

Chapter 10

Summary

NeuroSim, a new simulation system for biological neural networks has been developed. It is based on a client-server architecture that is most effective for performing extensive calculations on high-powered computers, while control and visual results presentation are left to a personal computer.

NeuroSim is platform-independent and provides a comfortable graphical user interface for all aspects of model definition and control of simulation results. The client part is responsible for designing the model and transferring the model description to a server which performs the calculations. The client has been developed in Java and can be run on any computer; it accesses a powerful server available over a network. The results of mathematical modelling performed on the server are uploaded to the user's computer for visual presentation and evaluation. One can observe membrane voltages and channels conductance curves; at the same time, an animation of the pulses propagating through the network connections and of neuron activations can be launched.

Detailed modelling of neurons and neural networks, implemented in NeuroSim, is realized within the compartmental modelling approach. The NeuroSim server is responsible for solving a system of differential equations arising from mathematical modelling. It describes the spread and interaction of electrical and chemical signals in real neurobiological systems. As a benefit of the client-server architecture, the constructed models can be complex and computationally intensive without affecting a user's computer.

In the first stage of the project the server for solving the system of differential equations has been realized on the base of the Genesis simulator. In the second stage our own C++ server for numerical integration has been implemented. It consists of the C++ classes of common neural elements in a hierarchical structure. They are easily extensible, in case of further development of the program for newly-arising modelling tasks.

The functioning of the sensory neuron B21 of the mollusc *Aplysia* has been simulated as an illustration of using of NeuroSim for simulating of a real neurobiological system. The model of the cell was suggested based on the data of neurobiological experiments. The simulated behavior shows good agreement

with experimental data. It can be used for analysis of spike initiation and its propagation mechanisms providing further insight into regulation mechanism of “afferent transmission”. The simulation results propose further ideas for testing the structure of B21 and its functioning.

The system has been integrated into the electronic chalkboard, E-Chalk. A free-hand drawing GUI has been realized to define a model of neurons, connections and their properties and perform the simulation control. It can be effectively used for educational purposes.

Thus, NeuroSim has been designed as the tool for research modelling experiments as well as a powerful education software for presenting lecture material during neurobiological courses.