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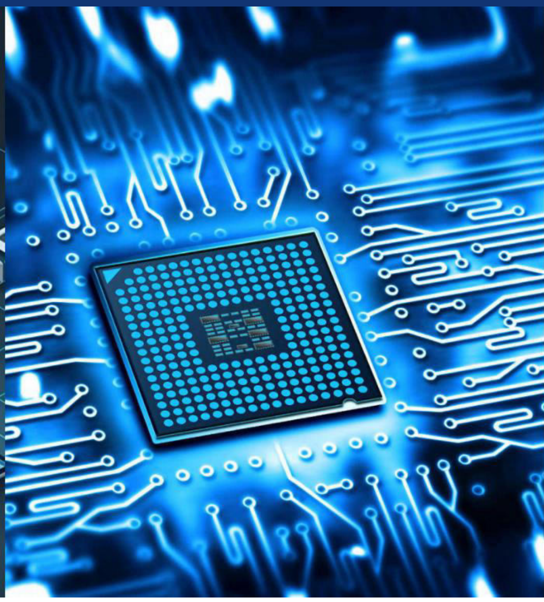


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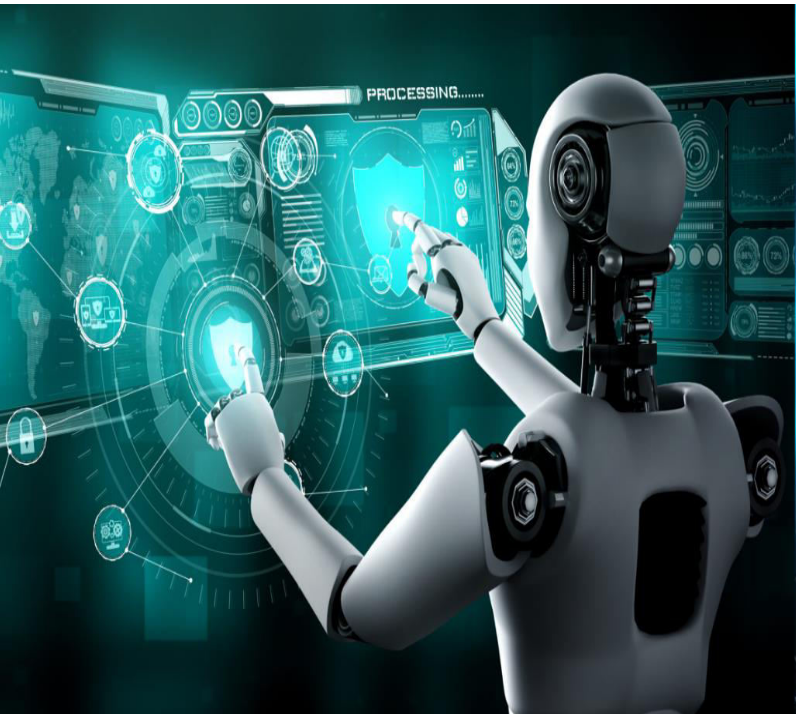

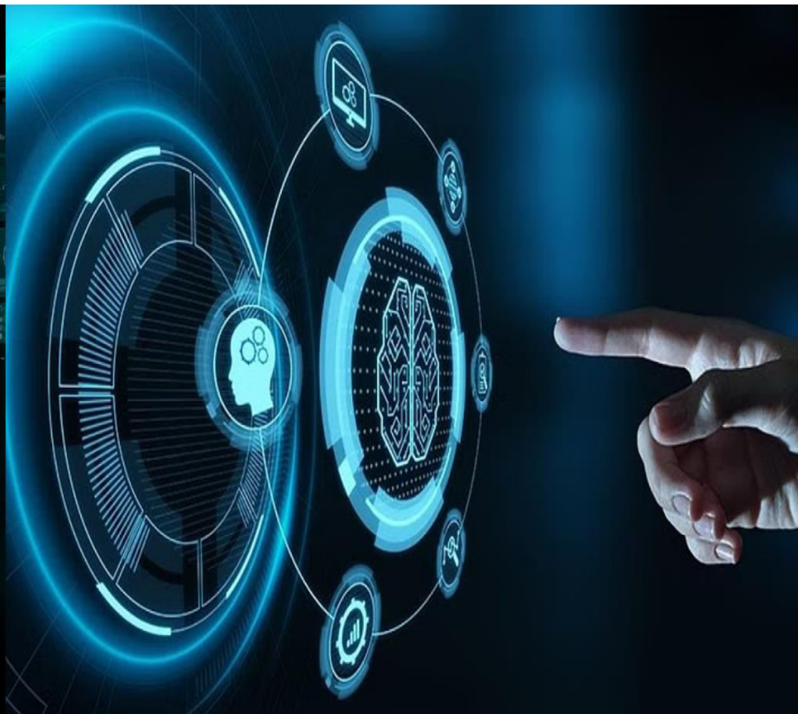

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Detecting Alzheimer's Disease with Machine Learning

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ABSTRACT: This study proposes a computer-aided diagnostic model for detecting Alzheimer's disease (AD) and Mild Cognitive Impairment (MCI) using EEG data. The approach involves two main steps: signal processing and classification. First, the EEG signal is decomposed using Discrete Wavelet Transform (DWT) and augmented with windowing. Then, an improved CascadeNet model is used for feature extraction and classification, chosen for its ability to achieve high accuracy with small datasets. The model is evaluated using metrics like sensitivity, specificity, F-measure, and accuracy, achieving impressive results of 98.84% and 97.78% on the Figshare and Brazilian datasets, respectively. Unlike previous methods, this approach distinguishes between MCI and AD. The model's high performance makes it a valuable tool for identifying biomarkers and aiding in clinical diagnosis of AD. A support vector machine (SVM) is used to classify the collected features.

KEYWORDS: Electroencephalogram (EEG), Discrete Wavelet Transform (DWT) , CascadeNet, Figshare and Brazilian datasets.

I. INTRODUCTION

Any condition affecting the brain or another area of the nervous system is considered a neurological brain disorder, and Alzheimer's disease is among the most prevalent neurological brain disorders worldwide. The primary cause of dementia is Alzheimer's disease (AD), a neurodegenerative disease that deteriorates brain neurons, especially axons, by destroying neurotransmitters that are crucial for memory storage and message transmission to the brain. AD is characterized by a progressive loss of neurological, mental, and cognitive functions, including memory, as well as changes in judgment, behavior, and emotions. According to a World Health Organization (WHO) assessment, hundreds of millions of individuals worldwide suffer from neurological illnesses, which pose a threat to global public health. According to WHO estimates from 2005, 0.379% of people worldwide suffer from dementia, and by 2030, that number is expected to rise to 0.556%. According to recent data, 47.5 million people suffer from dementia, with 60–70% of instances possibly being caused by Alzheimer's disease. Globally, there were about 29.8 million AD sufferers in 2015.

Because of this, many researchers have begun developing computer systems that can detect Alzheimer's disease by analyzing patient brain waves. For instance, it was suggested to use Convolutional Neural Networks (CNN) and Deep Learning's representational power to create suitable sets of EEG signal features that might be used to categorize AD EEG patterns. To categorize sets of EEG from different people, the suggested method uses a series of convolutional-sub sample layers to create a multivariate assembly of distinct patterns. The accuracy of the suggested method was 80%. described a low-density (7-channel) EEG configuration and an automated artifact removal (AAR) algorithm-based automated EEG-based AD detection system. Common EEG metrics, such as amplitude-modulation characteristics and spectral power and coherence, are calculated after AAR. Classifying the gathered features is done using a support vector machine (SVM).

II. LITERATURE SURVEY

Alzheimer's disease, the most prevalent neurological brain condition, can be identified by a number of clinical techniques. Nonetheless, it has been demonstrated that the electroencephalogram (EEG) is a useful tool for identifying Alzheimer's disease. A band-pass elliptic digital filter was employed in this work to remove disruptions and interference from the EEG data. In order to extract the features of EEG signals, the filtered signal was then broken

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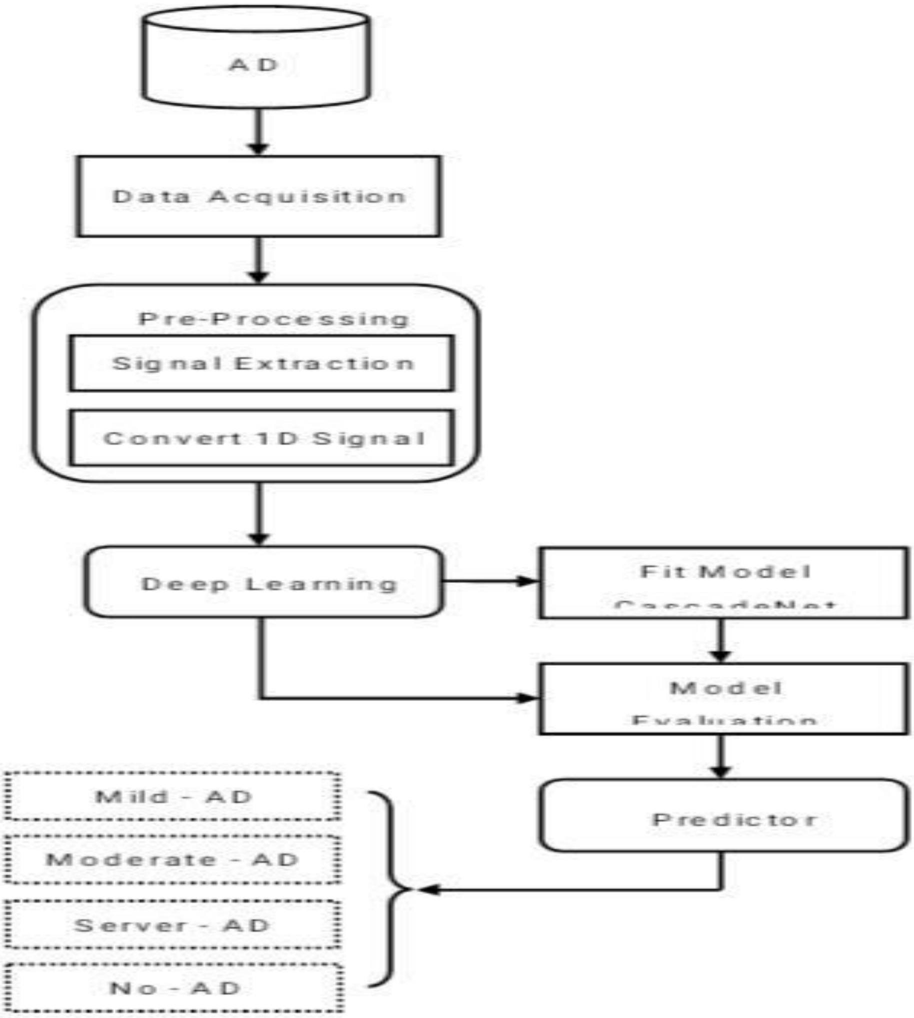
down into its frequency bands using the Discrete Wavelet Transform (DWT) approach.The performance of the different proposed machine learning approaches have been compared and evaluated by computing the sensitivity, specificity, overall diagnosis accuracy, and area under the receiver operating characteristic (ROC) curves and plotting the ROC curves and confusion matrices for five classification problems. These investigations aim to compare the proposed approaches and recommend the best combination method for the diagnosis of Alzheimer's disorders. Alzheimer is a common and significant neurological disorder worldwide, typically associated with agerelated dementia. Alzheimer's patients exhibit slower brain activities compared to healthy individuals and the most prominent symptom of the disease is the impairment of cognitive functions. Early diagnosis of Alzheimer's is crucial to prevent the rapid progression of the disease.utilized EEG signals from both Alzheimer's patients and healthy individuals, which were made publicly available by Florida State University. Preprocessing was applied to the EEG signals to eliminate existing noise. Subsequently, a total of 34 various feature in the time and frequency domains, such as entropy, Hjorth parameters, etc., were extracted from the EEG signals for the purpose of Alzheimer's diagnosis. In older persons, mild cognitive impairment (MCI), a precursor to dementia, can result in Alzheimer's disease (AD). Therefore, early detection of MCI and implementation of treatment and intervention can effectively slow down or even inhibit the progression of the disease, thus minimizing the risk of AD **.**

The classification results of different feature sets (including with sleep features from sleep EEG and without sleep features from awake EEG) and different classification methods were evaluated. Finally, the MCI classification accuracy of the GRU network based on features extracted from sleep EEG was the highest, reaching 93.46%. Recent years have witnessed a surge of sophisticated computer-aided diagnosis techniques involving Artificial Intelligence (AI) to accurately diagnose and classify Alzheimer's disease (AD) and other forms of Dementia. Despite these advancements, there is still a lack of reliable and accurate methods for distinguishing between (AD) and Healthy Controls (HC) using Electroencephalography signals (EEG). The main challenge is finding the right features from the intricate spectral-temporal EEG data, which can provide information sufficient for diagnosis. This study proposes a new approach integrating Deep Ensemble Learning (DEL) and 2-dimensional Convolutional Neural Networks (2D-CNN) to address these issues. Public EEG-based Alzheimer's datasets have been classified in the DEL model without applying any feature extraction after cleaning from noise and artifacts. Furthermore, the proposed DEL model used 5 different 2D-CNN models as internal classifiers. As a result, the EEG-based DEL model proposed for the first time provided high accuracy in AD classification.

The proposed DEL model reached an average accuracy of 97.9% in AD classification due to 5 cross-fold training. In conclusion, this work renders that incorporating ensemble learning techniques into automotive health applications create extensible and stable AI models needed for computer-aided diagnostic. However, although the reported results and evaluation are promising, further efforts will need to be made to improve the accuracy of our proposed model. In addition, a fine-grid evaluation will be necessary to accurately understand potential impacts in clinical applications, such as earlier diagnosis or treatment decisions.

III. METHODOLOGY

Method of deep learning along with the brain network and clinical significant information like age, ApoE gene and gender of the subjects for earlier examination of Alzheimer's. Brain network was arranged, calculating functional connections in the brain region by employing the resting-state functional magnetic resonance imaging (R-fMRI) data. To produce a detailed discovery of the early AD, a deep network like auto encoder is used where functional connections of the networks are constructed and are susceptible to AD and MCI.Memory loss, difficulty processing language, communication challenges and emotional changes are just a few. A big change in lifestyle and the capacity to perform everyday tasks goes hand-in-hand with the primary effects of the disease on a patient's mind and body.



IV. PROPOSED SYSTEM

In the proposed method, the discrete wavelet transform (DWT) is initially employed to decompose recorded EEG signals into their constituent sub-bands. CascadeNet decision-making is utilized to extract optimal features from the spectrogram image, providing an accurate representation of the EEG signal. Spectrograms are generated by varying frequencies in windowed signals using a short-time Fourier transform (STFT) as input to a CascadeNet. Although the windowing method significantly separates them and overcomes the non-stationary property, low and high-frequency changes still exist depending on the frequency resolution. There is a need to use a model that solves this challenge with this small amount of data. Meanwhile, the CascadeNet method was recognized as one of the most effective signal analyzer methods.Subsequently, windowing is applied to the decomposed signals to address the non-stationary nature of EEG, thereby enhancing classification accuracy. The method employs a modified CascadeNet architecture combined with DWT for sub-band decomposition and STFT from the spectrogram image to overcome the non-stationary and nonlinear effects of EEG signals.The application of a filter method reduces the number of features in the EEG signal, enabling neurologists to identify the most relevant features and explore adapted patterns. This reduction enhances the interpretability of the results and supports more effective clinical decision-making by focusing on the most significant aspects of the EEG data.

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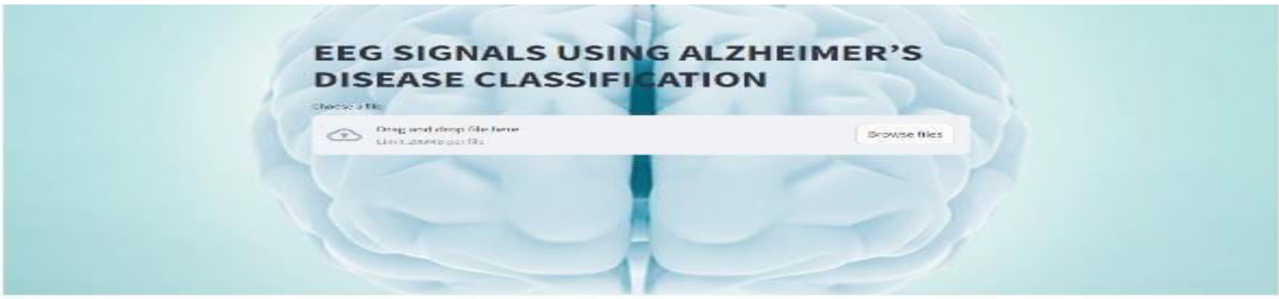
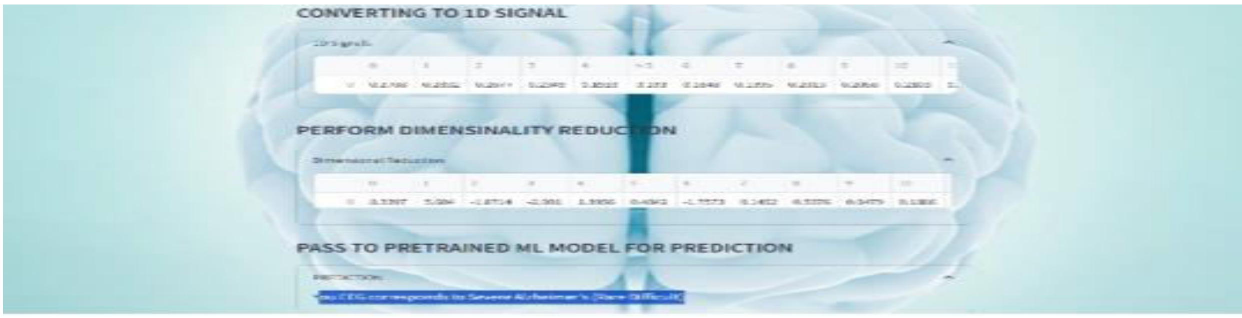
OUTPUT



An SVM-based approach for classifying Alzheimer's disease using EEG signals is presented. The landing page of a system designed for EEG signal analysis and Alzheimer's disease classification is shown. The system likely uses a Support Vector Machine (SVM) algorithm to analyze EEG data and classify it to detect Alzheimer's disease. The system allows the selection of EEG datasets for analysis. The presented approach aims to provide a tool for early diagnosis and monitoring of Alzheimer's disease using non-invasive EEG measurements and machine learning techniques.

Prediction:



The process depicted in the image involves analyzing EEG data to predict the likelihood of severe Alzheimer's disease using machine learning techniques, potentially involving Support Vector Machines (SVM). The process includes these stages:

1. Converting to 1D Signal:
Raw EEG signals are converted into a one-dimensional representation, with the image showing an example of 20 signal values.
2. Performing Dimensionality Reduction:The dimensionality of the data is reduced, likely to extract the most relevant features and improve model efficiency. The image displays 10 reduced dimensions.
3. Passing to Pretrained ML Model for Prediction:The processed data is fed into a pretrained machine learning model, possibly an SVM, which has been trained to recognize patterns associated with Alzheimer's disease.
4. Prediction:The model outputs a prediction, in this case indicating that the EEG corresponds to Severe Alzheimer's (Rare Difficult).

V. CONCLUSION AND FUTURE WORK

For Alzheimer's disease (AD) patients to receive the right medications and manage their illness effectively, mild cognitive impairment (MCI) must be identified early. This suggests a novel approach that uses integrated electroencephalogram (EEG) features to diagnose both AD and MCI. In order to categorize AD using EEG data, a hybrid deep learning model was created. The model combines handcrafted characteristics with an effective CascadeNet architecture. centered on the creation of an Alzheimer's disease diagnosis system that analyzes EEG data. The speed and precision of the diagnosis procedure will be increased with the creation of an Alzheimer's disease diagnosis system that can automatically analyze brain signals. The band-pass filter was used in this work to filter the recorded EEG datasets. The datasets that are used moderate AD—were created from the used datasets. Five categorization problems—Control vs. mild AD group, Control vs. moderate AD group, mild vs. moderate AD group, Control vs. mild and moderate AD group, and Control vs. mild AD vs. moderate AD group—have been examined from these groups. These five categorization issues have been used to assess the suggested diagnosis system. Future studies should examine the value of deep learning classification techniques and other sophisticated feature extraction strategies. Various neurological brain illnesses will be used to assess the suggested diagnosis method before it is put into use as a hardware system for real-time diagnosis. Therefore, it is crucial and will be done in future work to validate this with a bigger dataset and to extend this technology so that the input signals can be acquired from a varietEEGrecorders.

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