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BioSyM
BIOSYSTEMS AND MICROMECHANICS

Focused Seminar Series on Statistics and Optimisations in Biological Studies

13 June — 11 July 2016, Level 5 Seminar Room, Enterprise Wing @ UTown, S'138602

Seminar 1: A Data-Driven Approach to Nonlinear System Dynamics, Robotics, and Life Sciences in the Era of Big Data

Professor H. Harry Asada

Massachusetts Institute of Technology

Date: 13 June 2016, Monday

Time: 4pm to 5pm

Venue: Perseverance Room, Enterprise Wing Level 5 @ UTown

Abstract

Data-driven techniques are increasingly important as a vast amount of data is becoming available at low cost. Yet, we are still lacking in effective methodologies for extracting useful information from the large data. Traditional methods have not yet fully exploited Big Data. This is particularly the case for nonlinear system dynamics and control, robotics, and life sciences. This talk will address how we can exploit Big Data, both measured and simulated, for complex system modeling and control. First, a new data-driven approach to building a compact state equation will be developed by using Latent Variable methods with physical system modeling theory, the Bond Graph. It will be shown how to find a complete set of variables that can ***sufficiently inform*** the system's nonlinear dynamics. While the resultant latent state equation is ***linear***, complex nonlinearities can be embedded in the compact model. The new methodology will be applied to: a) Model Predictive Control of nonlinear bio-reactor systems, b) wearable robots for controlling complex human-robot interactions, and c) interactions of a population of biological cells migrating into an extracellular matrix. Emergent behaviors of interacting cells are predicted by superimposing sets of latent state equations, each extracted from single cell simulation data. Linearity of the latent state equations allows for superposition to predict multiple cell interactions, which would otherwise be prohibitively complex to compute.

Biography

H. Harry Asada is Ford Professor of Engineering and Director of the Brit and Alex d'Arbeloff Laboratory for Information Systems and Technology in the Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA. He received the B.S., M.S., and Ph.D. degrees in precision engineering in 1973, 1975, and 1979, respectively, all from Kyoto University, Japan. He specializes in robotics, biological engineering, and system dynamics and control. His current research in the biological engineering area includes bio-artificial muscles, angiogenesis, optogenetic control, computational modeling of cell migration and emergent behaviors, and cell tracking image processing. He received the Rufus Oldenburger Medal from ASME in 2011. He won the Best Paper Awards at the IEEE International Conference on Robotics and Automation in 1993, 1997, 1999, and 2010, the O. Hugo Schuck Best Paper Award from the American Control Council in 1985, Best Journal Paper Awards from the Society of Instrument and Control Engineers in 1979, 1984, and 1990, and the Henry Paynter Outstanding Researcher Award from ASME Dynamic Systems and Control in 1998. He also received the Spira Award for Distinguished Teaching from the School of Engineering, MIT. Dr. Asada is a Fellow of ASME.