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Comparative Study on the Detection of Parkinson's Disease using Machine Learning

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Abstract: *Parkinson's disease is a progressive disorder that affects the nervous system and the parts of the body controlled by the nerves and the root cause of it is falling rates of dopamine levels in the forebrain. It is a chronic degenerative disease with progressive illness, which means it develops new symptoms over time, actually the average diagnosis time is above two years. The prediction of the Parkinson's disease is the most challenging problem for the biomedical engineering researches and doctors. Due to the decrease in motor control that is the hallmark of the disease, voice can be used as a means to detect and diagnose PD. With advancements in technology and the prevalence of audio collecting devices in daily lives, reliable models that can translate this audio data into a diagnostic tool for healthcare professionals would potentially provide diagnoses that are cheaper and more accurate. We provide evidence to validate this concept here using a voice dataset collected from people with and without PD.*

Keywords: Parkinson's disease.

I. INTRODUCTION

Parkinson's disease (PD) is a degenerative neurological disorder that affects millions of individuals worldwide. The resulting dopamine deficiency leads to a range of motor symptoms, including tremors, rigidity, bradykinesia (slowness of movement), and difficulty with balance and coordination. PD is also associated with non-motor symptoms such as sleep disorders, anxiety, and depression. Early detection of PD is crucial for the effectiveness of treatment and the ability to delay disease progression. However, current diagnostic methods are often unreliable and may require multiple visits to a specialist before a definitive diagnosis is made, and the evaluation of symptoms is done by the use of rating scales such as the Unified Parkinson's Disease Rating Scale (UPDRS) and the Hoehn and Yahr scale. Moreover, PD is often misdiagnosed or not diagnosed until the later stages of the disease, when significant neural degeneration has already occurred. This highlights the need for more accurate and efficient diagnostic methods for PD. Artificial intelligence (AI) has the potential to revolutionize the early detection of PD by providing a more accurate and efficient diagnostic process. AI algorithms can analyse large amounts of data, identify patterns, and make predictions with high accuracy. In recent years, there has been a growing body of research on the use of AI for the early detection of PD. This includes the use of machine learning algorithms to analyse various types of data, such as clinical data, genetic data, and imaging data, voice data etc. to identify early signs of PD. In this review, we will examine the current state of AI-based approaches for early detection of PD and discuss their potential benefits and limitations. We will also explore on-going research in this field and discuss potential directions for future work. Our aim is to provide a comprehensive overview of the current state of the field and to identify opportunities for future research and development.

II. LITERATURE SURVEY

[1] Importance of Voice data: Speech or voice data is assumed to be 90% helpful to diagnose a person for identifying presence of disease. In general, Person with PD suffers from speech problems, which can be categorized into two: hypophonia and dysarthria. Hypophonia indicates very soft and weak voice from a person and dysarthria indicate slow speech or voice, that can hardly be understood at one time and this causes because of damage to central nervous system. So, most of the clinicians who treat PD patients observe dysarthria and try to rehabilitate with specific treatments to improvise vocal intensity.

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[2] Symptoms Of Parkinson's Disease : The treatment of PD is more successful when it is in initial stage. The PD symptoms are notified slowly and the PD patients live many years. The one million American people were affected by PD and more than sixty thousand people are diagnosed every year. The almost all early signs of PD may be similar to other PSP, so it is too difficult to diagnose. Symptoms of Parkinson's disease

- Tremor in finger, hand or foot
- Sleeping Problem
- Limb Hardness & Steady Moving
- Throat Voice Change
- Rigid Facial Expression
- Stooped Posture

[3] First of all First of all, it is important to differentiate between PD and parkinsonism. Parkinsonism is the clinical presentation for a set of symptoms which could be attributed to PD such as tremors, rigidity, and bradykinesia. PD is considered as one form of parkinsonism, so not all the subjects present
the parkinsonism symptoms will have PD as it could be due to other health issues such as a vascular disorder or other neurodegenerative diseases (Parkinson's Disease Foundation, 2015).
There is difficulty to distinguish PD from the other types of parkinsonism by only monitoring the motor features of PD patients. Therefore, it is necessary to add other features to increase the clinical diagnostic accuracy, like asymmetry and a robust response to levodopa treatment (Berg et al., 2013).
There are several obstacles facing the diagnosis criteria from motor features including:-

1. This criterion focuses on movement problems but, as mentioned in section 2.1.2, PD is also normally associated with non-motor features which do not respond to levodopa treatment and occur before any motor symptoms (Berg et al., 2013).
2. A main measure in the criteria is the response to dopamine replacement, which also happens in other types of parkinsonism (Berg et al., 2013).

The UK Parkinson's Disease Society Brain Bank Diagnostic Criteria comes as an update of the earlier diagnosis and includes both asymmetry and a robust response to levodopa treatment to increase the specificity of the diagnosis.
[4] The proposed algorithm is as follows:

1. Provide training sample to NN.
2. Compute error from difference between network output and expected output.
3. For every neuron, compute how much to modify the weight (local error).
4. Optimize weight to reduce local error.
5. Compute 'blame' on each error. 6) Repeat from 3.

II. DECISION TREE CLASSIFIER

Decision tree [7] builds classification or regression models in the form of a tree structure. It breaks down a data set into smaller and smaller subsets while at the same time an associated decision tree is incrementally developed. The final result is a tree with decision nodes and leaf nodes. A decision node has two or more branches and a leaf node represents a classification or decision. The topmost decision node in a tree which corresponds to the best predictor called root node. Decision trees can handle both categorical and numerical data.

III. KNN CLASSIFIER

KNN classifier is an instance-based learning Algorithm which is based on a distance function for pairs of observations, such as the Euclidean distance or Cosine. In this paradigm, k nearest neighbors of a training data is computed first. Then the similarities of one sample from testing data to the k nearest neighbors are aggregated according to the class of the neighbors, and the testing sample is assigned to the most similar class.

IV. RANDOM FOREST

Random forests or random decision forests are an ensemble learning method. It is used mainly used to solve classification, regression problems and also other problems. Random forest is one of the accurate learning algorithm. The basic concept

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of the algorithm is to build many small decision-tree and then merging them to form a forest. It is computationally easy and cheap process to build many such small and weak decision trees. So such decision trees can be formed in parallel and then it can be combined to form a single and strong forest. The algorithm for random forests uses the common technique of bootstrap bagging.

V. CHALLENGES AND RECOMMENDATIONS

The use of AI to help detect and treat diseases is of increasing interest to researchers and clinicians. Mobile technologies such as smartphones and widely used low-cost sensors produce large amounts of health data. These data may be used by AI to provide previously unattainable insights on the prevalence of diseases and patient status in a setting where people are free to move about and, furthermore, from clinical datasets. The use of AI can help with global epidemiology initiatives and patient symptom monitoring. Despite how stimulating these applications are, it is important to consider both the value and potential limitations of these cutting-edge analytical techniques. The most promising applications of AI are yet futuristic. Future applications of AI to relevant datasets will, for instance, help in characterizing the molecular subtypes of Parkinson's disease. This will make it possible for doctors to pair their patients with appropriate molecular treatments, which will advance precision medicine. Prioritizing customized monitoring, AI will continue to be most useful until it can demonstrate its ability to advance the field of precision medicine. We compiled the remaining drawbacks and challenges and we suggested possible future recommendations that might result in effective ML techniques to solve the problems.

VI. RESEARCH CHALLENGES AND DIRECTIONS

Besides the significant experimental results achieved using deep learning architectures, we demonstrate here that there are still some main unsolved research issues/challenges facing the medical application of DL in detecting PD. The accurate diagnosis of PD is still a challenge, and error rates of PD diagnosis range from 15% to 24%. The most- reported error rate comes from misdiagnosing PD as non- Parkinson's disease, tremor disorders, or secondary Parkinsonism.

VII. PAST STUDIES AND FUTURE PERSPECTIVES

Parkinson's disease, commonly known as Tremor, is affected by a diminution in dopamine levels in the brain, which damages a person's motion functions, or physical functioning. It is one of the world's most common diseases. Intermittent neurological signs and symptoms result from these lesions, which become worse as the disease progresses. Because aging causes changes in our brains, such as loss of synaptic connections and changes in neurotransmitters and neurohormones, this condition is more frequent among elders. With the passage of time, the neurons in a person's body begin to die and become inimitable. The consequences of neurological problems and the falling dopamine levels in the patient's body show gradually, making it difficult to detect until the patient's condition requires medical treatment. However, the symptoms and severity levels are different for individuals. Major symptoms of this disease are deficiency in speech, short-term memory loss, loss of balance, and unbalanced posture

[8] In their paper, Rotation forest is an ensemble machine learning algorithm that can be used for feature selection and classification tasks. It works by training a set of decision tree classifiers on random rotations of the original feature space. The idea behind this approach is to decorrelate the base classifiers, which can improve the overall performance of the ensemble. In the context of computer-aided diagnosis of Parkinson's disease, several studies have explored the use of rotation forest ensembles for feature selection and classification. One study found that a rotation forest ensemble classifier outperformed other machine learning algorithms, including support vector machine (SVM), in terms of classification accuracy for detecting Parkinson's disease based on speech features [1]. Another study compared the performance of rotation forest and SVM classifiers for detecting Parkinson's disease based on gait features [2]. The results showed that the rotation forest classifier had higher accuracy and sensitivity than the SVM classifier. A different study used a combination of rotation forest and SVM classifiers to classify Parkinson's disease based on brain imaging data [3]. The results showed that the combination of the two classifiers outperformed either classifier alone. In summary, the literature suggests that rotation forest ensembles can be effective for feature selection and classification in the context of computer-aided diagnosis of Parkinson's disease, and that they may perform better than SVM classifiers in some cases. However, more research is needed to fully understand the strengths and limitations of this approach.

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[9] In the paper Intelligent Parkinson Disease Prediction Using Machine Learning Algorithms by Tarigoppula V.S Sriram1, M. Venkateswara Rao2 , G V Satya Narayana3 , DSVGK Kaladhar4 , T Pandu Ranga Vital5 tells, Diagnosis of the Parkinson disease through machine learning approache provides better understanding from PD dataset in the present decade. . Clinical diagnostic classification of PD can be done on comprehensive review of the literature data and selection basing on the sensitivity and specificity of the characteristic clinical features. Prospective with clinic- pathologic studies in representative population of patients showing PD are needed to investigate the clinical, pathologic, and nosologic studies based on frequency of occurrence, characteristics, and risk factors in patients. They have used Neural Networks, DMneural, Regression and Decision Trees are previously employed for calculating the performance score of the classifiers reliable diagnosis of PD, PD causes vocal impairment that effects speech, motor skills, and other functions like behavior, mood, sensation and thinking. Tele_monitoring of the disease using voice measurement has a vital role in its early diagnosis of PD.

[10] In their paper, Dragana Miljkovic et al (2016) explored the potential use of machine learning and data mining techniques in the management of Parkinson's disease. They discussed the various data sources that could be used in these approaches, such as clinical and demographic data and voice and image analysis. The authors also noted the potential benefits of using these techniques, such as the ability to identify patterns and trends in the data that may not be apparent to human analysts and the potential to identify risk factors and predict the course of the disease. However, they also recognized the challenges of using these techniques, including the need for robust and representative datasets and the potential for bias and overfitting in the models. Overall, the authors provided a review of the current state of the field and did not report specific results from their own research.

VIII. CONCLUSION

The use of machine learning in the field of medical diagnoses through dermoscopic images have been identified as a future dominant technology due to its potential for high accuracy reduction of resources in terms of time and cost. With many datasets available for public use it is essential to develop tools to be able to fully utilize these resources. Globally, there is a drastic increase in the rate of skin cancer cases because of several factors. So early detection plays a crucial role in detection and treatment.

Convolutional Neural Networks-based method for classifying has been proposed. A method is created to make it easier for patients and medical professionals to identify or categorise different types of skin cancer, whether benign or malignant. According to the experimental and assessment portion, the model can be used as a baseline for helping medical practitioners find skin cancer. Any doctor can obtain accurate results by collecting a few random photos, but the old approach takes too long to identify cases correctly.

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