field were trained on MR brain scans that had been modified for the purpose of Inception in order to recognize Alzheimer's disease. The hippocampus was the primary diagnostic target during the initial surgery (since it is one of the first to be damaged by AD). Using conditional random field, we were able to correctly reconstruct pieces of the hippocampus formation across all three brain planes, despite their varied sizes and shapes. This foundation is what the properties of the deep network are built upon. The efficacy of the suggested technique was verified in tests utilizing photos from the common ADNI dataset. Here, we employ an Inception network that has already been trained using the massive Image Net database. A summary of what you already know about the issue comes first. The data augmentation technique was adjusted so that the resultant model would better reflect the actual anatomy of the hippocampus. When compared to the gold standard, the diagnostic accuracy for Alzheimer's disease increased by 2.56 percentage points and the diagnostic accuracy for moderate cognitive impairment increased by 8.41 percentage points. This study's results lend support to the idea that artificial intelligence algorithms can be effective in analyzing MRI scans for AD symptoms.

(Karatekin, 2021) [35] Creating techniques for early Alzheimer's disease detection has been a key area of attention in medical research for many years in the aim of halting the illness's devastating consequences. Numerous studies have examined ways to use well-established feature selection procedures to improve the accuracy of Alzheimer's disease diagnoses. Together with more traditional feature selection approaches, the ensemble feature selection methodology represents a new and exciting field of study. Better results can be achieved by integrating the ranked features from other feature selection techniques, as is suggested. As a result, this research aims to develop a predictive model for AD diagnosis using ensemble feature selection techniques. Included in the Alzheimer's disease dataset are people with and without cognitive impairment (AD). In this research, we used both homogeneous and heterogeneous ensemble methods to choose features. Through the use of these ensemble feature selection techniques, we produce two feature subsets. Using data mining techniques like Random Forest, Artificial Neural Network, Logistic Regression, Support Vector Machine, and Naive Bayes, one may create a model to predict the start of Alzheimer's disease. We construct a prediction model by independently applying these algorithms to the two groups of features. The next step is an analysis of the data to establish which method of ensemble feature selection yielded the best results. This research found that the Random Forest algorithm had the best results (91% accuracy) when fed a feature subset derived using a heterogeneous ensemble feature selection method.

4. MACHINE LEARNING METHODS FOR DETECTING ALZHEIMER'S

These methods have attracted a lot of attention over the years and are often used in clinical applications. With its current architecture, this area of artificial intelligence is able to eliminate a data model or pattern that expresses meaning. Clustering techniques are under the unsupervised category, whereas classification techniques go under the supervised category. This article will examine the similarities and differences between two widely used methods of data analysis: classification and clustering, often known as supervised learning (also known as Unsupervised Learning).This method of machine learning requires a trainer to be used, which then trains label data using a training set and the label group. Biomarkers are a type of characteristic that must be learned in order to tackle the current issue. The basic framework of the ML classification approach to AD is shown in Figure 2.

A. **Decision Tree:** With the decision tree framework, you can iteratively divide your data into subsets based on the values of its features' thresholds, as demonstrated in the overview. A new subset is obtained when an instance is split. When compared to nodes at the leaf level, internal level nodes are terminal subsets. A decision tree may be quite beneficial when the qualities and the aim are highly interacting.

B. **Random Forest:** A random forest model is more accurate in predicting outcomes than choice trees because it avoids the issue of overfitting. Typically, decision trees in random forest-based models differ slightly from one another. Using each individual decision tree model as input, the ensemble makes predictions using the majority voting approach (bagging). As a result, each tree's ability to predict outcomes is maintained, but the amount of overfitting is reduced.

C. **SVM:** Classifying information by using hyper planes that are meaningful in a dimensional space. By using SVMs, we can locate a hyper plane separating vector clusters that represent examples of two categories of variables. The support vectors are located at certain points on the hyper plane. As a machine learning technique, SVM benefits from both training and test data. Organizing training data into categories helps to better order values and attributes of interest. The Support Vector Machine (SVM) model allows us to foresee the thresholds at which our tests will fail.

D. **XGBOOST:** Extreme Gradient Boosting, often known as XGBoost, is a term used to identify a particular branch of machine learning. It concerns a technique for improving the effectiveness and speed of gradient-boosted decision trees specifically. Because model training must be done incrementally, gradient boosting machines are difficult to build and have a limited potential to scale. XGBoost's main priorities are performance and speed.

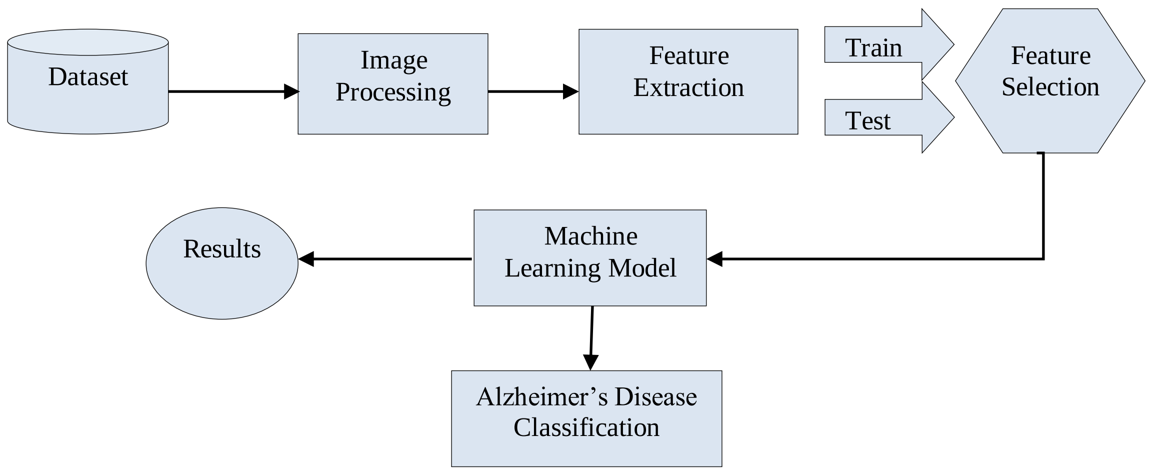

Figure. 2 “Process diagram of ml technique for classification of Alzheimer’s disease”

5. DEEP LEARNING-BASED METODS

A. Transfer Learning: In certain cases, researchers built an AI system from scratch. Overfitting, however, might happen as a result of the limited quantity of neuroimaging datasets and the lengthy training process. In the DL architectures analysis that came before, it was discovered that TL is faster and more effective than training from scratch. Recent studies have used a variety of CNN-based TL designs for initialization or feature extraction, including ResNet, deep ResNet, CaffeNet, Alex Net, Dense Nets, inception with or without fine-tuning, and an extended network architecture. However, some approaches benefited from the TL of the region. The other CNNs utilized the categorization weights of the CNN as initial weights to predict Alzheimer's disease.

B. CNN: When it comes to processing visual data, convolutional neural networks (CNN/ConvNets) are standard fare in the deep learning world. Keep in mind that ConvNet does not use the common neural network activity of matrix multiplication. The complex convolutional method is applied. A deep network made up of numerous artificial neuronal layers is known as a convolutional neural network. Similar to their biological counterparts, artificial neurons are mathematical functions that accept several inputs and produce an activation value that depends on the sum of those inputs. Convolutional, activation, pooling, fully linked, and Softmax layers are just a few of the layers found in typical CNNs. In the forward phase of CNN training, the loss cost between the projected outputs and the ground truth labels is determined, and in the backward phase, the learnable parameters are punished. The design of the layer and the parameters of the filters are what determine how well the CNN performs, which has motivated academics to concentrate on creating new architectures. Here, the essential components of a CNN architecture are described. To identify patterns in 2D pictures, CNNs were first proposed. Although it takes more parameters than a 2D CNN, classifying 3D brain images can be done using a 3D convolutional neural network (CNN).Therefore, when attempting to diagnose AD using a 3D brain scan, 2D CNNs are superior than their 3D counterparts. The volumetric data from a 3D MRI scan is used to segment the image into 2D slices, which may then be examined in greater detail. This technique decreases the number of parameters in CNNs, assuming that certain 3D MRI properties of interest are maintained in 2D pictures.

Table 1 Comparison between various researchers result and methods

Author	**Method**	**Algorithm**	**Results**
"E.M. Alkabawi et al.[36]	"Features extraction" and "classification"	CNN + LR	**74.93%**
Laske et al.[37]	AD and NC	SVM	**81.7%**
'T. Glozman" et al. [38]	AD classification	"ImageNet Transfer Learning"	**83.5%**
Cui et al. [39]	AD diagnosis	RNN	**89.7%**
Smith Vikos et al. [40]	AD and NC	SVM	**90.3%**

S. Wang, et al. [41]	AD classification	Transfer Learning	**90.6%**
"Afzal. S" et al. [42]	"Multiclass AD classification"	"SVM"	**92.4%**
Muazzam et al. [43]	AD	Transfer Learning	**92.85%**
Gunawerdena et al. [44]	AD	CNN	**96%**
"J. Akhila et al". [45]	"Classification of AD"	"Feedforward NN"	**97.5%**

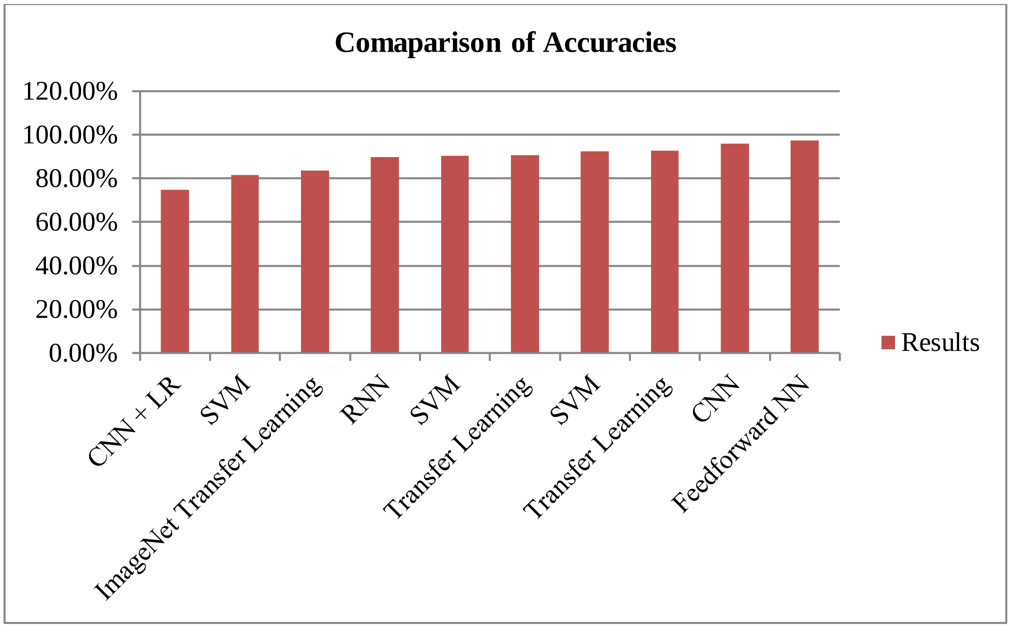

Figure. 3 Result comparison graph

CONCLUSION

The literature on the use of AI and ML for the diagnosis and early detection of Alzheimer's disease is reviewed and examined in this paper. This article discusses the data types used and the efficacy of the algorithms to explain the most recent developments in machine learning with reference to the early identification of Alzheimer's disease. Machine learning clearly produces more accurate predictions than more conventional statistical methods. Even though anticipated outcomes were examined, the study notes that clinical diagnoses were not entirely accurate because no pathological confirmation was provided. As an added bonus, the proposed method also works well with pathologically proven data, eliminating the issues of class imbalance and overtraining. Because combining many modalities requires more computational resources, the suggested method only uses one. We hypothesize that classifiers would gain from a more complete set of data, and that evidence with a pathological pedigree would improve the quality of the evidence. This method has the potential to improve clinical outcome prediction and overcome the limitations of the prior research**.**

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