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EDITORIAL

Special Issue on Nonlinear Models in Biosignaling, Biosensor and Neural Systems—Modeling, Simulations and Applications

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Despite many recent advances in experimental and computational technologies for medical and neurosciences, several human lives are lost each year due to many neurological disorders. Biological, neurological and dynamical diseases of human brain are critical in understanding the challenges. Modeling dynamical diseases of human brain remains crucial for the design of prevention and control policies and public health programmes.

Nonlinear dynamics of neuron-neuron interaction via complex networks forms the basis of all brain activity. How such inter-cellular communication gives rise to behaviour of the organism, has been a long-standing question. In the context of intra-cellular signaling, we consider the attractor network models of nervous system activity and investigate how modular structures affect the dynamics of convergence to attractors and its implications for basin size of dynamical attractors in modular networks, whose nodes have threshold-activated dynamics. The study of complexity of the nervous system and its dysfunction has emerged as a discipline which unifies many disciplines of scientific pursuit such as biophysical dynamics, neural signal transduction and network architecture. In recent years, new techniques and new areas of applications have emerged as bursting patterns, spike generating dynamics, large scale neural networks/dynamics, delay effect in brain dynamics, synaptic depression and integration, travelling waves in realistic dendritic morphologies, synchrony in cerebellar network, population coding and models of sleep/wake cycle etc. Mathematical models describing these complex processes and their solutions have led to a better understanding of computational neuroscience that is more variant, dynamic and unpredictable. In 1999, H. R. Wilson (Journal of Theoretical Biol. 200(4), 375–388) has introduced a human and mammalian neocortical neuron (HMNN) model which limits the potential nonlinearities to cubic polynomials and produces a good approximation to spike shapes, firing rates, and bursting behaviour throughout the physiological range. This model has been widely used in neural dynamics, neural networks, neural field theory, and epilepsy. The diversity of disciplines and success of approaches based on nonlinear dynamics, complexity theory and systems biology in resolving some difficult issues and answering some outstanding questions related to computational neurosciences, biosignaling, biosensor and neural systems and other related problems of current interest led to the idea of compiling a special issue on the subject.

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In this special issue, Rashidinia and Sajjadian demonstrate the analytical solutions of HMNN model using a Step Homotopy Analysis Method and the convergence of the method for solving the model of gray matter behavior is analyzed. Burlakov investigates the existence of solutions to the Hammerstein integral inclusion generated by a discontinuous neural field equation with delay and memory. The problem of continuous dependence of solutions to neural field equations under the transition from continuous to discontinuous firing rate function is discussed. Bayrak, Hövel and Vuksanovi´c have presented a network of FHN model and Balloon–Windkessel Hemodynamic model for the studying the neuronal activity of the human brain. A comparative analysis of the brain graph and random graph is discussed based on the numerical simulations. Further, their findings on hierarchy in anatomical connectivity are in good agreement with the previous investigations performed on cat and macaque monkey. Hai-An, Hien, and Loan discussed the problem of generalized exponential stability of neural networks with a proportional delay and time-varying impulsive effects. Based on an assumption of periodic-type distribution of impulsive strengths, a unified delay-independent stability criterion has been derived and LMI-based conditions are formulated to make the closed-loop system stable. Sau, Hong, Huyen, Huong and Thuan have studied the effects of time-varying delay and external disturbance for robust H_∞ control for fractional-order neural networks. The authors have shown the delay and order-dependent stability criteria with regard to linear matrix inequality with zero disturbances, using fractional-order Razumikhin theorem. Ambrisio, Aziz-Alaoui and Balti have considered a network of reaction–diffusion Hodgkin–Huxley model. Existence, uniqueness and regularity of mild solutions are established for a spatial model. Mondal, Paul, Vishwakarma and Upadhyay have considered a stochastic three-dimensional modified Hindmarsh Rose (H-R) neural model and investigate the issue of parameter estimation using the least square method. The denoising technique has been applied to reduce the influence of noisy stimuli in an experimentally collected EEG data set and the results are presented in terms of reduction in variance level.

1. [DEDS-D-18–00070] Continuously Bursting Simulations and Analytical Solutions of the Neocortical Neurons Model. **By J. Rashidinia and M. Sajjadian**
2. [DEDS-D-18–00090] On Inclusions Arising in Neural Field Modeling. **By E. Burlakov**
3. [DEDS-D-16–00206] Modeling Functional Connectivity on Empirical and Randomized Structural Brain Networks. **By S. Bayrak, P. Hövel, V. Vuksanovi´c**
4. [DEDS-D-18–00,086.1] On Exponential Stability of Neural Networks with Proportional Delays and Periodic Distribution Impulsive Effects. **By L. D. Hai-An, L. V. Hien, T. T. Loan**
5. [DEDS-D-20–00058] Delay-Dependent and Order-Dependent H∞ Control for Fractional-Order Neural Networks with Time-Varying Delay. **By Nguyen Huu Sau, Duong Thi Hong, Nguyen Thi Thanh Huyen, Bui Viet Huong, Mai Viet Thuan**
6. [DEDS-D-16–00211] Propagation of Bursting Oscillations in Coupled Non-homogeneous Hodgkin–Huxley Reaction–Diffusion Systems **By B Ambrosio, MA Aziz-Alaoui, A Balti**
7. [DEDS-D-16–00189] Parameter estimation in a spiking-bursting H-R neural model with random fluctuation. **By A. Mondal, C. Paul, G.K. Vishwakarma1, R.K. Upadhyay**