Universität Rostock Traditio et Innovatio

Master thesis
Modelling of local voltage sources for application in neuroscience

Project description:

Neural activity manifests itself in electrical signals. These signals can, for example, be recorded in the brain [1]. A fundamental aspect of the interpretation of the recorded signals is the localisation of the signal-generating neurons [2]. In a nutshell, the research question is: Which voltage is measured at a recording electrode given a voltage or current source somewhere in the brain volume?
The heterogeneous structure of the brain and electrochemical effects at the electrode surface complicate the theoretical modelling [2]. Thus, this project starts with simple models of well-known electrodes and materials (usually electrolyte solutions).
During the work on the thesis, the candidate is expected to conduct the following research steps:
1) Familiarise yourself with the topic and conduct a literature review focusing on technical aspects.
2) Develop a 3D model of an electrode that is used in the Department of Neurology (contact person: Dr. René Reese of the Rostock University Medical Center).
3) Validate the geometrical model using impedance spectroscopy in collaboration with experts from the SFB 1270 ELAINE.
4) Integrate a point source model of an active neuron into the 3D model and conduct numerical studies to predict recorded voltages under different scenarios.
Depending on the progress, the following step should also be realised:
5) Suggest an experimental setup to test the numerical predictions and contribute to its realisation.

For the successful completion of the thesis it is required that you acquaint yourself with the Good Rules of Scientific Practice of the University of Rostock and the publication “Avoiding plagiarism, self-plagiarism, and other questionable writing practices: A guide to ethical writing“ by Miguel Roig, second edition, 2015.

References:

[1] Einevoll, G. T., Kayser, C., Logothetis, N. K., & Panzeri, S. (2013). Modelling and analysis of local field potentials for studying the function of cortical circuits. Nature Reviews Neuroscience, 14(11), 770–785. https://doi.org/10.1038/nrn3599
[2] Miceli, S., Ness, T., Einevoll, G. T., & Schubert, D. (2017). Impedance spectrum in cortical tissue: Implications for propagation of LFP signals on the microscopic level. ENeuro, 4(1), 1–15. https://doi.org/10.1523/ENEURO.0291-16.2016

Requirements:

Sound knowledge of C/C++ or Python.
First experiences with UNIX-like systems.
Interest in electrical engineering, particularly computational electromagnetics and the realisation of experimental set-ups.

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