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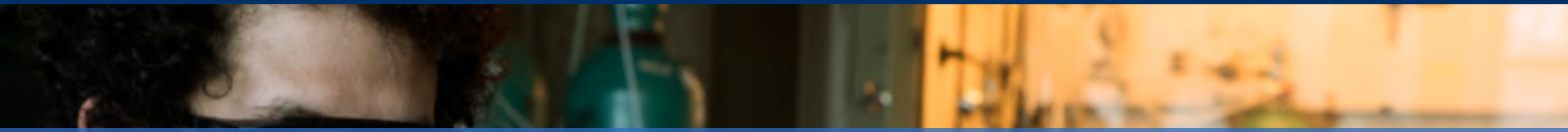

The Department of Mechanical Engineering Presents

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Title: Chasing Biomimetic Mobility and Speed with Untethered Soft Robots

Abstract: Soft robots represent an emerging class of biologically inspired machines that have potential advantages over traditional piecewise rigid robots in maneuvering through complicated environments and resisting external disturbances. They are primarily composed of elastomers, fluids, and other forms of soft matter and electronics for control and power regulation. However, despite drastically growing interest and efforts in soft robotics, building an untethered soft robot that is as fast and mobile as natural organisms remains a significant challenge. This seminar will address this challenge by presenting untethered soft robotic systems with tight integration of soft multifunctional materials, bioinspired soft actuators and sensing skin, miniaturized flexible electronics, and a real-time physics engine. First, I will discuss how to develop a dynamic, powerful, load-bearing, and “sensorized” artificial muscle that can be actuated with miniaturized electronics for untethered soft robots using shape memory alloy (SMA) and liquid metal embedded sensing skin. Next, I will show that we can improve soft robots' locomotion performance and robustness by integrating soft multifunctional materials into soft actuators and soft circuitry. These materials include a thermally conductive liquid metal embedded elastomer, an autonomously electrically self-healing composite, and a highly conductive silver-hydrogel composite. Then, I will present an untethered soft quadruped that tightly integrates the artificial muscles and onboard miniaturized flexible electronics. The robot can move at biologically relevant speed, navigate unstructured terrains, and be resistant to mechanical impact. I will also present an untethered fast multi-gait multi-terrain compliant tensegrity robot with high fidelity closed-loop control and real-time state reconstruction. Finally, I will present a discrete differential geometry-based real-time physics engine for soft robots. The numerical framework is experimentally validated by a multi-limbed underwater soft robot, a star-shaped rolling robot, and a jumping robot. The physics engine is also used as a computational tool to optimize the design and controlled operation of an untethered dynamic frog-inspired soft robot.

About the Speaker: Xiaonan (Sean) Huang is a postdoctoral research fellow in Prof. Rebecca Kramer-Bottiglio’s Faboratory group at Yale University. He received his Ph.D. at Carnegie Mellon University in 2020, advised by Prof. Carmel Majidi. His research focuses on creating untethered soft robots and tensegrity robots that match the speed and mobility of natural organisms. He received his B.S in Mechanical Engineering and B.A in Japanese from Harbin Institute of Technology and M.S in Mechanical Engineering from Carnegie Mellon University.

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