

Chapter 9

Processing and Communication Techniques for Applications in Parkinson Disease Treatment

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ABSTRACT

This chapter deals with processing and communication techniques for Parkinson's disease treatment applications. First, the authors summarize the background of physiological dynamics related to degenerative disorders of the central nervous system and common clinical procedures using microelectrode recordings (MER) for detecting brain areas. This summary is followed by a discussion of different aspects related to the inclusion of a communication platform for specialized assistance by expert neurologists to remote hospitals. Next, the authors present different techniques derived from biomedical signal processing for analyzing non-stationary and complexity components, with the aim of developing an automatic recognition system that will support computer-based clinical decisions in detecting brain areas. In addition, they explain each component of medical teleconsult. Finally, they discuss the whole integrated system, including the advantages, limitations and viability of this clinical procedure based on modern technology resources.

INTRODUCTION

Parkinson's disease is a degenerative disorder of the central nervous system that often impairs a per-

son's motor skills and speech. It is characterized by muscle rigidity, tremor, a slowing of physical movement (bradykinesia) and, in extreme cases, a loss of physical movement (akinesia). Deep brain stimulation can be applied to the thalamus, the pale

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or the nucleus subthalamicus. The success of neurosurgery mainly depends on the ability of the specialist in detecting the area where the micro-electrode is found. In most cases, the target area is the globus pallidus internus (GPI) or the nucleus subthalamicus (STN), where the neuro-stimulators are located. These treatments use a stereotaxic apparatus and imaging techniques to guide the electrode implantation into the correct area of the brain. The microelectrode crosses through regions with shooting characteristics (action potentials), and its amplified and filtered output is heard by a neurophysiologist using a speaker. Thus, the specialist identifies the brain area by listening to the rhythm created by the action potentials from nearby neurons. These signal types are not stationary due to the presence of action potentials, thus the detection of each area becomes a very complex task. Moreover, it is known that information contained in biological signals is highly dependent on numerous biological aspects with nonlinear structure, which means that the biological signal is not the sum of its components.

Automatic procedures have several advantages over clinical perception because computer-based clinical support offers more information and evidence, high objectivity and different communication possibilities, which are frequently used in decision committees of specialists with the aim of evaluating the case from different points of view. Ever since technical advances have allowed the transfer of electronic information, the possibility of remote diagnosis has been studied in order to enable access to distant resources. Telemedicine has become an important alternative for isolated populations and for medical centers that lack specialists or require the assistance of experts (Field, 1996). There are two things that form the base of medicine practiced at a distance; these are *telepathology* and *teleconsult*. Telepathology is the interaction between signals (1D or 2D) and clinical reports where the primary diagnosis is given by a doctor in a remote location. Teleconsult is the interaction between signals and medical records

where the primary diagnosis is given by the doctor at the medical center. The purpose of teleconsult is to provide a second opinion by a specialist to either confirm the diagnosis or to help the local doctor make a correct diagnosis (Norris, 2002). Further development of telepathology and teleconsult is limited by the large file sizes generated by medical equipment.

For this reason, the development of a compression tool is necessary for transferring information in less time. Moreover, with the aim of facilitating the remote perception processes, it is very important to create an audio and visualization application in order to provide the remote specialist with the tools for generating an accurate and timely clinical verdict. This kind of collaborative procedures can be analogically taken as a knowledge network (Cataño et al, 2008).

PARKINSON'S DISEASE: TREATMENT AND SURGICAL PROCEDURE

The basal ganglia are part of a comprehensive cortico-basal- thalamic-cortical brain circuit and they are anatomically and functionally separated in parallel.

Normal Physiology

In the most accepted model, the neurons of the GPI (Globus Pallidus Internus) and NS (Substantia Nigra) have a pattern of similar high-tone discharges. The activation of the direct path causes the inhibition of GPI and NS, which translates into thalamic disinhibition, providing the excitation for the thalamic motor pre-central areas. The effect of this is a positive feedback for the initiated crustal movement. Indirect activation produces the inhibition of GPE (Globus Pallidus external) and second facilitation of SN (Subthalamic Nucleus), which sends excitatory impulses toward GPI / NS and inhibition of the thalamus and brain stem occurs.

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