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Distinguishing the Type of Input Noise in the Fitzhugh-Nagumo Neuronal Model

A nonlinear system of differential equations known as the Fitzhugh-Nagumo (FN) is used to describe the physiological state of a nerve membrane. Several different kinds of noise are added to the FN model to investigate the effect of noise on the membrane. They are Gaussian white noise, O-U process and Poisson noise. Gaussian white noise represents many small synaptic inputs and Poisson noise represents a few large synaptic inputs. The non-oscillatory region before and after the bifurcation region is used to distinguish between Wiener vs. Poisson inputs by a hypothesis test about the mean number of level crossings. The null hypothesis is the expected level crossings of the equilibrium state by a time sampled linearized FN set of differential equations with Wiener input. The test performs well in rejecting non Wiener inputs in simulation studies, both in the linearized and nonlinear F-N model. A resonance type phenomena was also observed.
Key Words: Neuron; First passage time; level crossings; Poisson process; stochastic differential equation