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Dynamics of the Coupled Fitzhugh-Rinzel Neurons

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Abstract : Excitable cells often produce different oscillatory activities that help us to understand the transmitting and processing of signals in the neural system. We consider a FitzHugh-Rinzel (FH-R) model and studied the different dynamics of the model by considering the parameter c as the predominant parameter. The model exhibits different types of neuronal responses such as regular spiking, mixed-mode bursting oscillations (MMBOs), elliptic bursting, etc. Based on the bifurcation diagram, we consider the three regimes (MMBOs, elliptic bursting, and quiescent state). An analytical treatment for the occurrence of the supercritical Hopf bifurcation is studied. Further, we extend our study to a network of a hundred neurons by considering the bi-directional synaptic coupling between them. In this article, we investigate the alternation of spiking propagation and bursting phenomena of an uncoupled and coupled FH-R neurons. We explore that the complete graph of heterogenous desynchronized neurons can exhibit different types of bursting oscillations for certain coupling strength. For higher coupling strength, all the neurons in the network show complete synchronization.

Keywords : excitable neuron model, spiking-bursting, stability and bifurcation, synchronization networks
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