Public Abstract

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Title: Specific Bio-modeling and Analysis Techniques At Cellular and Systems Level

Computational models provide an effective avenue to test hypotheses regarding mechanisms that underlie the behavior of biological system, at all levels, including molecular, cellular, systems, and behavior levels, and to model emergent properties for such systems. Modeling approaches are developed for two different levels, cellular (Part I) and systems (Part II).

PART I consists of three chapters focusing on computational neuroscience models at cellular level. Accurate modeling and analysis techniques are developed for the dynamics of single cell and networks of mammalian neurons for two different applications, and validated using experimental data. The mechanisms of action of a drug on prefrontal cortical cells are elucidated with two possible hypotheses, and a systematic methodology to study the excitability of cells under inhibitory post synaptic currents (IPSCs) is developed. For the second application, single cell models are developed for baroreceptor cells and it is shown to successfully model the conversion of an analog blood pressure signal to discrete firing patterns. Also, we investigate whether spike frequency adaptation is mediated by a pre- or post-synaptic mechanism. Nucleus tractus solitarius (NTS) cells which receive the baroreceptor afferents are also modeled, and three specific network configurations of these are investigated.

PART II focuses on mathematical models at the systems level. Specifically, thermal physiology models of the entire human body are developed using statistical and black box (artificial neural network, ANN) techniques.

MU 2-D Man is a human thermal model developed by our group at the University of Missouri (MU). The model has been developed for designing an automatic thermal comfort control strategy for NASA astronaut space suits and for the US Air Force warfighters in chemo-bio suits. The model has been enhanced using more accurate modeling of digits incorporating arterio-venous anastomoses (AVA) mechanisms that the fingers and toes use for better control of heat transfer. Also, a black box model has bee developed using ANN techniques to predict the thermal response of supine subjects to transient environmental conditions, using a US Army data set.