Hamilton Institute

Identification and feedback control in deep brain stimulation: a simulation study

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Deep brain stimulation (DBS) is an effective electric therapy introduced to treat movement disorders associated with chronic neural degenerative diseases like essential tremor, dystonia and Parkinson's disease. In spite of a long clinical experience and detailed studies, the cellular effects of the DBS are still partially unknown because of the lack of information about the target sites. Recent studies, however, have proposed the local field potentials (LFPs) generated by the simultaneous electric activity of several neurons in the target sites as a useful tool to investigate the behavior before and after stimulation.

Our work investigates the relationship occurring between DBS settings (i.e., frequency and amplitude of the stimulus) and LFPs in a 3D simulation environment reproducing the activity of the Vim (a thalamic nucleus, one of the main surgical targets) in tremor conditions. A least-square identification approach is adopted to define a functional, input-output autoregressive model of the Vim and evaluate the effects of the stimulation on its electric patterns. Starting from that model, a minimum variance control scheme is then proposed to restore the auto-spectrum of the Vim LFPs to reference values, derived from subjects not affected by movement disorders. The control law works by updating the amplitude of the stimulus while the frequency is fixed at an aliasing-free value. Results indicate good performances in tracking the healthy spectral features through selective changes in the low (2-7 Hz), alpha (7-13 Hz) and beta (13-35 Hz) ranges.

Venue: Seminar Room, Hamilton Institute, Science Building,
NUI Maynooth

Time: 2.00 - 3.00pm (followed by tea/coffee)

Travel directions are available at www.hamilton.ie

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