

STUDY OF AMPLITUDE AND FREQUENCY VARIABILITY OF THE DEEP BRAIN STIMULATION IN THE MODULATION OF BASAL GANGLIA CONNECTIVITY IN PARKINSON'S DISEASE

Aditya Robin Singh^{1,2} and Phool Singh³

¹Department of Mathematics, Janki Devi Memorial College, University of Delhi, New Delhi, India-110060

²Department of Mathematics, Central University of Haryana, 123031, India

³Department of Applied Sciences and Humanities, School of Engineering and Technology, Central University of Haryana, 123031, India

Email: adityarobinsingh@gmail.com

Abstract. The root cause of Parkinson's disease has been reported as the degeneration of dopaminergic neurons of the substantia nigra, which further results in the development of beta-band oscillatory activity mainly in the basal ganglia region of the brain. Deep brain stimulation which involves surgically implanting electrodes in specific regions of the brain has proven to be an effective approach in assessing brain activity in Parkinson's disease. In this paper, we present a detailed computational study on the effects of variations in synaptic weight parameters within key nuclei of the BG including the subthalamus nucleus, thalamus, cortex, nucleus reticularis thalami, internal and external globus pallidus. By systematically varying the 12 synaptic weight parameters, we explore their impact on the dynamic behavior of these nuclei and their contribution to Parkinson's disease pathology. Furthermore, we investigate the effects of deep brain stimulation of these nuclei and analyzed how changes in the deep brain stimulation amplitude (ranging 0 to 12 units) and frequency (ranging 0 to 200 Hz) influences the neural mechanism underlying Parkinson's disease and the efficacy of deep brain stimulation. This study provides computational evidence for how deep brain stimulation parameters can be optimized for therapeutic interventions.

Keywords. BG, Computational stimulation, Deep Brain Stimulation, Parkinson's Disease, Synaptic weight.

AMS (MOS) subject classification: 92 – 08, 92 – 10.

1 Introduction

Parkinson's disease (PD) is a common movement disorder that leads to severe motor disorders due to the progressive degeneration of dopaminergic neurons