Visiome Platform at the cellular and local network level

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Basic Neuroscience in Visiome Platform

At various levels along the visual pathway, a various types of neurons and local neural circuits are involved in processing visual information. To understand how our visual system work, we need to understand how the neurons and the local circuits work. In the Visiome Platform, we therefore incorporated information regarding neurons and local circuits and labeled them with indices of "Basic Neuroscience" category. Since "Basic Neuroscience" is a very wide field, we focused ourselves to provide fundamental information, sample data and models, and tools.

Fundamental concept

There is an important fundamental concept in the way we organize information in the "Basic Science" category. That is to organize efforts to construct **VIRTUAL NEURONS** is the way to materialize neuroinformatics at the cellular and local circuit level. The rationale for this concept is the following.

Neural system is a complex system. What needs to be done?

Share knowledge

Integrate data and knowledge to produce new ideas/hypothesis most importantly by facilitating interplay between experimental research and theoretical research.

Share new ideas/hypothesis and test them

What is in our way to do the above?

Diversity of data.

How do we cope with this situation?

Give mathematical model descriptions to new findings. At the cellular level and local network level, majority of experimental findings can be describe as models, such as kinetics of channels, kinetics of enzyme reactions, density distribution of channels, morphology of proteins , organelles, cells, circuits . These can all be incorporated to compartmental model neurons which we call VIRTUAL NEURONS. Once the properties of neurons are described as model neurons, those can be used as research tools for future study. One might use them as building blocks for large neuronal networks to test new ideas. One might use them to analyze their new experiments. With model descriptions in mind, experimental data will be collected and shown in a way easier to be incorporated in models, easier to be shared. This way, new findings will be integrated, and new ideas will be produced, tested and be shared. Thus, experimental data should be made available to those who wish to analyze theoretically. Models should be made

available to those who wished to use. In short, we should organize efforts to construct VIRTUAL NEURONS.

Illustration of the fundamental concept:: an example

My colleagues in my laboratory performed a fast voltage-sensitive dye imaging and obtained data showing how EPSPs propagate along the dendrites of hippocampal pyraidal neurons. The raw data is digitized and can be shared. A part of the data was submitted to the Visiome Platform. We analyzed our data by using compartment model simulator NEURON which we downloaded from a web site at Yale University, and obtained a set of cable parameters. The model was made available on the Visiome Platform.

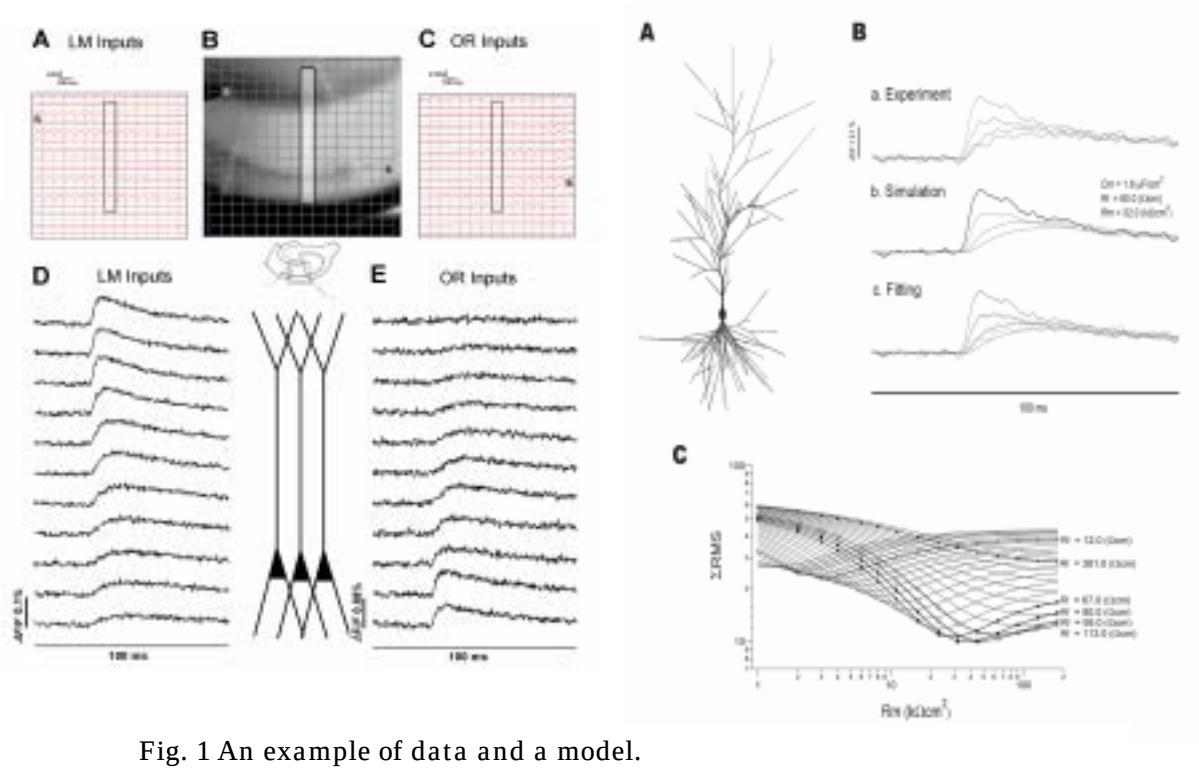


Fig. 1 An example of data and a model.
Left. Voltage sensitive dye imaging of synaptic potential in hippocampal CA1 pyramidal neurons. Right. Estimation of cable parameters by using experimental data and a compartmental model simulator.

This kind of models can be used by other researchers. Those are particularly useful for theoretical neurobiologists who is interested in the behavior of local circuits. Aonishi et al. used a compartment model of hippocampal pyramidal neurons which generate backpropagating action potentials in the apical dendrites and calculated phase-response curves. By using the curves, they have shown that backpropagating action potentials change the structure of coupled oscillator from monostability to bisatbility.

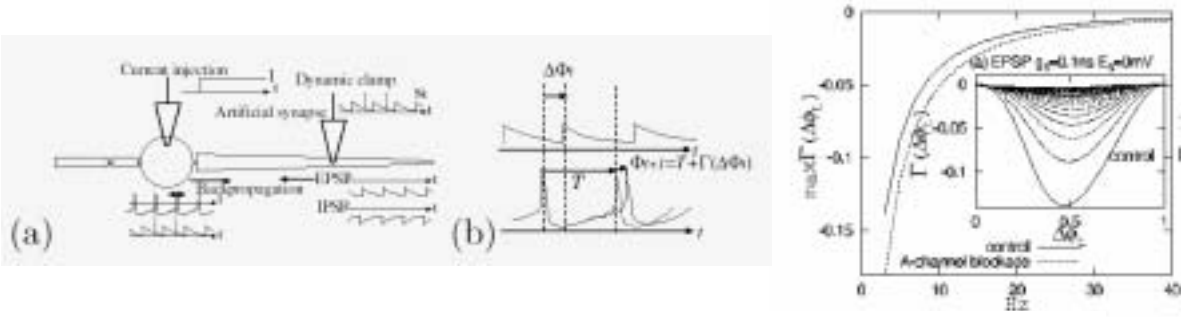


Fig.2 Phase response curve obtained using realistic compartmental model neuron. Top. The arrangements of a virtual experiments on model CA1 pyramidal neurons. Bottom. Phase response curve.

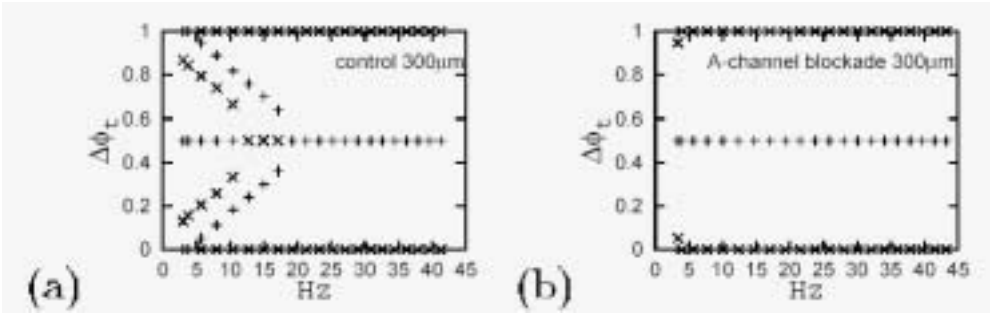


Fig.3 Equilibrium states as a function of _ring frequencies. The mark + denotes stable equilibrium

What we have in the Visiome Platform

1)Important publications (Reviews, Regular articles, Books, Teaching materials). Important web sites (Channel data base, morphology data base, publication data base).

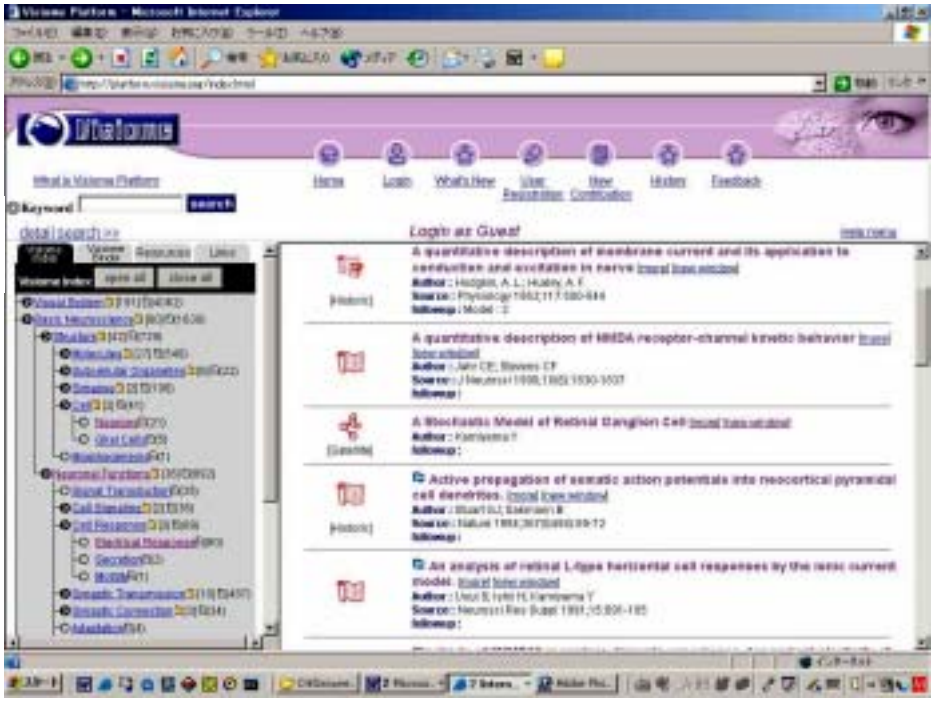


Fig.4 Contents in Basic Science

2)Downloadable sample model scripts of compartmental model simulators. Downloadable sample experimental data

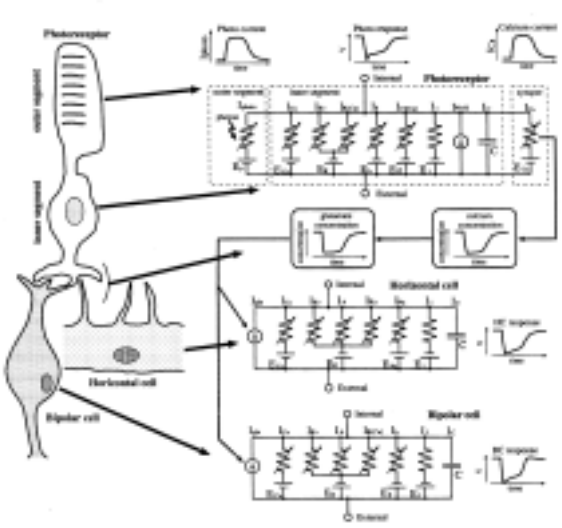


Fig.5 Ionic current model of the outer retina

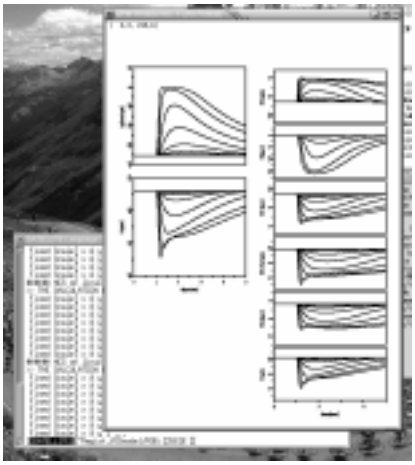
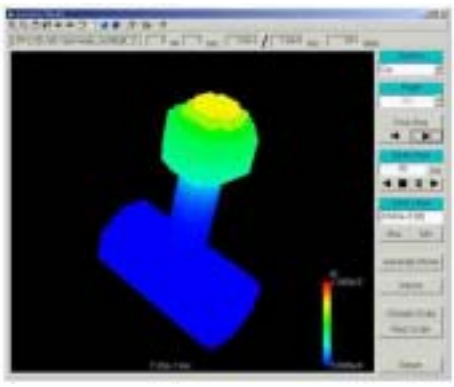


Fig.6 Execution of a downloaded model of a photoreceptor on SATELLITE

3) Modeling tools for compartmental model simulation (SATTELLITE), cell signaling (A-CELL, A-CELL 3D). Links to simulators (NEURON, GENESIS). Simulation servers.



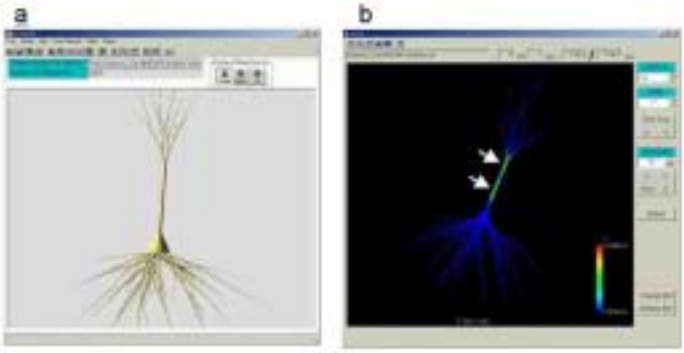


Fig.7 A-Cell-3D A free software for constructing biochemical reactions and equivalent circuit models for cells.

Future

It is a formidable task to cover the entire field of cellular neurobiology. We intend only to provide fundamental knowledge, examples of data and models, and tools. Bioinformatics has tremendously thrusted molecular biology in recent years. In this post-genome era, we need to facilitate interplay between those who are interested in the functional aspects of systems and those who are interested in the molecular entities of systems. We hope what we have developed and incorporated in the Visiome Platform will serve as a prototype for establishing neuroinformatics at the cellular and network level in the coming years.