Towards a Computer Study of Pulsing Fields: a Report

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Abstract

In this brief note, the authors provide initial thoughts related to the simulation of electric fields of neurons in the central nervous system.

Figure 1 shows the color-coded instantaneous electric field vectors around an axon's node of Ranvier, generated using MATLAB. Electric fields are potentially long-range modalities. Our final objective is to map out the signature of a single axon's electric field on the surface EEG measurement. We are looking for noninvasive probes of deep brain events. The following is a discussion of the initial part of the code which generates this figure.

The script "efieldmainv5.m" is located in the "CorrectedAxonGe" folder. We first set the value of the variable "numnodes" to 1. If we examine the subsequent code, we find that it doesn't have a limit on the number of nodes that it can accept or handle. These are nodes of Ranvier. We have not modeled yet the paranodal regions. Ion channel density differs somewhat in these regions; thus the conduction properties would also differ. There is much to be done in incorporating accurate, paranodally-augmented, models of the node of Ranvier into computer simulations of myelinated axons.

Two different methods for carrying out the electric field computation have been employed in the script. The next variable to be set is called "choice." It must be held at 0 for the initial method and 1 for the final method. We prefer the final method since, as the comments also mention, it gives accurate vectors.

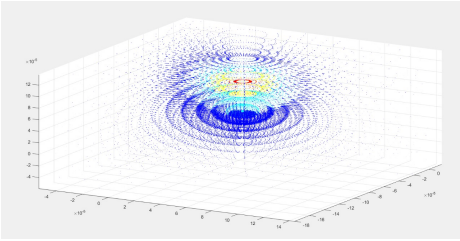

Figure 1: Instantaneous electric field of an axon with a signle node.

This script is constructive and there is no reason to believe that our methods are the only ways to simulate the electric field of a node in an axon. It leaves open the possibility of future extensions to our work via different approaches.

After setting the variable "choice" we set "numaxons." This variable can't be set arbitrarily since the following code is geared towards only two options: either numaxons is set to 1 or it is set to 2. A larger number of axons should be modeled in future versions. Choice is set before numaxons, indicating perhaps that regardless of the simulation method used, multiple axons can be included in the simulation. General tracts contain many hundreds of axons. Extending the script to handle hundreds of axons becomes necessary for ontological accuracy. An ontologically accurate script will generate accurate results and provide insights that enhance our knowledge of reality in the present context.