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Diffusion Dynamics of Leech-Heart Inter-Neuron Model

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Abstract : We study the spatiotemporal dynamics of a neuronal cable. The processes of one- dimensional (1D) and 2D diffusion are considered for a single variable, which is the membrane voltage, i.e., membrane voltage diffusively interacts for spatiotemporal pattern formalism. The recovery and other variables interact through the membrane voltage. A 3D Leech-Heart (LH) model is introduced to investigate the nonlinear responses of an excitable neuronal cable. The deterministic LH model shows different types of firing properties. We explore the parameter space of the uncoupled LH model and based on the bifurcation diagram, considering v_k2_ashift as a bifurcation parameter, we analyze the 1D diffusion dynamics in three regimes: bursting, regular spiking, and a quiescent state. Depending on parameters, it is shown that the diffusive system may generate regular and irregular bursting or spiking behavior. Further, it is explored a 2D diffusion acting on the membrane voltage, where different types of patterns can be observed. The results show that the LH neurons with different firing characteristics depending on the control parameters participate in a collective behavior of an information processing system that depends on the overall network.

Keywords : bifurcation, pattern formation, spatio-temporal dynamics, stability analysis
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