Optimization of Orientation and Positioning of Magnetic Coils for Implantable Neural Stimulation

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Implantable magnetic neurostimulators have recently garnered considerable interest as an alternative approach to conventional electrical neurostimulation. Traditionally, magnetic stimulation has been employed in extracutaneous applications. For example, Transcranial Magnetic Stimulation (TMS) has provided medical solutions for some conditions, like depression. Along with its application in central nervous system, magnetic stimulation is being explored for its possible application to peripheral nervous system stimulation, to provide sensory and prosthetic applications. The reason behind the increased interest in magnetic stimulation is that it offers a potential solution to some of the issues faced by electric stimulation techniques, such as the need for direct contact with the neural tissue or limited control of the induced currents. However, these advantages come with some challenges; mainly high-energy requirement and less focused target sights due to relative larger size of the coils employed to date with respect to electrodes. These challenges raise the requirement for more efficient, smaller stimulation coils and optimized orientation and positioning of these coils with respect to nerve to be stimulated.

We created a heterogeneous computational model of the rat's sciatic nerve in our previous work [RamRakhyani et. al, TBME, 2015]. This μm-resolution model is based on the histological cross sectional image of nerve and contains fine details of tissue and tissue interfaces (nerve membrane, epineurium, perineurium, extracellular and intracellular space). This model is used to accurately compute the induced electric fields using the impedance method [A. K. RamRakhyani *et al.* 2015, N. Orcutt *et al.* 1988]. The predicted stimulation threshold values, using the mentioned model and methods, are validated with the help of *in vivo* experiments.

In this work, we present a simulation study to gain an understanding of the effects that different coils have on stimulation thresholds. The effect of various orientations and alignment of coils on the selective activation of different target regions of the nerve will also be presented.