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An Enhanced Detection and Segmentation of Parkinson's Disease using Novel Deep Learning based Approaches.

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Abstract: Parkinson's disease (PD) is a progressive neurodegenerative condition histologically defined by the degeneration of dopaminergic neurons in the substantia nigra pars compacta (SNpc) and the development of Lewy bodies in many brain regions. The SNpc is a compact midbrain region essential for motor coordination and movement regulation, generating dopamine, a neurotransmitter crucial for the start, speed, and fluidity of voluntary movement sequences. The etiology of the majority of Parkinson's disease cases, referred to as 'sporadic' or 'idiopathic' PD, remains elusive, however it encompasses intricate interplay between hereditary and environmental influences. Parkinson's disease is the second most prevalent neurodegenerative ailment behind Alzheimer's disease, impacting 1% of those over 60 years old and around 5% by age 85. The incidence is increasing owing to aging demographics.

The Parkinson Disease Foundation estimates that around 10 million individuals globally are affected with Parkinson's disease, including one million in the USA, 1.2 million in Europe, and a predicted two million in China by 2030. One in 500 persons in the UK is afflicted, and this figure is anticipated to increase thrice over the next 50 years. No established disease-modifying treatment presently exists. The diagnosis of Parkinson's Disease requires the presence of bradykinesia, with either muscular stiffness, tremor, or postural instability. Approximately 20% of patients do not have a tremor. The signs of Parkinson's disease extend beyond motor deficits. Timely identification of Parkinson's Disease is crucial for delivering suitable therapy and prognosis information to patients. Nonetheless, a precise early diagnosis may be difficult due to the overlap of movement symptoms with other illnesses. Physicians diagnose Parkinson's disease by clinical assessment, mostly using data obtained from patient history and examination. Occasionally, brain imaging may be solicited to assist in corroborating the clinical diagnosis; nevertheless, there are yet no diagnostics that are entirely sensitive or specific for Parkinson's disease. The misdiagnosis rate of Parkinson's Disease is roughly 10–25%, with an average duration of 2.9 years needed to get 90% accuracy. Autopsy remains the definitive standard for illness confirmation.

This study developed an advanced convolutional neural network model to predict Parkinson's disease using both picture and audio data. Typically, conventional machine learning algorithms like SVM and Random Forest do not filter data repeatedly, resulting in lower prediction accuracy. Consequently, this study employs Convolutional Neural Networks (CNN), which filter data many times via neuron values, thus enhancing prediction accuracy. This study utilizes WAVE and SINE pictures of those with normal conditions and those with Parkinson's disease for imaging data, while UCI Parkinson's recorded voices serve as speech samples.

Keywords: *Parkinson disease, CNN, voice and image samples.*

INTRODUCTION

Parkinson's disease (PD) is characterized by the degeneration of dopaminergic neurons in the substantia nigra pars compacta of the midbrain. This neurodegeneration results in several symptoms such as coordination difficulties, bradykinesia, alterations in vocalization, and stiffness. Dysarthria is prevalent in individuals with Parkinson's disease, characterized by weakness, paralysis, and impaired coordination within the motor-speech system, impacting breathing, phonation, articulation, and prosody. Due to the variability of symptoms and disease progression, Parkinson's disease is often undiagnosed for extended periods. Consequently, there is a want for more sensitive diagnostic instruments for Parkinson's disease diagnosis, since the progression of the illness results in the emergence of additional symptoms that complicate treatment. The primary deficiencies of Parkinson's disease speech are diminished intensity, pitch and loudness monotony, decreased stress, improper pauses, brief speech bursts, irregular speech pace, inaccurate consonant articulation, and a harsh, breathy voice (dysphonia). The spectrum of speech-related symptoms is encouraging for a prospective detection tool, since capturing voice data is non-

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invasive and may be easily conducted using mobile devices.

Parkinson's disease is one of the most prevalent chronic neurodegenerative disorders affecting individuals in today's society. Parkinson's disease (PD) is a quintessential movement disorder characterized by basic symptoms including tremor, rigidity, bradykinesia, and postural instability, together referred to as Parkinsonism syndrome. Parkinson's disease (PD) is a chronic neurological disorder that mostly affects the elderly population in contemporary society. Recent enabling technologies need the development of effective and robust automated procedures for diagnosing the early stages of Parkinson's disease. Deep learning algorithms using diverse diagnostic approaches have been created to identify Parkinson's disease and address associated diagnostic challenges. This research paper provides a comprehensive evaluation of existing surveys and deep learning-based diagnostic techniques for Parkinson's disease detection. This assessment covers the methodologies of deep learning-based diagnostic methods for Parkinson's disease identification, including dataset pre-processing, feature extraction and selection, and classification.

In recent years, the use of machine learning-based computer-aided diagnostic (CAD) systems for illness diagnosis, including early-stage detection, has markedly increased. There has been a rise in the application of CAD systems for diagnosing Parkinson's disease (PD) using diverse modalities, including speech signals, gait signals, magnetic resonance imaging (MRI), positron emission tomography (PET), single-photon emission computed tomography (SPECT), Dopamine Transporter Scan (DaT Scan), tremor signals, handwriting signals, handwritten images, and various clinical features (CF).

LITERATURE SURVEY

Haq et al. examined the diverse datasets used to assess the proposed PD recognition algorithms for a comprehensive understanding of these datasets. This review has also examined the model assessment metrics and cross-validation approaches used by various works in this field. This study analyzed the reviewed literature and investigated emerging research challenges and corresponding solutions. This study identified various trends and topics for future research that will facilitate advancements in automated illness identification, namely in the detection of Parkinson's disease and its integration into E-healthcare systems.

Clayton et al. presented convolutional neural networks to extract characteristics from pictures generated by handwriting dynamics, which convey distinct information throughout the individual's evaluation. This effort provides a collection of pictures and signal-based data to further studies in computer-aided Parkinson's disease diagnosis. The study of handwriting dynamics with deep learning algorithms has shown effective for the automated detection of Parkinson's illness and can surpass handmade characteristics.

Tanveer et al. conducted an extensive evaluation of literature from 2013 to 2021 about the diagnosis of Parkinson's disease (PD) and its subtypes using artificial neural networks (ANNs) and deep neural networks (DNNs). This paper provided comprehensive information and analysis on the use of many modalities, datasets, architectures, and experimental settings concisely. This study provided a comprehensive comparative examination of many potential designs. Ultimately, proposed some pertinent future avenues for scholars in this field. Dash et al. used machine learning (ML) techniques to tackle these challenges and enhance the diagnostic and evaluative processes of Parkinson's Disease (PD), facilitating the categorization of PD patients and healthy controls or those with analogous clinical manifestations. Machine learning (ML) is a subset of artificial intelligence (AI) that is increasingly used in many medical diagnostic activities, including the identification of several illnesses. This chapter offers an overview of the use of machine learning methods and discusses essential principles for Parkinson's disease diagnosis.

Nilashi et al. used an Incremental Support Vector Machine to forecast Total-UPDRS and Motor-UPDRS scores. This study used non-linear iterative partial least squares for data dimensionality reduction and a self-organizing map for the clustering challenge. This study assessed the strategy by doing many experiments using a PD dataset and presenting the findings in contrast to previously existing methods. The prediction accuracies of the approach, assessed by MAE, were achieved for Total-UPDRS and Motor-UPDRS as MAE=0.4656 and MAE=0.4967, respectively. Vilda et al. proposed a methodology that utilizes highly normalized descriptors representing the probability distribution of kinematic variables related to vowel articulation stability. This approach, possessing intriguing properties from an information theory perspective, enhances the efficacy of simple yet robust classifiers in yielding satisfactory detection outcomes for Parkinson's Disease.

Maachi et al. introduced an innovative intelligent system for Parkinson's identification using deep learning methodologies to assess gait data. This study used a one-dimensional convolutional neural network (1D-Convnet) to construct a deep neural network (DNN) classifier. The proposed model analyzes 18 one-dimensional inputs obtained from foot sensors that measure the vertical ground response force (VGRF). The first segment of the network has 18 parallel one-dimensional convolutional networks matching to system inputs. The second component is a fully connected network that integrates the concatenated outputs of the 1D-Convnets to provide a final classification. This study evaluated the methodology for detecting Parkinson's disease and predicting its severity using the Unified Parkinson's Disease Rating Scale (UPDRS).

Shivangi et al. developed two neural network-based models, the VGFR Spectrogram Detector and the Voice Impairment Classifier, designed to assist physicians and individuals in the early diagnosis of diseases. A comprehensive empirical assessment of CNNs (Convolutional Neural Networks) has been conducted on large-scale picture classification of gait signals transformed into spectrogram images, alongside deep dense ANNs (Artificial Neural Networks) applied to speech recordings, to forecast the illness.

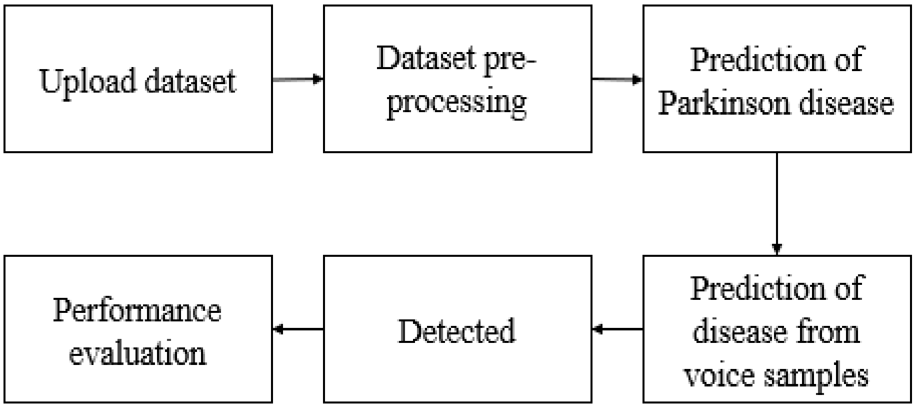
Pahuja et al. examined three classifiers: Multilayer Perceptron, Support Vector Machine, and K-nearest Neighbor, using a benchmark speech dataset to evaluate their efficiency and accuracy in Parkinson's Disease categorization. The Voice input dataset for these classifiers was sourced from the UCI Machine Learning Repository. The artificial neural network using the Levenberg–Marquardt algorithm emerged as the most effective classifier, with the greatest classification accuracy of 95.89%.

Research by Lavalle et al. on the identification of Parkinson's disease (PD) indicates that voice problems are associated with symptoms in 90% of PD patients during the early stages. Consequently, there is a keen interest in using voice characteristics for computer-assisted diagnosis and remote monitoring of individuals with Parkinson's disease in its first phases. This study enhances accuracy and decreases the number of chosen voice characteristics in Parkinson's disease identification by using the most recent and extensive public dataset available. The optimal accuracy is achieved with the use of a support vector machine, surpassing the results reported in the first study using the identical dataset. Moreover, the associated computational complexity is further reduced by limiting the selection to no more than 20 characteristics. Zhang et al. examined mobile health (mHealth) technology for preventative medicine, namely in the treatment of chronic diseases. Numerous research studies have investigated the potential of mobile and wearable personal gadgets to identify the symptoms of Parkinson's disease, with encouraging results. It facilitated the transition of early Parkinson's disease detection from clinical settings to everyday life. This survey paper aimed to provide a thorough review of mHealth technologies for Parkinson's disease detection from 2000 to 2019, comparing their advantages and disadvantages in practical applications, and offering insights to bridge the performance gap between advanced clinical methods and mHealth technologies. Alzubaidi et al. sought to investigate and consolidate the uses of neural networks for diagnosing Parkinson's disease (PD). The PRISMA Extension for Scoping Reviews (PRISMA-ScR) was adhered to in the execution of this scoping review. Relevant papers were identified by searches of both medical databases (e.g., PubMed) and technical databases (IEEE). Three reviewers independently conducted the research selection and retrieved data from the included studies. Subsequently, the narrative technique was used to synthesize the gathered data. Ali et al. suggested use the random undersampling technique to equilibrate the training process. The second issue is the poor classification accuracy rate, which has constrained clinical relevance. This study proposes a cascaded learning method that integrates a Chi-squared model with an adaptive boosting (Adaboost) model to enhance PD detection accuracy. The Chi2 model ranks and picks a subset of relevant characteristics from the feature space, whereas the Adaboost model predicts PD based on this subset of features.

Wodzinski et al. proposed a method for detecting Parkinson's disease via persistent phonation of vowels, using a ResNet architecture initially designed for picture classification. This study computed the spectrum of audio recordings and used them as picture input for the ResNet architecture, which was pre-trained on the ImageNet and SVD databases. To mitigate overfitting, the dataset underwent extensive augmentation in the temporal domain. The Parkinson's dataset, sourced from the PC-GITA database, comprises 100 individuals, with 50 classified as healthy and 50 diagnosed with Parkinson's disease. Each patient was documented three times. The achieved accuracy on the validation set exceeds 90%, similar to contemporary state-of-the-art approaches.

PROPOSED SYSTEM

For the purpose of this project, we are developing an algorithm model for machine learning that is built on advanced convolutional neural networks in order to assess the likelihood of Parkinson disease based on both image and speech data. Because all of the currently available machine learning algorithms, such as SVM and Random Forest, do not filter data several times, the accuracy of their predictions is lower. As a result, we have implemented the CNN algorithm, which filters data many times using NEURON values, in order to improve the accuracy of its predictions.



Pre-processing

It is a technique that involves preparing the raw data and making it acceptable for a machine learning model. This process is known as data pre-processing. During the process of developing a machine learning model, this is the first and most important phase.

It is not always the case that we come across data that is clean and prepared when we are involved in the process of establishing a project. In addition, it is essential to clean the data and arrange it in a structured manner before carrying out any activity using the data. For this reason, we make advantage of the data pre-processing job.

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Splitting the Dataset into the Training set and Test set

During the pre-processing stage of machine learning, our dataset is separated into two distinct sets: a training set and a test set. This is one of the most important processes in the data pre-processing process since it allows us to improve the performance of our machine learning model with the help of this step.

Let's say that we have trained our machine learning model using a dataset, and then we test it using a dataset that is entirely different from the one we used to train it. In such case, our model will have a tough time comprehending the relationships that exist between the models.

If we train our model extremely well and its training accuracy is also quite good, but then we feed it with a fresh dataset, then the performance of the model will decline. In light of this, we always make an effort to develop a machine learning model that provides satisfactory results when applied to both the training set and the test dataset.

CONCLUSION AND FUTURE WORK

Early identification of Parkinson's disease is critical for gaining a deeper comprehension of the factors that contribute to the condition, initiating therapeutic interventions, and facilitating the development of effective medications. In this effort, a deep convolutional neural network (CNN) model was presented with the purpose of automatically distinguishing between normal persons and patients who were afflicted by Parkinson's disease (PD). The ParkinsonNet model that was proposed demonstrated a high level of detection capability by achieving a high level of accuracy. Specifically, this is mostly attributable to the desired qualities of the machine learning model, which include the ability to learn linear and nonlinear features from PD data without the need of manually constructed feature extraction. We want to do research on the aspects that have been taken into consideration and to implement a PD detection system for patients who are diagnosed with PD at an early stage.

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