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Editorial

Modeling and Control of Complex Dynamic Systems 2013

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1. Introduction

The concept of complex dynamic systems arises in many research fields and practical applications, which can be found anywhere such as in the areas of energy generation and distribution, ecosystems, health delivery, safety and security systems, telecommunications, transportation networks, biomedical systems, and the rapidly emerging research topics seeking to be understood and analyzed. A complex process may be characterized by a system with environmental uncertainties, communication time delay, stochastic perturbation, hybrid dynamics, distributed dynamics, chaotic dynamics, and systems with collective behavior. As a result, modeling and control of a complex system are interesting but challenging. Following the great success of the special issue last year [1], the guest editorial team is pleased to organize the second special issue for "Modelling and Control for Complex Dynamic Systems."

This special issue aims to provide a platform for researchers to discuss various mathematical methods and techniques for modeling and control of complex dynamic systems and to identify critical issues and challenges for future investigation in this field. The special issue received 56 submissions, and 14 papers are selected after a strict peer review procedure, indicating an acceptance rate at 25%.

2. Modeling of Complex Dynamic Systems

Partial differential equations can be used to describe infinite-dimensional dynamics of a complex process. In the paper by Khosroushahi et al. the infinite-dimensional dynamics of a prototype micro-fluidic thermal process is investigated for genetic analysis purposes. Compared with conventional lumped modeling approaches, the infinite-dimensional dynamic model is more effective to be used to develop a precise control framework to meet the very tight performance requirements. The equations of the dynamic models are solved analytically and the proposed models are validated by a known experimentally verified model. The model framework can be used for designing a precise tracking controller applicable to the selected Lab-on-a-Chip device.

Model reduction is a technique to reduce model dimensions particularly for a high-dimensional system. It is noted that, for certain types of nonlinear partial differential equations, some neglectful modes could be crucial in the modeling although they only represent a tiny amount of energy. In the work by J. Shuai and X. Han, an optimal EEF (empirical eigenfunction) method is proposed for model reduction of nonlinear partial differential equations, which is based on the basis function transformation from the initial EEFs. The present model reduction method can generate a lower-dimensional dynamic model but keep dynamical information of neglectful modes, leading to a more precise model for the partial differential equations. The effectiveness and feasibility for model reduction are verified by simulated results.

Recently, uncertainty theory has attracted attention on the modeling of complex problems. For instance, flight scheduling, practically for the case with irregular flights, is a real-time optimization problem. Due to the uncertainty of the problem and insufficiency of the data in the decision-making procedure, the traditional modeling tool (such as probability theory) becomes invalid. In the paper by D. Mou