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Embracing and Escaping Instabilities: Exploring New Capabilities in Robotic Systems

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ABSTRACT:

With greater proliferation of robotics in society, there is a greater need, more than ever before, to push the limits of performance of robotic systems. This presentation will discuss two different applications where completely opposite approaches are taken to explore new capabilities in robotic systems. A new method of propulsion for underwater vehicles is developed by destabilizing the equilibrium configuration of a structure and impulsive forces are applied to stabilize an equilibrium from points lying outside its region of attraction. The first part of the presentation will discuss the flutter mode of instability in structures and different means for generating post-flutter oscillations in the fluid environment. It includes the design and development of underwater vehicles that can propel themselves using passive and flexible tail-like appendages; such systems have the potential to be energy-efficient, quiet, and capable of agile maneuvers. The second part of the presentation will discuss the effect of impulsive forces on underactuated systems, implementation of impulsive control using high-gain feedback, and development of a new algorithm for estimating the region of attraction of an equilibrium and its intersection with the impulse manifold. It includes demonstration of an underactuated system regaining stability using impulsive inputs; such inputs have the potential to effectively enlarge the region of attraction of equilibria and overcome the destabilizing effect of large unknown disturbances.

BIOGRAPHY:

Ranjan Mukherjee is a Professor of Mechanical Engineering at Michigan State University. He received his BTech degree from the Indian Institute of Technology, Kharagpur, in 1987 and his MS and PhD degrees from the University of California, Santa Barbara, in 1989 and 1991, respectively, all in Mechanical Engineering. Prior to joining Michigan State University, he was an Assistant Professor at the US Naval Postgraduate School in Monterey, California. His research interests lie in the areas of robotics and mechatronics and he has published over 200 refereed conference and journal papers. He is a Fellow of the ASME, a recipient of the Fulbright Research Scholar Award in 2008, the MSU Withrow Distinguished Senior Scholar Award in 2011, and the 2014 ASME DSCD Charles Stark Draper Innovative Practice Award. He is currently the Editor for the ASME Journal of Dynamic Systems, Measurement, and Control.