# EML WEBINAR

ZOOM ID 271 079 684
YOUTUBE LIVE: HTTPS://TER.PS/EMLYOUTUBELV
WEDNESDAY, 5 AUGUST 2020
7 AM CALIFORNIA, 10 AM BOSTON
3 PM LONDON, 10 PM BEIJING

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## LIVING ROBOTICS

Industrial revolution of the 19th century marked the onset of the era of machines that transformed societies. However, these machines cannot self assemble or heal themselves. On the other hand, since the discovery of genes, there is a considerable body of knowledge on engineering living cells. It is now possible to envision biohybrid machines with engineered living cells and scaffolds. These machines may self assemble and emerge from complex interactions between the cells and the scaffolds at various hierarchical levels. In this talk we will present two elementary biohybrid machines. They are both small scale swimmers. One of the swimmers is powered by primary rat cardiomyocytes. These cells are plated without any patterning on a scaffold which consists of a head and a tail. The cells self-orient to maximize scaffold deformation, and synchronize their beating. As a result, the tail deforms periodically and propels the swimmer forward. As a first step towards intelligent machines, the second swimmer consists of optogenetic neurons and muscle cells. It's scaffold consists of a head and two tails. The muscle cells self assemble into myotubes around the tails, while the neurons are hosted by the head. The neurons spontaneously send out long cables of axons preferentially towards the muscle forming functional neuro functional junctions. They also form a neural network within themselves. Upon shining light, the neurons fire synchronously in a periodic fashion. The muscle contracts and bends the tails to propel the swimmer. This new generation of swimmer powered by neurons paves the way towards intelligent biohybrid machines. The central role of mechanics in the emergence of the biohybrid machines will be highlighted.

**Professor Taher Saif** received his B.S. and M.S. degrees in civil engineering from Bangladesh University of Engineering and Technology and Washington State University, respectively, in 1984 and 1986. He obtained his Ph.D. in theoretical and applied mechanics from Cornell University in 1993. He worked as a post doctoral associate in electrical engineering and the National Nanofabrication Facility at Cornell University from 1993-97. He joined the Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign in 1997, and is the Edward William and Jane Marr Gutgsell Professor in the department. His research includes cancer tumor micro-environment, the mechanics of neurons and cardiac cells, development of biological machines and materials, and electro-thermo-mechanical behavior of nano-scale metals and semiconductors. His research is supported by the NSF and NIH.

Discussion leader: Professor Yuhang Hu, Georgia Tech

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