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Machine and Deep Learning Approaches for Alzheimer's Disease Prediction: A Comprehensive Survey

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***Abstract*— Alzheimer's disease is one of the neurodegenerative disorders. Although the symptoms are initially mild, they gradually worsen over time. As there is no cure for the disease, Alzheimer's disease is one of the most challenging diseases. They first conducted research to discover a treatment for this illness, after which they shifted their attention to disease analysis and prediction. Alzheimer's disease can be diagnosed, but only in it's advanced stages. Thus, if Alzheimer's is identified earlier, the disease's progression or symptoms can be slowed. This paper uses machine learning and deep learning algorithms to predict Alzheimer's disease.**

I. INTRODUCTION

Alzheimer's disease is one of the different forms of brain disorders that many the genetic changes guarantee a person will develop this disease.

Over time, this illness gradually destroys brain tissue. People with Alzheimer's disease are incapable of performing even basic tasks, let alone remembering their own names. In the past, it impacted adults between the ages of 60 and 90. Today, it affects people between the ages of 35 and 60. In 1906, Dr. Alois Alzheimer found the changes in the tissue of the brain in a woman, she died because of mental disorder. That woman's symptoms included memory loss, language issues, and erratic behavior. Her brain was then examined, and it was discovered that abnormal fiber clumps and collections had formed there. Based on this, study was initiated, and the doctor named the condition Alzheimer's. Alzheimer's disease cannot be cured with medicine. Dehydration, starvation, or infection are consequences that can arise in severe stages of the illness and cause mortality. The diagnosis of MCI at this point will assist the patient in concentrating on a healthy lifestyle and effective preparation to deal with memory loss.

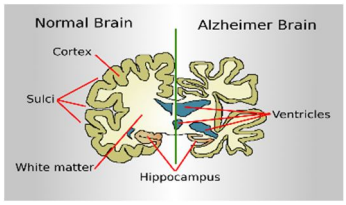

Fig 1. Alzheimer's disease

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II. LITERATURE SURVEY

In the paper [1], J Neelaveni et Al. aim to analyze the MMSE (Mini mental state examination) scores to gauge the onset of Alzheimer's disease. Over a given period of time the score obtained by the concerned patients reduce drastically. Those people having MCI have a huge risk of growing dementia. They aim to predict the onset of AD, so that necessary precautions can be taken to circumvent the effects. The authors have employed algorithms such as Support Vector Machines and decision trees for the purpose and have compared the accuracy returned by the two models. The dataset has various parameters but only the significant parameters that greatly help in predicting the disease like MMSE score, age, number of visits, and education of the patients were used.

[2] Using machine learning techniques and an ontology approach, the aim of this research is to create an automated intelligent system to predict the multi-modal symptoms of Alzheimer's disease in terms of Mobility and Mood. The proposed system in this prototype makes use of machine learning and artificial intelligence approaches, and it also incorporates context-based analysis and mood prediction. The model gathers sensor data from the smart home, which is utilised for a variety of purposes, including activity detection, estimating sleep and movement patterns, and determining the length of particular activities. When estimating sleeping patterns, motion sensor data is used to calculate the total number of sleep disturbances experienced by the older adult Similar to this, the older adult's total walking times are calculated by tracking sensor events across the rooms to estimate their mobility pattern. The older adult estimates the frequency of various activities and the order of all the activities to perform activity recognition. To determine how much time is spent on each activity each day, the length of certain activities is computed in the last step. Anxiety and sadness are detected using information on sleep and movement patterns. Anxiety detection and context-based analysis both contribute to mood prediction The hybrid assessment model that forecasts the condition of the older adult using the random forest classifier model receives the output of mood prediction, which is the mood level data together with activity recognition and duration.

[3] Sivakani. R and Gufran Ahmad Ansari have reviewed the existing literature on Alzheimer's disease research, focusing on prediction, classification, and related topics. They have utilized a supervised classification approach to distinguish between healthy control and Alzheimer's disease cases, based on MRI images. To predict AD, a transfer learning technique has been applied, along with an entropy-based method for selecting data. This approach has yielded promising results and achieved the latest standards. The authors have also employed multi-scale feature combinations for classification, processing both static and dynamic high-order functional networks. Features that vary over time have been extracted, and the researchers plan to explore feature selection methods in future studies. The UTSVM algorithm has been used to identify universal data points from EEG datasets, and various feature-extraction techniques have been applied to different datasets to demonstrate the effectiveness of this system, achieving a classification accuracy of 99%. In addition, SVM-based algorithms have been used for comparison purposes, and multi-class classification has been incorporated into the research. The AAL atlas approach has been employed to divide the brain into multiple regions and retrieve features for classification on MRI data, utilizing several kernel classifiers. The ADR approach has been utilized to obtain AD characteristics. Machine learning has been applied to speech analysis for Alzheimer's diagnosis, allowing for early detection of the disease. The grading biomarker approach has been used to predict AD following MCI, and once feature selection is complete, AD is classified. Finally, the sparse representation approach has been used on the ADNI dataset to develop a biomarker.

[4] The suggested strategy involves utilizing the two pathways discussed in the preceding section, as well as providing justifications for using a single MRI scan. The aim is to identify individuals who have received a diagnosis of dementia, while also receiving a non-demented result after a limited number of evaluations. This serves as an indicator of how the model has improved. In this proposed design, the primary focus is on determining the best approach for implementing storage methods, with AWS selected as the preferred option. AWS has established prepared frameworks for implementing big data at an expert level. Dementia diseases have been evaluated based on precision and recall. Previous research in this area has focused on imaging techniques such as MRI, sMRI, and fMRI. This paper aims to examine the implementation of a scenario utilizing longitudinal data, the number of slices, and the image properties taken into account. The random forest model has achieved the highest accuracy when compared to all other models. The deployment of big data and machine learning models on Alzheimer's disease, the most common and difficult-to-manage illness worldwide, is the central focus of this paper. Machine learning is the most common use of cutting-edge approaches, and the random forest algorithm is the most prominent one. The implementation will be on the AWS cloud platform, which will aid in the management of live and large amounts of medical data. The implementation will include popular models that can extract the required features from the dataset, and these models will provide the accuracy rate of the model. The

machine learning models will then take the data collected using AWS as input, and a graph displaying the accuracy rate of each method will be generated.

In the paper [5] Yagis et Al. have devised a way to parse the nueroanatomical alterations occurring in a patient suffering from Alzheimer's disease. They have proposed a way based on convolutional autoencoding, thereby creating an end-to-end deep learning system to predict anomalies in the MRI scan due to AD. Deep Convolutional Autoencoders work in two parts. The first part deals with encoding and learns how to compress the input data in a way such that the data points are close together and follow a latent approach. The data which is expressed in this latent space extracted from the MRI scans are used to distinguish between individuals suffering from Alzheimer's Disease and Mild Cognitive Impairment from healthy controls. For early stage prediction, they have also discovered concerning patterns in the concerned patient's cerebral atrophy.

This paper [6] explores the use of convolutional neural networks (CNNs) to diagnose Alzheimer's disease (AD) using brain MRI and PET images. The authors first review the existing literature on CNNs for AD diagnosis, and then propose a new CNN architecture that is specifically designed for this task. The proposed architecture is called "divNet," and it has several features that make it well-suited for AD diagnosis, including; It uses a diverging reception area, which means that the size of the receptive field increases as the network progresses through the layers. This helps to reduce feature redundancy and improve the generalization ability of the network.

It uses a simple encoder-based design, which makes it easy to train and interpret.

It is efficient in terms of memory and computation, which makes it suitable for use on large datasets.

The authors evaluated the performance of divNet on a dataset of brain MRI and PET images from patients with AD, MCI, and CN. The results showed that divNet was able to achieve a classification accuracy of 92.5%, which is significantly better than the performance of other CNN architectures that have been proposed for AD diagnosis

The authors concluded that divNet is a promising new approach for AD diagnosis, and that it has the potential to improve the accuracy and efficiency of AD diagnosis in the future.

In [7], Mahyou et al. propose to use concepts from domains such as Artificial Intelligence and Machine Learning to detect AD earlier instead of using metrics such as Mini Mental Score Examination which detect AD at very late stages when the symptoms start appearing. The research conducted by the group aims to develop a framework to diagnose and predict AD at the early stages. The framework aims to use large sets of related data collected from multiple sources which is subsequently fed into the framework as input required for deploying the machine learning model. The data is collected from sources and existing datasets such as ADNI, which contains MRI scans for analysis of AD, DNA, dietary, medical history, lifestyle and any other related data linked to risk factors of AD.

In [8], Jabason Et al. have proposed to use Deep sparse Autoencoder based feature learning approach to predict Alzheimer's Diseases using a semi-supervised learning approach, wherein the model's input consists of a combination of unlabeled and labeled datasets. The deep autoencoder is a form of feed-forward network which maps an input, X to an output, X' through some hidden layers. They use two hidden layers in the aforementioned network and the autoencoder has the potential to learn through noisy or redundant data due to the presence of hidden layers.

In the survey paper [9] by Subetha T et al. they have summarized numerous research papers based on the early prediction of Alzheimer's Disease using Machine Learning and other various assistive technologies. The general overview of the research carried out in the Alzheimer's Disease, and they have summarized all of it into two major categories viz. Wearable Assistive Technology and Machine Learning algorithms. Wearable devices consist of, but not limited to, Smart-Phones, Smart Home systems, Microphone, wearable cameras and Biometric Sensors.

Machine Learning Techniques such as Forecasting, Prediction and RAR algorithms have also proved to be beneficial for predicting the onset of Alzheimer's Disease

In [10], Kaur et al. aim to use transfer learned Deep CNN with ensemble learning and the ADNI dataset to predict neurological diseases such as AD. Image preprocessing techniques are used to manipulate the contrast and decrease the noise in the image. A Voxel Based morphometry is used to examine the difference in gray matter of the patients affected by AD. Their goal is to classify major variations in the volume of Gray Matter. These extracted features are fed to the pre-trained VGG-16 model and transfer learning is applied respectively.

III. Algorithms And Softwares

Machine learning algorithm

1. SVM: A supervised machine learning approach called the Support Vector Machine (SVM) is useful for both regression and classification The objective of SVM is to find the hyperplane that maximizes the distance between

the two classes is known as the optimal hyperplane. In the feature space, this hyperplane forms the decision boundary that separates the two classes.
2.Decision Tree: A popular machine learning technique known as decision tree is commonly used to solve both regression and classification problems. It is a tree like model of decisions and their possible consequences, with in a decision tree, an internal node represents a test on an attribute, each branch emanating from it depicts the test outcome, and a leaf node represents a class label or a numeric

Deep learning algorithms

1. Convolutional Neural Networks: (CNNs) that is Convolutional Neural Networks are a kind of deep network of neural that particularly well-suited for processing tasks. They use convolutional layers to extract relevant features from the input images, and pooling layers to make the features' dimensions smaller. It is a powerful network that extracts features from images using filters. In comparison to typical feed-forwarding neural networks, CNN's architecture was inspired by the sort of neurons found in the human brain, which allows it to recover vital information from images. The parameters of layers comprising some of trainable filters (or kernels) that keep a small but increased territory throughout the whole depth into the input density. CNN is useful in a variety of fields, including image segmentation, classification, and identification. CNN was used to identify the cattle illness picture collection in our suggested architecture since it has achieved current image recognition. CNN is divided into two sections: Feature Extraction and Classification. Pooling and convolution layers are used in feature extraction, whereas a fully connected layer is used in classification.
2. Long Short Term Memory: Long Short Term Memory is a kind of recurrent neural network. The output from the previous phase is sent into the current step of an RNN as input. Hochreiter & Schmidhuber created LSTM. It addressed the issue of long-term RNN dependency, in which the RNN can predict words from current data but cannot predict words held in long-term memory. RNN's performance becomes less effective as the gap length rises. By default, LSTM may save the data for a very long time. It is utilized for time-series data processing, forecasting, and classification.

IV. METHODOLOGY

Deep learning can be a useful tool for predicting Alzheimer's disease, as it can process large amounts of complex data and identify patterns that may be difficult for humans to discern. Here are some steps that can be taken to apply deep learning methodology to predict Alzheimer's disease:
Collect Data: Every deep learning project starts with gathering and preparing the data. In this situation, you would need to gather information on brain imaging, such as an MRI scan, as well as other pertinent information, such demographic data, medical histories, and cognitive tests.
Preprocess Data: Preprocessing is required to ensure that the data is in a format that can be fed into a deep learning model after it has been collected. In order to do this, it might be necessary to perform operations like scaling, normalising, and noise removal on the images.
Build a Model: The next step is to build a a deep learning model that can analyse the data and generate predictions is the next step. Convolutional neural networks (CNNs), a class of deep learning models that are particularly effective for image recognition tasks, are one strategy.
Train the Model: The model must be trained using the data after being constructed. In order to reduce the discrepancy between the projected and actual outputs, it is necessary to feed the model input data and modify the model's parameters.
Evaluate the Model: The model needs to be evaluated after training to see how well it predicts Alzheimer's disease. This is typically accomplished by evaluating the model's precision, sensitivity, and specificity using a test dataset.
Deploy the Model: If the model is reliable enough, it can be used to foretell Alzheimer's in new patients. This could entail creating a standalone application that medical professionals can use or integrating the model into a clinical workflow.
It's important to remember that deep learning is simply one method for forecasting Alzheimer's disease. In order to make the most accurate forecasts, it is frequently best to combine different techniques, including statistical modelling and machine learning.

V. CONCLUSION

Yes, machine learning algorithms have shown promise in predicting Alzheimer's disease and other forms of dementia. One of the advantages of using machine learning is that it can analyze large amounts of data from

different sources, including cognitive tests, brain MRI scans, and genetic information, to identify patterns and make accurate predictions.

Combining psychological characteristics with brain MRI images is a promising approach that has already shown some success. For example, one study used a machine learning algorithm to predict Alzheimer's disease in patients based on their brain MRI scans and cognitive test results. The algorithm was able to accurately distinguish between patients with Alzheimer's disease and those without the disease, and it also predicted the likelihood of disease progression.

In the future, it is possible that machine learning algorithms could be used to predict Alzheimer's disease even earlier, before symptoms become apparent. By analyzing changes in the brain and psychological characteristics over time, machine learning could identify subtle changes that indicate the onset of the disease.

Of course, there are still many challenges to overcome before machine learning algorithms can be used effectively to predict Alzheimer's disease in a clinical setting. For example, data privacy and ethical considerations need to be taken into account when collecting and analyzing large amounts of medical data. Nonetheless, machine learning has the potential to revolutionize our ability to detect and treat Alzheimer's disease, and it is an exciting area of research to watch.

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