SEMINARIO DE MATEMÁTICAS

Departamento Académico de Matemáticas del ITAM

On-line detection of qualitative dynamical changes in nonlinear systems: the resting-oscillation case

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Abstract

On-line detection of qualitative dynamical changes in nonlinear systems: the resting-oscillation case. Motivated by neuroscience applications, we introduce the concept of qualitative detection, that is, the problem of determining on-line the current qualitative dynamical behavior (e.g., resting, oscillating, bursting, spiking etc.) of a nonlinear system. The approach is thought for systems characterized by i) large parameter variability and redundancy, ii) a small number of possible robust, qualitatively different dynamical behaviors and, iii) the presence of sharply different characteristic timescales. These properties are omnipresent in neurosciences and hamper quantitative modeling and fitting of experimental data. As a result, novel control theoretical strategies are needed to face neuroscience challenges like on-line epileptic seizure detection. The proposed approach aims at detecting the current dynamical behavior of the system and whether a qualitative change is likely to occur without quantitatively fitting any model nor asymptotically estimating any parameter. We talk of qualitative detection. We rely on the qualitative properties of the system dynamics, extracted via singularity and singular perturbation theories, to design low dimensional qualitative detectors. We introduce this concept on a general class of singularly perturbed systems and then solve the problem for an analytically tractable class of two-dimensional systems with a single unknown sigmoidal nonlinearity and two sharply separated timescales. Numerical results are provided to show the performance of the designed qualitative detector.

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SALÓN B1, CAMPUS RÍO HONDO