IDENTIFICATION OF PARKINSON'S DISEASE WITH SPEECH DATA PROCESSING

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Abstract— **Parkinson's disease is the second common neurological disabling disease in which it is people have difficulty in doing activities like speaking, writing, and walking. With the increase in the severity of the disease, the patient's voice gets more and more deteriorated. In the recent past, speech, gait and EEG signals have been investigated for the detection of Parkinson's disease. Thus, for building the telemonitoring and telediagnosis models for prediction, the speech analysis has been tremendously increased. Deep learning (DL) techniques have been used as a part of discovery for the efficient classification of Parkinson's disease (PD). The proper interpretation of speech signals is one of the important classification problems for Parkinson's disease diagnosis. In this paper, we revise a deep neural network for the Parkinson's disease prediction using voice data.**

Keywords— **PD, ML, SVM, k-NN.**

I. INTRODUCTION

Parkinson's disease (PD) is a neurological disorder which deteriorates the motor functions [1] as well as non-motor functions of the body which includes speech disorders [2]. Dr. James Parkinson describes it as a shaking palsy [3]. Out of the world's total population, over 10 million people are diagnosed with Parkinson's disease according to the survey done by American Parkinson Disease Association (APDA) [4] and is considered as the second largest neurological problem after Alzheimer's disease. It is commonly seen in elder aged people; whose age is over 60 [5].

The cause, as well as cure of Parkinson's disease, is yet unknown [6, 7], but it can be treated through medication during its earlier stages which offers a significant mollification of symptoms [8].

The primary symptoms of this disease are difficulty in movement, stiffness in body parts, poor balance [9] tremor, voice impairment, and bradykinesia.

Researchers have shown that 90% of people with Parkinson have speech problems and vocal impairment [10, 11] which are considered to be the earliest indicators for the disease. Thus, the first symptom that can be found in analyzing the PD subjects is the degradation of voice. With an increase in the severity of the disease, the patient's voice gets more and more affected. The vocal tremor, monotone, hoarseness, reduced loudness, breathiness, and imprecise articulation [12] are some of the vocal impairment symptoms.

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The symptoms of this disease are instigated by the death of certain brain cells that produce neurotransmitters such as dopamine, serotonin, and acetylcholine [15]. The loss of dopamines causes urinary problems, depression, dementia, anxiety, weight loss, and sleep disturbances. The diagnosis of PD from voice impairments is very popular because the telemonitoring and telediagnosis systems that are established on voice signals are very economical and can be used easily, and thus the physical visits of PD subjects to clinics are lowered, which in turn reduces the workload on medical personnel.

II. SYSTEM DESCRIPTION

In latest years, there has been rising attention in the progress of tele-diagnosis and tele-monitoring methods for Parkinson's disease based on evaluating the motor system disorders. As around 90% percent of Parkinson's disease patients have some type of vocal disorders in the earlier stages of the disease. Latest Parkinson's disease tele-diagnosis techniques spotlight on the recognition of the vocal impairments

from sustained vowel phonations or running speech of the subjects.

The advancements in deep learning and their applications in the field of health diagnosis have been very encouraging, therefore providing a better way for healthcare and also in the early detection of many diseases. Large databases of clinical data are accessible. The secondary use of these medical databases for prediction purposes involving deep learning has fueled the excitement of health experts. Research studies have shown that voice is an early marker for PD detection. PD is the second-largest neurological problem. Over one million people are suffering from this disorder in North America alone and this number is increasing day in and day out in an aging population as suggested by various research studies particularly in the people whose age is 60 or above.

The PD diagnosis generally consists of three steps that include data pre-processing, extraction of features and classification [16]. In the data pre-processing step, the segmentation of speech signals with time windows is performed. To eliminate the noise from the speech signals, they are subjected to filtering. In the feature extraction step, the extraction of several features is done from each segment that was obtained from the data pre-processing step. This step is considered to be an important step in diagnosing the people suffering from PD efficiently by analyzing their speech signals.

Finally, the classification is done in the last step. The classification method performance has a strong impact on the method that is used for extracting the features. Therefore, choosing the right classification method is also a key issue which needs to be maneuvered in diagnosing the people suffering from PD.

III. REVIEW OF DIVERSE TECHNIQUES

From time to time, there have been several notable attempts done by various researchers to develop techniques for predicting Parkinson's disease in subjects. The diverse techniques related to subject are described below:

A. *Machine Learning Algorithms*

Various studies have shown that machine learning algorithms outperformed the human expert analysis in the field of medical diagnosis. In this section various machine learning algorithm is compared. The performance of different methods in order to diagnose the PD very effectively is summarized in table 1.

Table 1: Survey of Machine Learning Algorithms

Author	Technique	Accuracy (%)
Little et al (2009)	SVM	91.4
David Gil A. et al (2009)	SVM	93.3
Resul Das (2010)	NN	92.9
Ipsita Bhattacharya et al (2010)	Linear SVM	65.2
R.Arefi Shirvan et al (2011)	k-NN	98.2
Uma Rani et al (2012)	SVM(RBF)	87.5
A.Ozcift et al (2012)	IBk	96.9
B.E Sakar et al (2013)	Linear SVM	85
Mohammad Shahbakhi et al (2014)	SVM	94.5
Achraf Benba et al (2015)	Linear SVM	91.1
Achraf Benba et al (2016)	Linear SVM	90
Salama A. Mostafa et al (2018)	Random forest	99.4
Diogo Braga et al (2018)	Random forest	99.9
Richa Mathur et al (2019)	k-NN + AdaBoost	91.2
Amin ul Haq et al (2019)	SVM	99
C.O. Sakar et al (2019)	SVM(RBF)	86
I.Nissar (2020)	XGBoost	95.3
K. Akyol (2020)	ELM	83.7
C.D. Anisha et al (2020)	AdaBoost	94
T. Tuncer et al (2020)	k-NN	96.8

B. *Deep Learning Algorithms*

Various author suggested a deep neural network (DNN) for the diagnosis of PD. The prediction of PD is accomplished by using a DNN. It has multiple hidden layers, an input layer and an output layer. The input layer is simply called a fan-out layer, as no computation is done by this layer. The hidden layers or computational layers transform the given input into output by mathematical manipulations.

The accuracy comparison of detection of PD using these algorithms is depicted in table 2.

Table 2: Survey of Deep Learning Algorithms

Author	Technique	Accuracy (%)
Ali H. Al-Fatlawi et al (2016)	DBN	94

Alex Frid et al (2016)	CNN	83.6
Abdullah Caliskan et al (2017)	DNN classifier	86.09
Savitha S. Upadhya et al (2018)	NN classifier	98
Srishti Grover et al (2018)	DNN	81.6
Chitra Rajagopal et al (2019)	NN classifier	99.4

IV. CONCLUSION

Deep Learning is a prevailing learning tool which has much to offer to neurologists, health experts and data scientists as well. In recent times, there are vast contributions of deep learning methods used to the different kinds of medical data. The relevance of deep learning has gained traction in various fields. A deep learning approach is adding value to the decision-making problems in the domain of healthcare.

In our paper, we have presented diverse algorithm for PD detection which involves the use of a deep neural network. The accuracy comparison of various techniques is presented in table 1 and table 2.

REFERENCES

[1] C.W.Olanow, M.B.Stern, and K. Sethi. The scientific and clinical basis for the treatment of Parkinson disease. Neurology, vol. 72, pp. s1–s136, 2009.

[2] S. B. O'Sullivan and T. J. Schmitz. Parkinson disease in Physical Rehabilitation. 5th ed. Philadelphia, PA, USA: F. A. Davis Company,2007, pp. 856–894.

[3] J. W. Langston. Parkinson's disease: Current and future challenges. NeuroToxicology, vol. 23, no. 4-5, pp. 443–450, 2002.

[4] D. G. Standaert, M. H. Saint-Hilaire, C. A. Thomas. Parkinson's Disease Handbook. American Parkinson Disease Association, New York, USA, 2015.

[5] S.K.V.D. Eeden, C.M. Tanner, A. L. Bernstein, R.D.Fross, A. Leimpeter, D. A. Bloch, and L. M. Nelson. Incidence of Parkinson's disease: Variation by age, gender, and race/ethnicity. Amer. J. Epidemiol., vol. 157, pp. 1015–1022, 2003.

[6] M. A. Little, P. E. McSharry, E. J. Hunter, J. Spielman, and L. O. Ramig. Suitability of dysphonia measurements for telemonitoring of Parkinson's disease. IEEE Trans. Biomed. Eng., vol. 56, no. 4, pp. 1010–1022, Apr.2009.

[7] National Collaborating Centre for Chronic Conditions, Parkinson's Disease, London, U.K.: Royal College of Physicians, 2006.

[8] N. Singh, V. Pillay, and Y. E. Choonara. Advances in the treatment of Parkinson's disease. Progr. Neurobiol., vol. 81, pp. 29–44, 2007.

[9] L. Cunningham, S. Mason, C. Nugent, G.Moore, D. Finlay, and D. Craig. Home-based monitoring and assessment of Parkinson's disease. IEEE Trans. Inf. Technol. Biomed., vol. 15, no. 1, pp. 47–53, Jan. 2011.

[10] G. Rigas, A. Tzallas, M. Tsipouras, P. Bougia, E. Tripoliti, D. F. D. Baga, S. Tsouli, and S. Konitsiotis,. Assessment of tremor activity in the Parkinson's disease using a set of wearable sensors. IEEE Trans. Inf. Technol. Biomed., vol. 16, no. 3, pp. 478–487, May 2012.

[11] S. Marino, R. Ciurleo, G. Lorenzo, M. Barresi, S. De Salvo, S. Giacoppo, A. Bramanti, P. Lanzafame, and P. Bramanti. Magnetic resonance imaging markers for early diagnosis of Parkinson's disease. Neural Regeneration Res., vol. 7, no. 8, pp. 611–619, 2012.

[12] Dastgheib, B. Lithgow, and Z. Moussavi. Diagnosis of Parkinson's disease using electrovestibulography. Med. Biol. Eng. Comput. vol. 50, no. 3, pp. 483–491, 2012.

[13] K. Ho, R. Iansek, C.Marigliani, J. L. Bradshaw, S. Gates. Speech impairment in a large sample of patients with Parkinson's disease. Behav. Neurol., vol. 11, pp. 131–137, 1998.

[14] J. A. Logemann, H. B. Fisher, B. Boshes, E. R. Blonsky. Frequency and co-occurrence of vocal-tract dysfunctions in speech of a large sample of Parkinson patients. J. Speech. Hear. Disord., vol. 43, pp. 47–57, 1978.

[15] K.S.Perez et al.The Parkinson larynx: Tremor and videostrobo-scopicfindings. J. Voice, vol. 10, no. 4, pp. 354–361, 1996.

[16] B. Harel, M. Cannizzaro, and P. J. Snyder. Variability in fundamental frequency during speech in prodromal and incipient Parkinson's disease: A longitudinal case study. Brain Cognition, vol. 56, pp. 24–29,2004.

[17] R. J. Baken and R. F. Orlikoff, Clinical Measurement of Speech and Voice, 2nd ed. San Diego, CA: Singular Thomson Learning, 2000.