MAE Seminar Series

Dynamic Analysis and Control Design in Mechatronics: Application to Robotics and Energy Systems

Dr. Tuhin Das

Assistant Professor, Department of Mechanical Engineering
Rochester Institute of Technology

The first part of this presentation will focus on the design and development of a spherical mobile robot. The concept of a spherical robot is quite appealing due to its simple geometry and superior maneuverability. The spherical robot falls under the category of nonholonomic systems, a field where there has been significant research. For the spherical robot, the problem of reconfiguration (referred to in literature as the 'Ball-Plate Problem') using state feedback is central. The problem is challenging due to the specific kinematic structure of the system that does not admit the use of standard control techniques. An overview of a geometric control strategy will be presented where complete reconfiguration is achieved through a repeating sequence of elementary maneuvers. The concept is generalized to develop a computationally efficient geometric motioning planning algorithm. Key elements of the mechanism design and fabrication of the robot will be highlighted. The presentation will also outline the speaker's current robotics research.

The second part of the presentation will give an overview of the speaker's research in the area of fuel cells. Solid Oxide Fuel Cells (SOFCs) has attracted considerable interest in recent years. SOFCs are fuel flexible with simple on-board fuel reforming process and serve as excellent combined heat and power systems. An overview of the control-oriented multi-physics models of the system will be presented. A structured architecture, that imparts flexibility and scalability, forms the basis of the model. The modeling challenges lie in capturing the coupled physical phenomena, and the numerous energy interactions. The models provide a glimpse into the rich system dynamics and open-up opportunities of addressing several problems that can contribute to improving the SOFC technology. Model-based analysis leads to prediction of steady-state and transient behaviors, yielding fuel-optimum operating points. Also, there are opportunities for sensor reduction through non-linear observer designs. Dynamic analysis provides insight into the varied time scales associated with the different physical phenomena. Furthermore, the model-based approach shows the inherent deficiencies of fuel cell systems in terms of load-following capability. It provides a platform for developing power-split feedback control strategies and hardware-in-the-loop simulation of hybrid fuel cell systems. Finally, by incorporating various stack technologies and new reforming paradigms (such as plasma reforming) into the model architecture, a number of system configurations can be compared and optimized.

Bio:

Dr. Tuhin Das is an assistant professor of Mechanical Engineering at Rochester Institute of Technology. Dr. Das received a B.Tech from Indian Institute of Technology, Kharagpur, in 1997, and MS and PhD from Michigan State University in 2000 and 2002 respectively, all in ME. His doctoral research was in the area of design, dynamics, and control of a spherical mobile robot. From 2002 to 2006, he was employed as a Control Systems Engineer at Emmeskay, Inc. in Plymouth, MI where he was involved in modeling and simulation of automotive power-trains and fuel cells. From 2006 to 2007, Dr. Das was a visiting assistant professor at Michigan State University. His current research is in the area of system dynamics and control of high temperature fuel cell systems and is initiating research in the area of novel bio-mimetic robots.

206 Furnas Hall
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3:30 pm – 4:30 pm

Please contact Dr. Venkat Krovi at vkrovi@eng.buffalo.edu for more information or to request a meeting with Dr. Das.