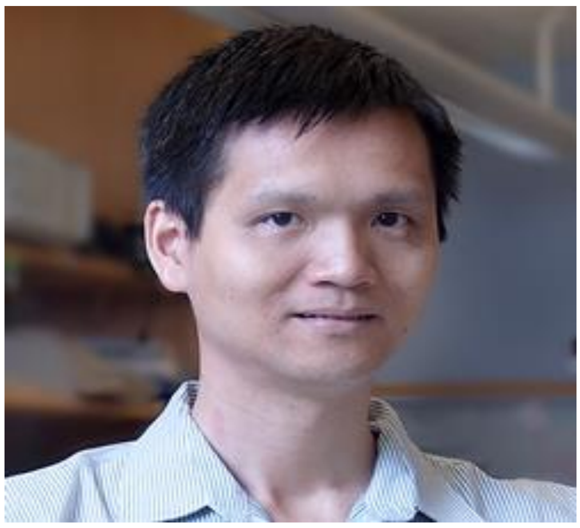
NJIT New Jersey Institute of Technology

BME

Department of Biomedical Engineering
Graduate Seminar



Dr. Zi Chen, Ph.D.

Assistant Professor, Thayer School of Engineering, Dartmouth College

Subject: Mechanics and Geometry: From Twisted Embryonic Brain to Biohybrid Soft Robots

Abstract:

Mechanical forces play a key role in the shaping of versatile morphologies, especially chiral and multistable structures, in both natural and synthetic systems. In embryos, chiral structures can also arise via mechanics. The embryonic chick brain, for example, undergoes rightward torsion, one of the earliest organ-level left-right asymmetry events in development. Here we unveiled the mechanical origin of brain torsion and the associated development of left-right asymmetry, through both experiments and modeling. Moreover, inspired by the swimming organisms, we developed a tissue-engineered reconfigurable robot, which can be remotely controlled to adopt different mechanical structures for switching locomotive function. The actuation of the robot is by a muscular tail fin that emulates the swimming of whales and works as a cellular engine powered by the synchronized contraction of striated cardiac microtissue constructs. With the unprecedented controllability and responsiveness, the transformable robot is employed to work as a cargo carrier for programmed delivery of chemotherapeutic agents to selectively eradicate cancer cells. The realization of the transformable concept paves a promising pathway for potential development of intelligent biohybrid robotic systems. We further developed an energy harvesting strategy, which is to integrate porous piezoelectric thin films in a bioinspired self-wrapping helical configuration into part of the existing pacemaker lead and otherwise with no direct contact of heart for flexible integration with existing implantable medical devices. We demonstrate that this compact helical design can be seamlessly coupled with current leads without introducing additional implantation surgeries. This innovative cardiac energy harvesting strategy represents a significant step forward for clinical translation without a thoracotomy for patients, suggesting a paradigm for biomedical energy harvesting in vivo.

The study of mechanics and geometry will facilitate understanding of shape formation and evolution in natural and synthetic systems, and benefit the ongoing efforts in developing programmable micro-fabrication techniques and novel functional devices such as NEMS devices, active materials, drug delivery agents, energy harvesting devices, and bio-inspired robots. Studies of embryonic development can also benefit the future practices in preventing or treating certain diseases.

Bio:

Dr. Zi Chen is an Assistant Professor at Thayer School of Engineering at Dartmouth College. Dr. Chen received his bachelor's and master's degree in Materials Science and Engineering from Shanghai JiaoTong University, and a PhD in Mechanical and Aerospace Engineering from Princeton University. Before joining Dartmouth, Dr. Chen worked as a postdoctoral fellow in Department of Biomedical Engineering at Washington University in St. Louis. He was also a visiting scientist in the Weitz lab at Harvard University.

Dr. Chen's research interests cover such diverse topics as soft robotics, mechanical instabilities of materials and structures, multistable structures, energy harvesting devices, stretchable electronics, biomimetic materials/devices, nanofabrication, mechanics of morphogenesis in biological systems, and cancer cell biomechanics. Dr. Chen's research has been supported by NIH, Society in Science, and American Academy of Mechanics. He has published over 70 peer-reviewed papers in top journals such as Advanced Materials, Materials Today, Physical Review Letters, Small, Nanoscale, Journal of Royal Society Interface, Extreme Mechanics Letters, and Applied Physics Letters, many of which were featured on the journals' cover and hightlighted in media reports, and filed five US/International patents. Dr. Chen is also a recipient of the Society in Science – Branco Weiss fellowship, the American Academy of Mechanics Founder's award, and International Association of Advanced Materials (IAAM) Innovation Award. His research has also been supported by NIH, NSF, ONR, and Facebook Inc.

Date and time: Wednesday, December 9th, 2020 at 2:30 PM

WebEx Link: https://njit.webex.com/njit/k2/j.php?MTID=t3c913ad191e47dd94f3281de86e09ea3