An Extensive Survey on Applications of Advanced Deep Learning Algorithms on Detection of Neurodegenerative Diseases and in Tackling the Security Threats in their Treatment Protocol

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ABSTRACT

Introduction: A degenerative disorder results in deterioration of the structure or functions of the "nervous system", either by killing or rupturing the nerve cells, which is known as a neurodegenerative disease. The most frequently occurring nerve disorder is "Parkinson's Disease".

Objectives: The main objective is to focus on neurodegenerative Parkinson's disease its analysis using deep neural networks.

Materials and Methods: This survey briefly reviews some literature on advanced Deep learning algorithms in the diagnosis of neurodegenerative diseases and their treatment protocol.

Results: This paper presented few techniques followed by various researchers; accuracy, sensitivity, recall achieved by the methodologies have been presented for Parkinson's disease.

Conclusion: In conclusion, this study has reviewed some significant datasets related to Parkinson's disease, applications of advanced deep learning algorithms in their detection, and to ensure advanced neurodegenerative disorder treatments that make use of Brain Computing Interface.

Key Words: Deep Learning, Parkinson's Disease, Deep Brain Stimulation, Machine Learning, Convolution Neural Network, Medical Analysis

INTRODUCTION

Neurons are the basic building blocks of the human nervous system. When these structures are ruptured or dead, our bodies do not replace them. This leads to neurodegenerative diseases like Alzheimer's and Parkinson's. These diseases are incurable and cause the patient's brain to deteriorate over time, eventually leading to death. Dementias are the most common neuro disorders, and Alzheimer's disease is the most common cause of dementia.[1] This paper focuses on the use of deep learning models to detect the occurrence of neurodegenerative diseases such as Alzheimer's and Parkinson's.

Parkinson's disease, also known as "PD," is a form of neurodegenerative disease that causes involuntary trembling, kinetic difficulties, and a lack of self-coordination. As the disease progresses, it can pose a physical and mental challenge to patients, resulting in several issues such as depression, memory loss, behavioural changes, exhaustion, and sleep disturbances. The percentage of patients with "early-onset" is less than 10%.[2] Elderly people are more likely to be affected by this ailment. Some common symptoms include,

- Resting Tremor/Tremble.
- Limbs and trunk stubbornness.
- Hindrance in kinetic activities.
- Loss of balance.
- Depression
- Emotional and behavioural changes
- Difficulty in speaking, etc.

Existing Datasets

Different data types are available for analyzing the Parkinson's disease (a) "PPMI"[3] or "Parkinson's Progression Markers Initiative" dataset. There are seventy-two data tables available in PPMI that includes both lab and clinical data. (b) Physionet - "DBS Dataset"[4] includes rest tremor velocity recordings of the index finger for sixteen patients, who undertake "Electrical DBS" either it is unilateral or bilateral.

Deep Learning Models:

Some of the existing deep learning models that are used for analyzing Parkinson's disease are (a) Convolutional Neural Network (CNN) (b) Restricted Boltzmann Machine (c) Siamese Neural Networks (d) Residual Network (ResNet) (e) U-Net and (f) LSTM

Prediction of Parkinson's disease

Wu Wang et al.[5] proposed an innovative deep-learning technique that is based on "premotor features" to classify an individual as affected with Parkinson's disease or not. Different hyperparameter configurations are used to create three models: "DEEP1," "DEEP2," and "DEEP3," as well as an ensemble of the three models called "DEEP-EN." These models take into account things like "rapid eye movement" and "level of spinal fluid" As compared to other algorithms on a dataset of 183 healthy people and 411 early Parkinson's disease patients, the proposed deep learning model outperforms them all, with an average accuracy of 96.45%.

K. H. Leung et al.[6] have proposed a hybrid approach to predict the "MDS-UPDRS-III" score at "year 4" based on "year 0" and "year 1" results. The functionality is extracted from the "DAT-SPECT" images with the "Google InnceptionnV3" model[7] which is well-suited for medical data.[8,9,10] Veronica Munoz Ramrez et al.[11] suggested a deep learning approach based on "quantitative Magnetic Resonance Imaging" data that uses autoencoders and a technique[14,15,16] called "anomaly scoring" to identify Parkinson's disease patients. This model obtained optimal results with "Area Under Curve" or "AUC" of 0.83, 0.80 and 0.74 for the "SAE", "saved" and "Dave", respectively. Conceptual research on brain jacking in deep brain stimulation (DBS) and its autonomy was suggested by Jonathan Pugh et al.[12]. To demonstrate the possibilities of brain jacking in a brain computing interface, the authors produced three conceptual case studies (BCI). This research also discusses the obligations and ethics that must be adhered to when developing advanced BCI applications. Heena Rathore et al.[13] have proposed an algorithm for third-party prediction of various attacks in DBSs. This approach employs the long short-term memory (LSTM RNN) to forecast and predict rest tremor velocity (RTV), a form of characteristic that aids in the assessment of the severity of neuro disorders.

COMPARATIVE ANALYSIS

A variety of methods have been used to diagnose Parkinson's disease (PD), and we can see that transfer learning methodologies have good accuracy with little data. Leung et al.[6] proposes a parallel hybrid approach for detecting Parkinson's disease based on neuroimage data and clinical information. Table 1 shows a comparison of different algorithms for detecting Parkinson's disease.

Table 1: Comparison of various algorithms on detection of Parkinson's disease.

Sr. No	Proposed Algorithm	Dataset	Results
1	DEEP1 DEEP2 DEEP3 DEEP_EN[5]	PPMI	96.45% (Average)
2	Google Inception V3 and LSTM[6]	PPMI	Method 1 - 4.33±3.36 (MAE)
			Method 2 - 3.71±2.91 (MAE)
			Method 3 - 3.22±2.71 (MAE)
3	Auto Encoders[11]	PPMI	sAE - 0.075 (Reconstruction Error)
			SVAE - 0.086 (Reconstruction Error)
			DVAE - 0.106 (Reconstruction Error)

CONCLUSION

Every year, a significant proportion of the world's population is affected by neuro disorders. Since early detection is critical for care and is often a difficult challenge, the use of intelligent systems in conjunction with medical experts is critical in detecting them. Some advanced deep learning models in the areas of identification and implementing protection in their treatment protocol have been reviewed in this paper. The PPMI database is the most commonly used dataset for Parkinson's disease classification. The model based on a parallel approach has demonstrated exceptional efficiency. The transfer learning method is assumed to aid in achieving maximum accuracy with the least amount of data. While Deep Brain Stimulation holds promise for treating Parkinson's disease, it also poses significant risks. Also detecting attacks on Deep Brain stimulators is used successfully for detecting various attack patterns. These types of methods

will be needed to ensure that Brain Computing Interfaces are used safely. To summarize, this research looked at some important datasets related to Alzheimer's disease and Parkinson's disease, as well as the applications of advanced deep learning algorithms in their identification and the protection of advanced neurodegenerative disorder therapies that use Brain Computing.

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