Gom2n: A toolchain to simulate and investigate selective stimulation strategies for FES

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When contracting a muscle using NFES (Neural Functional Electrical Stimulation), the stimulus always activates the axons of greater diameter first. Also selective activation of given fascicle inside a nerve is not possible with classical cuff electrode as the recruitment is performed uniformly around the nerve. These limits lead to poorly selective muscle recruitment, inducing fatigue and possible pain. To overcome this, selective stimulation strategies can be used.

We already developed multipolar electrodes and benchtop stimulators with industrial partners to provide for future implantable stimulation units, with up to 12 poles, and arbitrary stimulation shape [1]. Even though literature describes the principles of the strategies to be used, tuning remains a tricky problem. This is the reason why we develop a modelling toolchain, not only to simulate and investigate selective stimulation, but also to optimise it, mainly as regards charge injection minimisation, and selectivity level.

We propose a toolchain [2] to investigate, simulate and tune selective stimulation strategies. It relies on OpenMEEG [3] and Neuron [4] and consists of a conduction volume model to compute the electric field generated in the nerve by a cuff electrode surrounding it; an axon model to predict the effect of the field on the nerve fibre — the generation, propagation and possible block of action potentials.

Gom2n includes a graphical interface to enable to use of the toolchain to a wider audience. It is developped in Python, using PyGtk and matplotlib. All parameters can be visualised and set in the interface. It is also possible to resume previous simulations or to reuse part or all of the model descriptions.

Many improvements are in progress : optimisation of the injected currents vector for spatial selectivity, tools to assist setting the waveform for anodal block, and batch simulations. Some work has been done also to adapt the toolchain for cochlear implants tuning [5].

References

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