An enhanced adaptive deep brain stimulation control procedure for Parkinson disease

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The neurodegenerative Parkinson Disease (PD) is an illness associated with abnormal neuronal oscillations ($12 \sim 30$ Hz) in the Basal Ganglia (BG), which leads to movement disorder. Non-pharmacological treatments are based on Deep Brain Stimulation (DBS), delivering electric current waveform with constant frequency and amplitude to BG regions, the Subthalamic Nucleus (STN) and the Globus Palidus (GP). Novel designs of adaptive DBS (aDBS) with closed-loop feedback are a clinical necessity so to deal with patient variability and disease progression. Here we put forward an enhanced aDBS controller aimed to overthrow the mentioned oscillations at any stage of illness development and synaptic and connectivity parameters ranges, hence adjustable to distinct patient conditions. The control method generally addresses the BG network as a nonlinear-delayed dynamical system, employing a robust technique of delay compensation. The controller architecture relies on recording and stimulating both STN and GP, also using a straightforward predictor algorithm to select the external inputs for the BG. The stimulation inputs consist in simple brief pulses used to suppress or shift the onset of β-oscillations. After that, just rather weak amplitude signals are enough to sustain the achieved stabilization. The protocol has been fully simulated considering an *in silico* model and it has proven to be extremely efficient if the implant processing time is not too long. The proposed enhanced aDBS is based on implementable technologies, therefore amenable to concrete realization.

Type

ORAL