Linear Control of Neuronal Spike Timing Using Phase Response Curves

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We propose a simple, robust, and linear method to control the spike timing of a periodically firing neuron. The control scheme uses the neuron's phase response curve to identify an area of optimal sensitivity for the chosen stimulation parameters. The spike advance as a function of current pulse amplitude is characterized at the optimal phase, and a linear least-squares regression is fit to the data. The inverted regression is used as the control function for this method. The efficacy of this method is demonstrated through numerical simulations of a Hodgkin–Huxley style neuron model as well as in real neurons from rat hippocampal slice preparations. The study shows a proof of concept for the application of a linear control scheme to control neuron spike timing in vitro. This study was done on an individual cell level, but translation to a tissue or network level is possible. Control schemes of this type could be implemented in a closed loop implantable device to treat neuromotor disorders involving pathologically neuronal activity such as epilepsy or Parkinson's disease.

A Manual Insertion Mechanism for Percutaneous Cochlear Implantation

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Percutaneous cochlear implantation (PCI) is a recently developed minimally invasive technique that utilizes image guidance and a custom-made microstereotactic frame to guide a drill directly to the cochlea. It enables cochlear access through a single drill port, reducing invasiveness in comparison to mastoidectomy. With the reduction in invasiveness, PCI enables a corresponding reduction in visualization and space in which to work at the cochlear entry point. This precludes standard cochlear implant deployment techniques and necessitates a new insertion tool that can deploy a cochlear implant into the cochlea while working down a deep, narrow channel. In this paper, we describe a manual insertion tool that we have developed for this purpose. The tool is capable of inserting an electrode array into the cochlea using the advance off-stylet technique, using simple manual controls on its handle.

