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Sridhar P. Arjunan
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Techniques for Assessment of Parkinsonism for Diagnosis and Rehabilitation

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Series in BioEngineering

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Preface

Parkinson's disease is a disorder of the central nervous system. It is the second most common neurodegenerative disorder, with over 0.5% of the population having this disease. The median age of people first diagnosed with Parkinson's disease is around 65 years, and thus its prevalence is expected to increase with an aging population. With no blood tests, or easily available imaging tests, the presence of two or more motor symptoms of tremor, bradykinesia, rigidity, or postural impairment are considered as the basis for the diagnosis of the disease. Dopamine transporter scan can be performed using Positron Emission Tomography (PET) as confirmatory evidence, which however are yet only available in few places.

The standard tools for the diagnosis and monitoring of PD uses Movement Disorder Society Unified Parkinson's Disease Rating Scale Part III (MDS-UPDRS-III). However, this requires clinical observations and thus has the limitations of clinician bias and potential of missing some of the early symptoms. This results in a loss of sensitivity and specificity. Early stage diagnostics can be missed, and it is also difficult to monitor the effectiveness of treatment and disease progression.

Parkinson's disease is associated with the loss of habitual activity. Walking, speaking, and writing are three activities of people that are habitual to healthy people and have been found to be impaired among the people with Parkinson's disease. PD patients often have dysarthria, or slurring in voice, and display micrographia or handwriting becoming small in the early stages of their disease. These can occur up to 5 years before the tremor. Thus, the use of gait analysis, handwriting analysis, and speech or voice analysis has been proposed for early diagnosis of the disease. The number of researchers have proposed computer-based techniques that can be used to quantify these symptoms and provide objective measures for the clinicians. This field is fast developing and there is an urgent need for technical solutions to get accurate and objective measures of the symptoms so that the disease can be identified in the early stages, and its progression can be monitored.

Scheme for Promotion of Academic and Research Collaboration (SPARC) with the aim of supporting Indian researchers to solve global challenges, has provided a platform to collaborate with international experts for developing this book. The aim of this book is to provide a review along with expert opinions on this very needed issue. We, the authors have assembled this book with the aim of sharing with you

the current state of the art and identified potential research directions that will be useful. We are a team of clinicians, engineers, and scientists, and have provided the width of background and expertise through the book and attempted to provide you with the information regarding a large width of technologies. We do hope that you will find this useful, and we will soon have the methods to help reduce the burden of this disease in our society.

Kattankulathur, India — Sridhar P. Arjunan
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Contents

Abbreviations

A-Syn	α-Synuclein
AADC	L-Amino acid decarboxylase
AD	Autosomal dominant
ApoE4	Apolipoprotein E4
AR	Autosomal recessive
BDNF	Brain-derived neurotrophic factor
CBD	Cortico-basal degeneration
COMT	Catechol-O-methyltransferase
COMTI	Catechol-O-methyltransferase inhibitors
DaT scan	Dopamine Transporter single-photon emission computed tomography
DBS	Deep brain stimulation
DLB	Dementia with Lewy bodies
ET	Essential tremor
FDA	Food and drug administration
GBA	Glucocerebrosidase
GPi	Globus pallidus pars interna
ICD	Impulse-control disorders
MAOIs	Monoamine oxidase inhibitors
MAPT	Microtubule associated protein tau
MCI	Mild cognitive impairment
MPTP	1-Methyl-4-phenyl-1,2,5,6-tetrahydropyridine
MRI	Magnetic resonance imaging
MSA	Multiple systems atrophy
NMDA	N-Methyl-D-aspartate receptor
PD	Parkinson's Disease
PDD	Parkinson's disease dementia
PET	Positron emission tomography
PSP	Progressive supranuclear palsy
PSP-P	PSP-Parkinsonism
RBD	Rapid eye movement (REM) sleep behaviour disorder
REM	Rapid eye movement

SCA	Spinocerebellar Ataxia
SN	Substantia nigra
SSRI	Selective serotonin reuptake inhibitor
STN	Subthalamic nucleus
UKPDSBBCDC	United Kingdom Parkinson's disease society brain bank clinical diagnostic criteria
UPDRS	Unified Parkinson's Disease Rating Scale
VY-AADC01	Adeno-associated viral vector serotype-2
YOPD	Young Onset Parkinson's disease

Voice Analysis for Diagnosis and Monitoring Parkinson's Disease

Nemuel D. Pah, M. A. Motin, and D. K. Kumar

Abstract Parkinson's disease (PD) has complex and multi-symptoms, making it challenging to detect early-stage disease and to monitor the established patients. This also makes it challenging to design the protocol for conducting clinical trials to establish new medication and treatment to better support people with PD.

1 Introduction

Parkinson's disease (PD) has complex and multi-symptoms, making it challenging to detect early-stage disease and to monitor the established patients. This also makes it challenging to design the protocol for conducting clinical trials to establish new medication and treatment to better support people with PD. Some of the techniques that have been considered for this are based on the use of wearable sensors, handwriting analysis, and gait analysis. However, these require special-purpose devices and may not be suitable for monitoring patients in their own homes.

The voice of Parkinson's disease patients is one of the early symptoms of Parkinson's disease. The advantage of using voice for detection and monitoring of Parkinson's disease is that it can be recorded over the telephone and accessible to most people in their own homes.

There are two major vocal symptoms that are considered: Dysarthria and Dysfluency.

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