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# Review on Computer Aided System Approach for Predictive Diagnosis of Neurological Disease

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**Abstract:** *Neurological conditions in human brain affecting human body's cognitive function leading to the mental diseases like Alzheimer's disease, Parkinson's disease, multiple sclerosis, brain tumor, epilepsy, dementia, headache disorders, neuro infections, stroke and traumatic brain injuries. Alzheimer's disease is an irreversible neurological condition that affects the human body's cognitive functions. A previous diagnosis of Alzheimer's disease will aid in the treatment of the condition. Many mathematical and machine learning models have been used in studies supporting the disease. Magnetic resonance imaging (MRI) is a common method used to diagnose disease clinically. However, because to changes in its MRI samples and their stability in healthy people, it faces certain difficulties in diagnosis. Machine learning algorithms are currently being utilized to assess fundamental brain alterations in magnetic resonance imaging (MRI). Ensemble Learning (EL) also demonstrated its benefits by incorporating many models into the learning system's resilience. By forecasting the sickness, a machine learning system can help solve this problem. This paper presents a review of computer aided system approach for predictive diagnosis of neurological disease.*

**Keywords:** Neurological Disease, Artificial Intelligence, Machine Learning, Ensemble Boosting, Image processing, Magnetic Resonance Imaging (MRI), Alzheimer's Disease, Cognitive Functions.

## I. Introduction

A degenerative disease, Alzheimer's disease, induces a progressive decline in cognition and memory. It causes memory and language-related degeneration of nerve cells in the brain. Symptoms start at 65 years, with a sharp rise inincidence with age [1]. Genetic factors perform an essential part in furthering the onset of the disease, as specific genes may increase the pain, even if they are not directly responsible for the condition. Age, smoking, and alcohol consumption are other factors[2]. The symptoms of Alzheimer's are poor decision-making, misplacement, movement dysfunction, verbal contact, anomalous moods, and full memory loss. The severity of the disease increases if the condition is not diagnosed in the initial phase. Alzheimer's ailment includes an intricate combined pattern of cerebrum tissue injury. This shrinks the hippocampus and brain cortex and widens the ventricles. Some ground breaking work has been conducted in automatically curing Alzheimer's disease[3]

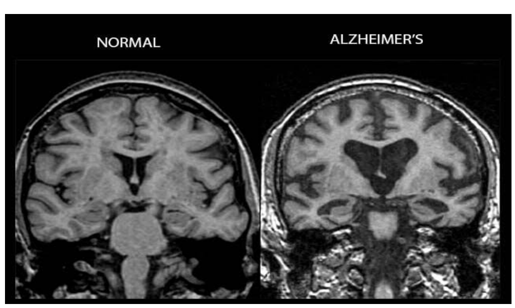


**Figure:** MRI Image of Normal brain and Alzheimer's Brain

The integration of the multiple learning systems and the use of the MRI was also useful for ensemble learning (EL). Machine learning (ML) is defined as the study of computer programs that leverage algorithms and statistical models to learn through inference and patterns without being explicitly programmed[4]. ML algorithms learn over experience and improve automatically. It finds techniques, trains models, and uses the learned approach to determine the output automatically.

Machine learning systems can also adjust themselves to a changing environment. A model is a machine learning system that has been trained to identify specific types of patterns using an algorithm in a machine learning system[5]. That means it processes the data and finds out the hidden structures in a dataset. The feature extraction and the known answers of a dataset determine the formula that relies upon the input and output functions and applies it to new data to predict the response. Hence, the model's algorithm uses a collection of data for training and builds a way to predict the output and saves that procedure for future purposes[6]. It is important to classify the classes with abnormal cognitive decline related to normal aging in the early stage with the actual symptoms of the cognitive disorder for AD. Our proposed classifier showed the best results in such classification[7]. Authors have been advocating the research ideology that artificial intelligence (AI)/machine learning (ML) techniques in an automated fashion can assist neurological disorders. Research in this area has been growing at an accelerating rate in the past decade. In this paper, authors explore and review recent articles on the applications of AI-based systems for the diagnosis of neurological disorders.

## II. Literature Review

The Various authors has implemented various techniques on computer aided system approach for predictive diagnosis of neurological disease using image processing and machine learning techniques.

Harkawalpreet Kaur et. al. [1] proposed technique selects best five machine learning models competitively, out of 25 state-of-the-art regression models to generate a robust ensemble. Data from 42 patients having early stage of Parkinson disease were collected which contains a total of 5875 voice recordings. Numerous state-of-the-art machine learning models have been explored to predict the motor Unified Parkinson's Disease Rating Score (UPDRS) for the collected voice measures. Evaluation parameters such as correlation, R-Square, RMSE, and accuracy have been calculated for comparative analysis. Results from the ensemble model consisting of best five models have been recalculated to analyze the prediction. K-fold validation has been incorporated to measure the robustness of ensembled model. The proposed ensemble yields UPDRS with higher accuracy of 99.6% making it well suitable to assist the diagnose for Parkinson disease.

Ning An et. al. [2] presented a deep ensemble learning framework which aims toharness deep learning algorithms to integrate multisource data and tap the 'wisdom of experts'. At the voting layer, a sparse auto encoder is trained for feature learning to reduce the correlation of attributes and diversify the base classifiers ultimately. At the stacking layer, a nonlinear feature-weighted method based on deep belief networks is proposed to rank the base classifiers which may violate the conditional independence. Neural network is used as meta classifier. At the optimizing layer, under-sampling and threshold-moving are used to cope with cost-sensitive problem. Optimized predictions are obtained based on ensemble of probabilistic predictions by similarity calculation. The proposed deep ensemble learning framework is used for Alzheimer's disease classification. Experiments with the clinical dataset from national Alzheimer's coordinating center demonstrate that the classification accuracy of our proposed framework is 4% better than 6 well-known ensemble approaches as well as the standard stacking algorithm. Adequate coverage of more accurate diagnostic services can be provided by utilizing the wisdom of averaged physicians. This paper points out a new way to boost the primary care of Alzheimer's disease from the view of machine learning.

Massimiliano Grassi et.al. [3] was developed using the open dataset from the Alzheimer's Disease Neuroimaging Initiative (ADNI), employing a sample of 550 MCI subjects whose diagnostic follow-up is available for at least 3 years after the baseline assessment. A restricted set of information regarding sociodemographic and clinical characteristics, neuropsychological test scores was used as predictors and several different supervised machine learning algorithms were developed and ensembled in final algorithm. A site independent stratified train/test split protocol was used to provide an estimate of the generalized performance of the algorithm.

Thomas W. Rowe et.al. [4] reviewed the use of machine learning algorithms for predicting Alzheimer's disease using single nucleotide polymorphisms and instances where these were combined with other types of data. We evaluated the ability of machine learning models to distinguish between controls and cases, while also assessing their implementation and potential biases. Articles published between December 2009 and June 2020 were collected using Scopus, PubMed and Google Scholar. These were systematically screened for inclusion leading to a final set of 12 publications. Eighty-five per cent of the included studies used the Alzheimer's Disease Neuroimaging Initiative dataset. In studies which reported area under the curve, discrimination varied (0.49–0.97). However, more than half of the included manuscripts used other forms of measurement, such as accuracy, sensitivity and specificity. Model calibration statistics were also found to be reported

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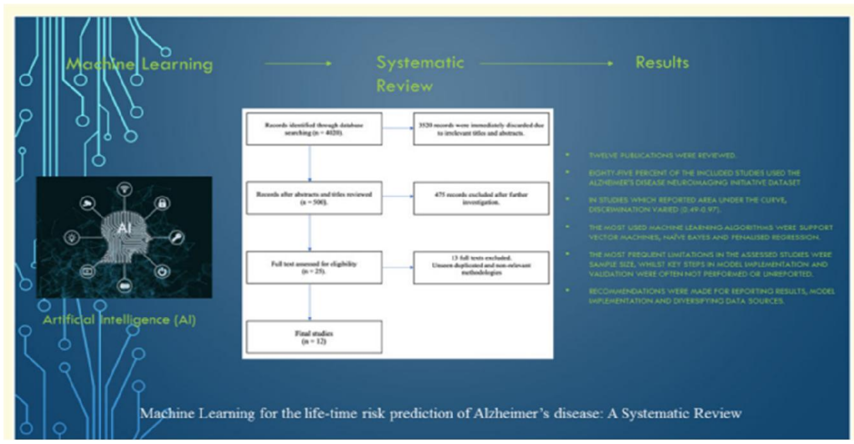
inconsistently across all studies. The most frequent limitation in the assessed studies was sample size, with the total number of participants often numbering less than a thousand, whilst the number of predictors usually ran into the many thousands. In addition, key steps in model implementation and validation were often not performed or unreported, making it difficult to assess the capability of machine learning models.




M. Rohini et.al. [5] predicted the prevalence of disease only after the advancement of the disease. With these existing prediction models, it is possible only to reduce and delay the symptoms of the disease. The exact usefulness is when the presence of the disease is identified at an early stage and this early detection makes a great impact in subjects recovery. Thus, early detection of controls at high risk of development of Alzheimer's disease is of a key objective of the proposed work. Existing machine learning and deep learning algorithms derive only limited predictive accuracy. Also, they derive results based on expensive machine learning algorithms that had hard-to-collect features and classifying becomes complex with numerous overfitting in choosing decision boundaries. The proposed study intends to develop a learning algorithm for the prediction of Alzheimer's disease at an early stage. It also classifies the features if the subjects with Mild Cognitive impairment (MCI) and Pre-Mild Cognitive Impairment (Pre-MCI) and Pre-Mild Cognitive Impairment has the likehood to develop Alzheimer's disease. A dataset of AD controls was used to train different machine learning algorithms. Onset information like social behavior, demographic characteristics, neurological test scores, clinical cardiovascular index, and brain atrophy ratio can also be used as the extract predictor.

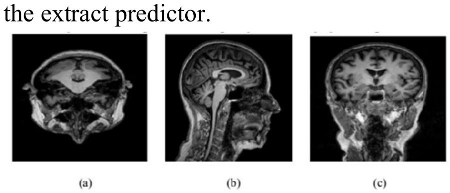



Fig.2 MRI Pre-processing-(a) Axial (b) Sagittal (c) Coronal

Lucia Billeci et.al. [6] a systematic review of recent machine learning applications on diffusion tensor imaging studies of Alzheimer's disease is presented, highlighting the fundamental aspects of each work and reporting their performance score. A few examined studies also include mild cognitive impairment in the classification problem, while others combine diffusion data with other sources, like structural magnetic resonance imaging (MRI) (multimodal analysis). The findings of the retrieved works suggest a promising role for machine learning in evaluating effective classification features, like fractional anisotropy, and in possibly performing on different image modalities with higher accuracy.

Sergio Grueso et. al. [7] conducted a systematic review following PRISMA guidelines of studies where machine learning was applied to neuroimaging data in order to predict whether patients with mild cognitive impairment might develop Alzheimer's disease dementia or remain stable. After removing duplicates, we screened 452 studies and selected116 for qualitative analysis.

Jyoti Islam et. al. [8] proposed a deep convolutional neural network for Alzheimer's disease diagnosis using brain MRI data analysis. While most of the existing approaches perform binary classification, our model can identify different stages of Alzheimer's disease and obtains superior performance for early-stage diagnosis. We conducted ample experiments to

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demonstrate that our proposed model outperformed comparative baselines on the Open Access Series of Imaging Studies dataset.

Manan Binth Taj Noor et.al. [9] examined and compared performances of the existing deep learning (DL)-based methods to detect neurological disorders—focusing on Alzheimer's disease, Parkinson's disease and schizophrenia—from MRI data acquired using different modalities including functional and structural MRI. The comparative performance analysis of various DL architectures across different disorders and imag-ing modalities suggests that the Convolutional Neural Network outperforms other methods in detecting neurological disorders. Towards the end, a number of current research challenges are indicated and some possible future research directions are provided.

Andr´es Ortiz† et. al. [10] constituted an important tool for the early diagnosis of Alzheimer's Disease (AD), which, in turn, allows the application of treatments that can be simpler and more likely to be effective. This paper explores the construction of classification methods based on deep learning architectures applied on brain regions defined by the Automated Anatomical Labeling (AAL). Gray Matter (GM) images from each brain area have been split into 3D patches according to the regions defined by the AAL atlas and these patches are used to train different deep belief networks. An ensemble of deep belief networks is then composed where the final prediction is determined by a voting scheme. Two deep learning based structures and four different voting schemes are implemented and compared, giving as a result a potent classification architecture where discriminative features are computed in an unsupervised fashion. The resulting method has been evaluated using a large dataset from the Alzheimer's disease Neuroimaging Initiative (ADNI). Classification results assessed by cross-validation prove that the proposed method is not only valid for differentiate between controls (NC) and AD images, but it also provides good performances when tested for the more challenging case of classifying Mild Cognitive Impairment (MCI) Subjects. In particular, the classification architecture provides accuracy values up to 0.90 and AUC of 0.95 for NC/AD classification, 0.84 and AUC of 0.91 for stable MCI/AD classification and 0.83 and AUC of 0.95 for NC/MCI converters classification.

## III. Conclusion

Early identification of Neurological Disease (ND) has always been a difficult issue, and computer scientists are always investigating new techniques to do so. Machine learning and deep learning are the most often used classification algorithms, and they perform better in this sector than other models. Unsupervised and self-monitoring approaches are growing study fields in medical imagery due to a lack of medical data. Although the majority of the obstacles in the field of ND classification have yet to be overcome, deep learning technology's progress cannot be overlooked. Its ND detection is superior to that of medical specialists in certain situations. In the future, further studies in this field are needed that combine diverse screening methodologies to accurately and promptly diagnose neurological illnesses. Researchers should concentrate on developing embedded apps that improve the accuracy of diagnosing such illnesses. This study has explored different AI based systems developed in last 2 decades.

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