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ANN FOR PREDICTION OF PARKINSON'S PATIENTS

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Abstract -

Parkinson's Disease (PD) is a long-term degenerative disorder of the central nervous system that mainly affects the motor system. The symptoms generally come on slowly over time. Early in the disease, the most obvious are shaking, rigidity, slowness of movement, and difficulty with walking.
Doctors do not know what causes it and finds difficulty in early diagnosing the presence of Parkinson's disease. Parkinson's Disease (PD) is a chronic neurodegenerative disorder that has been ranked second after Alzheimer's disease worldwide. Early diagnosis of PD is crucial to combat against PD to allow patients to deal with it properly. However, there is no medical test(s) available to diagnose PD conclusively. Therefore, computer-aided diagnosis (CAD) systems offered a better solution to make the necessary data-driven decisions and assist the physician. Numerous studies were conducted to propose CAD to diagnose PD in the early stages. No comprehensive reviews have been conducted to summarize the role of AI tools to combat PD.

Keyword - Epidemiology, genetics, India, Parkinson's disease, treatment

INTRODUCTION

The human brain is the primary controller part of the human body. Any minor damage to any of its parts will severely affect other organs—one of its adverse effects is Parkinson's disease." Parkinson's disease is a chronic and progressive neurodegenerative disease", and it occurs mainly in people over 50 years old. Its symptoms start slowly and increase over time. Parkinson's disease symptoms are characterized such as motor and nonmotor. Motor symptoms include movement disorders, shaking, walking issues, stiffness, and postural instability, while nonmotor symptoms including cognitive dysfunction, mood disorder, depression, and anxiety
Parkinson's disease is a lasting worsening syndrome of the central nervous system that mostly smidgeons the motor system [1]. The symptoms normally come on gradually over time [1]. In the early stage of the disease, the most obvious are shaking, inflexibility, leisureliness of movement, and trouble with walking [1]. Thinking and behavioural problems might similarly happen [2]. Dementia turns out to be common in the progressive stages of the disease [2]. Depression and anxiety are also common, happening in more than a third of people with PD [2]. Other symptoms comprise sensory, sleep, and emotional difficulties [1]. The crucial motor symptoms are together called "parkinsonism" or a "parkinsonian syndrome" [3].

Parkinson's is the second worse neurodegenerative disease worldwide after Alzheimer's disease. In 2019, its incident rate ranged from 40.37 to 53.89 per 100,000 population per year in the US alone [9]. Diagnosis of PD in an early stage is an important issue to mitigate its complications. However, no medical test is available to diagnose it in the early stages conclusively. In a traditional clinical setup, the physician will ask the patient to perform some mental and physical tasks (e.g., moving and walking around) [10] or take the magnetic resonance imaging (MRI) and/or Positron emission tomography–computed tomography (PET/CT) scan of the brain. However, it is challenging to differentiate PD from other neurological disorders, and it depends on the radiologist's experience to distinguish and identify it precisely. Therefore, a computer-aided diagnosis (CAD) system helps the radiologist interpret MRI scans. In 2003, the authors of [7] made a CAD system to monitor body acceleration to detect the freezing of gait in PD patients.

In 2015, PD pretentious 6.2 million people and caused in about 117,400 deaths worldwide [4]. Parkinson's disease naturally occurs in people over the age of 60, of which about 1% are affected. Males are more frequently affected than females at a ratio of around three to two. When PD is seen in people before the age of fifty, it is so-called young-onset PD [6]. The normal life expectancy after diagnosis is between seven and fourteen years.

The disease is called after the English doctor *James Parkinson*, who published the first detailed description in An Essay on the Shaking Palsy, in 1817RESEARCH PROBLEM AND OBJECTIVES

The scope of this paper is limited to the detection of Parkinson's disease (PD) in the early stage using neural networks. The patient dataset such as electronic health record (EHR) and medical image can be analysed using neural network (NN) features; in particular, patient's data can undergo many processes; analysis, segmentation, augmentation, scaling, normalization, sampling, aggregation, and sifting, in order to obtain accurate prediction that assists healthcare ecosystem and stakeholders in the healthcare domain. Many studies have been recently conducted to address and propose a solution to mitigate and prevent neurodegenerative disorders such as PD. However, most of these studies and research are dispersed. Therefore, summarizing NN technologies' involvement in resolving challenges related to PD is needed; an appropriate summarization allows new researchers to understand the current role of neural networks against PD. It will open new opportunities for researchers to have the necessary base that allows them to build on instead of starting from ground zero.

THE ARTIFICIAL NEURAL NETWORKS

Artificial neural networks (ANN) or connectionist systems are computing systems vaguely enthused by the biological neural networks that constitute human brains [10]. The neural network is a framework for many different machine learning algorithms to work together and process compound inputs [11]. This type of a system learns to do tasks by examples, normally without being programmed with any task-explicit rules. For example, in image recognition, it may learn to recognize images that contain dogs by considering example images that have been manually labelled as "dog" or "no dog" and using the outputs to recognize dogs in International Journal of Academic Health and Medical Research (IJAHMR) ISSN: 2000-007X Vol. 3 Issue 1, January – 2019, Pages: 1-7 www.ijeais.org/ijahmr 2 other images. It does this without any previous knowledge about dogs, for example, that they have tails and dog-like faces. Instead, they automatically produce recognizing characteristics from the learned material that it processes.

An ANN is established on a group of connected nodes called artificial neurons, which roughly model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transfer a signal from one artificial neuron to another. An artificial neuron that gets a signal can do some work on it and then signal further artificial neurons linked to it.

METHODOLOGY

❖ **The dataset of Parkinson's disease** The data used in this research is a voice recording originally done at University of Oxford by M.A. Little [2]. Furthermore, a detailed presentation was made on the specificities of the recording equipment as well as in what environment the experiment was carried out. The data consists of 195 recordings extracted from 31 people whom 23 are suffering from Parkinson's disease. The time since first diagnosis of Parkinson's disease was done 0 to 28 years ago and the age of the subjects ranged from 46 to 85 years and a total of 6 vocal sounds were recorded from each subject.

❖ **The Input Variables** The input variables selected are those which can easily be obtained from previous research. The input variables are as in Little et. al [22] where the exact computations of each measurement is described.

1	MDVP:Flo(Hz)	Average vocal fundamental frequency
2	MDVP:Jitter(%)	measures of variation in fundamental frequency
3	MDVP: Jitter(Abs)	measures of variation in fundamental frequency
4	MDVP: RAP	measures of variation in fundamental frequency
5	MDVP: PPQ	measures of variation in fundamental frequency
6	Jitter: DDP	Several measures of variation in fundamental frequency
7	MDVP: Shimmer	Several measures of variation in amplitude
8	MDVP: Shimmer(dB)	Several measures of variation in amplitude
9	Shimmer:APQ3	Several measures of variation in amplitude
10	Shimmer:APQ5	Several measures of variation in amplitude
11	MDVP:APQ	Several measures of variation in amplitude
12	Shimmer: DDA	Several measures of variation in amplitude
13	NHR	first measures of ratio of noise to tonal components in the voice
14	HNR	second measures of ratio of noise to tonal components in the voice
15	RPDE	First nonlinear dynamical complexity measure
16	DFA	Signal fractal scaling exponent
17	spread1	First nonlinear measure of fundamental frequency variation
18	spread2	Second nonlinear measure of fundamental frequency variation
19	D2	Second nonlinear dynamical complexity measure
21	PPE	Third nonlinear measure of fundamental frequency variation

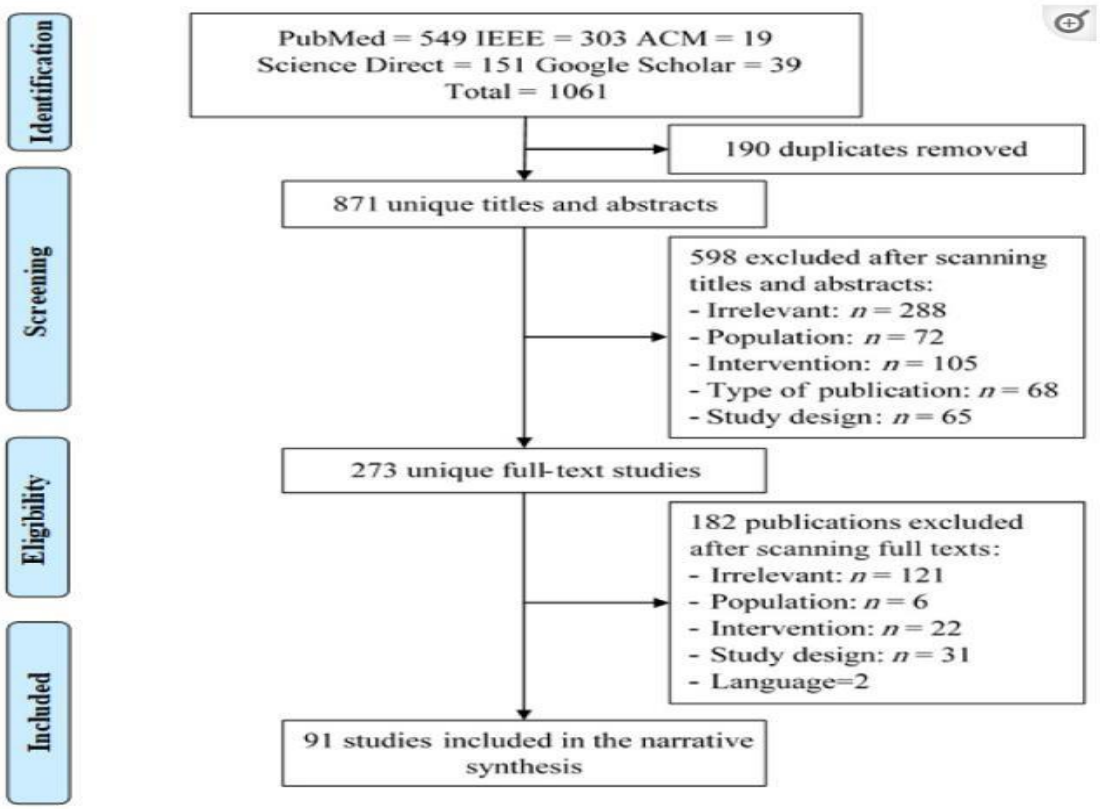
❖ **Evaluation and analysis** We have 195 samples in the dataset. We divide it into 170 training sample and 25 validating sample then we imported the dataset in Just Neural Network (JNN) environment (as shown in Figure 1). We then trained, validated the ANN model (as seen in Figure 2). We found the most important attributes contributing to the ANN model as shown in Figure 3. The detail of ANN model is shown in Figure 4. The accuracy of the ANN model was 100%.

Inclusion and exclusion criteria.

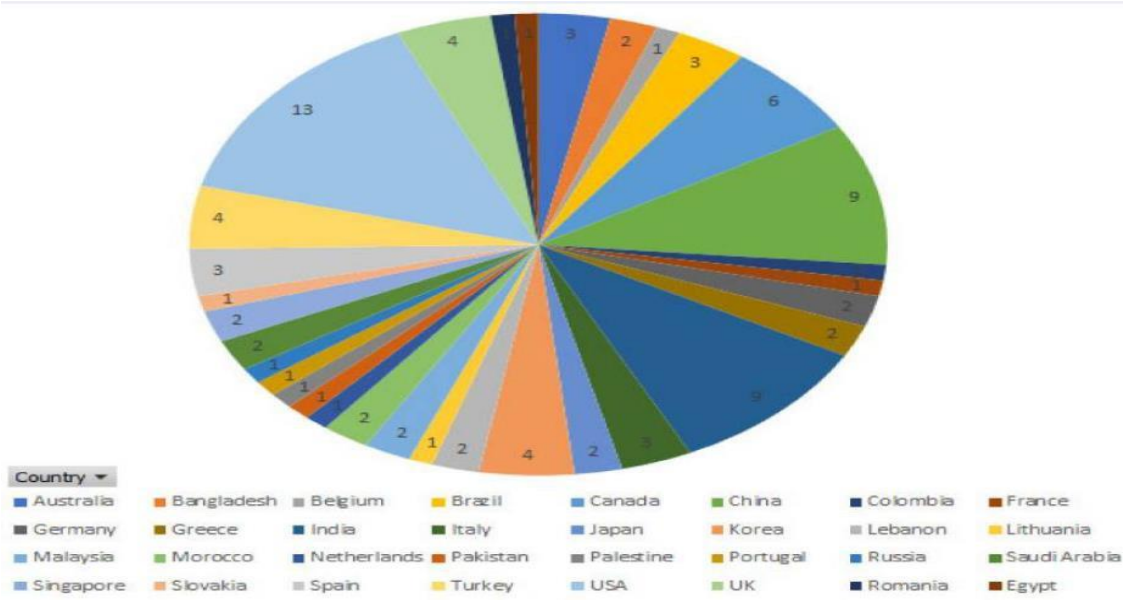
Criteria	Specified Criteria
Inclusion	• Studies that aim to diagnose Parkinson's using deep learning technique or approach • Studies that published from 2018 onwards • Empirical studies only • Only written in English
Exclusion	• Abstract • Review including an overview, scoping review, etc. • Non-English studies • Non-peer-reviewed articles

Results

In total, 1061 studies were retrieved by searching through 5 recognized E-Databases. Then, 190 (17.90%) were removed due to duplication, while 871 (82.09%) went through title and abstract screening; in this screening, we excluded 598 (56.36%) studies due to various reasons, as shown in Figure. The remaining 273 (25.73%) studies went through the full-text screening, and 181 (17.05%) studies were excluded, as detailed in Figure. In total, 91(8.67%) studies were included in this review.

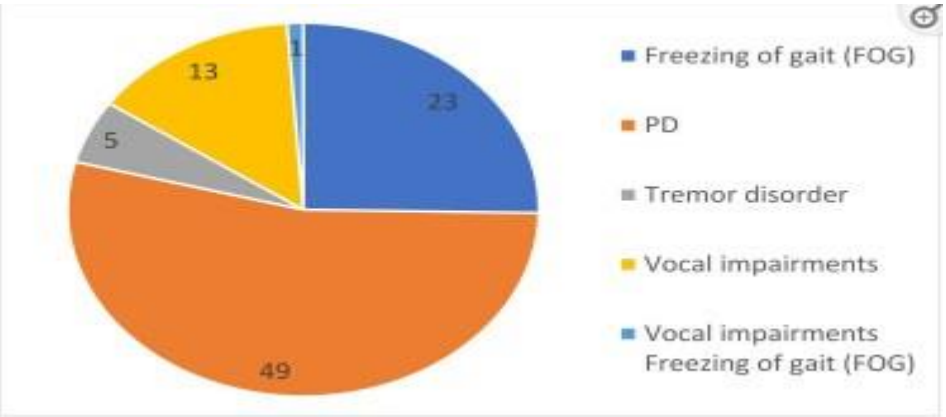


As shown in Table, the included citations were published in more than 30 different countries, as shown in Figure, about 13 studies from the US (14.13%), followed by 9 studies from China and India (9.78%). This shows that numerous papers were published in the last 3 years; for instance, 30 papers (32.60%) were published in 2019 and 2020. More than half (56.2%) of the included studies were conference papers. However, most conference papers (n = 18) were published in 2018, and 2020, respectively, and only (n = 16) conferences article were reported in 2019. In addition, (n = 39) journal articles were published in last few years: (n = 10) in 2018; (n = 14) in 2019; (n = 12) in 2020; and (n = 3) in 2021.



Characteristics	Studies, *n* (%)	Ref.
Year of publication	2021: 4 (4.34)	[6,18,19,20]
	2020: 30 (32.60)	[21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51]
	2019: 30 (32.60)	[4,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85]
	2018: 28 (30.43)	[3,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105]
Country	US: 13 (14.13)	[18,27,29,57,61,65,74,82,87,88,92,95,104]
	China: 9 (9.78)	[33,40,52,53,66,67,85,89,90]
	India: 9 (9.78)	[3,31,37,50,51,55,60,63,105]
	Canada: 6 (6.52)	[35,38,45,46,83,93]
	UK: 4 (5.43)	[48,58,62,103]
	Korea: 4 (4.34)	[30,41,56,98]
	Turkey: 4 (4.34)	[4,36,77,101]
	Brazil: 3 (3.26)	[75,97,102]
	Australia: 3 (3.26)	[20,42,100]
	Italy: 3 (3.26)	[21,49,96]
	Spain: 3 (3.26)	[76,91,94]
	Greece: 2(2.17)	[54,99]
	Bangladesh: 2 (2.17)	[44,59]
	Japan: 2 (2.17)	[6,72]
	Lebanon: 2 (2.17)	[68,69]
	Malaysia: 2 (2.17)	[39,84]
	Germany: 2 (2.17)	[71,79]
	Morocco: 2 (2.17)	[23,25]
	Saudi Arabia: 2 (2.17)	[28,80]
	Singapore: 2 (2.17)	[32,81]
	Belgium: 1 (1.08)	[43]
	Colombia: 1 (1.08)	[70]
	France: 1 (1.08)	[47]
	Lithuania: 1 (1.08)	[22]
	Netherlands: 1 (1.08)	[78]
	Pakistan: 1 (1.08)	[86]
	Palestine: 1 (1.08)	[73]
	Portugal: 1 (1.08)	[64]
	Russia: 1(1.08)	[26]
	Slovakia: 1 (1.08)	[19]
	Romania: 1 (1.08)	[24]
	Egypt: 1 (1.08)	[34]
Type of publication	Conference: 52 (56.52)	[3,18,21,22,23,24,25,26,27,29,30,31,36,44,45,46,47,48,49,50,51,53,54,55,56,57,58,59,60,61,63,64,65,66,68,69,70,71,74,77,79,81,82,83,84,85,86,87,88,89,92,95,96,99,100,101,102,103,104,105]
	Journal article: 39(42.39)	[4,6,19,20,28,32,33,34,35,37,38,39,40,41,42,43,52,62,67,72,73,75,76,78,80,90,91,93,94,97,98]

some studies target specific symptoms of PD, such as freezing of gait, vocal impairment, and tremor disorder. A more limited number of included studies proposed a deep learning approach to detect tremor disorder (n = 5) and vocal impairment (n = 13). However, various studies used the deep learning technique to diagnosis PD (n = 50), in general, and freezing of gait (FoG) (n = 23), in particular.



We summarized the dataset that was clearly explained within studies (*n* = 5). This dataset was collected and labelled in different entities such as hospitals, universities, and research centres. The number of PD and healthy control samples are reported, including gender. Table only provides a sample of the private datasets used within the included studies. The number of males in the PD sample is higher than the number of females, whereas the number of females in health control is higher than the number of males. Furthermore, different types of hardware devices were used to collect the dataset; we have noticed that most of the data were in the form of images collected with different devices, starting from hospital imaging device including MRI, CT, DaTscan and ending with smartphone images that were used to capture handwriting or drawing of the PD samples (*n* = 11).

Private dataset descriptions.

Dataset	Source/Host	Used Device/Sensor	Number of PD Patient		Number of Healthy Control		Ref.
			Male	Female	Male	Female	
Private	Wearable Bio mechatronics Laboratory at Western University	wearable assistive devices for suppressing tremor	13		NA	NA	[46]
	Pacific Parkinsons Research Centre (PPRC)"	wearable headset with 27 electrodes to capture the EEG signals.	10	10	11	9	[83]
	Hospital at Sun Yat-sen University	64-electrode Geodesic Sensor Net (Electrical Geodesics Inc.)	25	15	18	12	[85]
	RMIT University, Melbourne, Australia	Apple iPhone 6S plus®	41		40		[100]
	n/A	Digital software keyboard	18		15		[79]

CONCLUSION

Parkinson's disease is a long-term degenerative disorder of the central nervous system that mainly affects the motor system. The symptoms generally come on slowly over time. An ANN model was presented for Parkinson's disease prediction to help specialist in the field. The accuracy we got is 100%

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