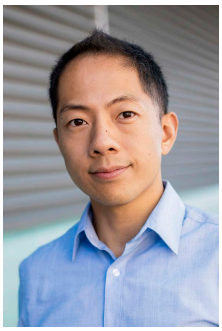
The Department of Civil and Environmental Engineering at the University of Houston presents...

CIVE 6111 Graduate Seminar

Some Rational Designs of Transformable Surfaces



Tian Chen, Assistant Professor
Department of Mechnical Engineering at University of Houston

Friday, October 28, 2022
2:45pm-3:45pm
Classroom Business Building (CBB) - Room 104
Zoom: https://uh-edu-cougarnet.zoom.us/j/95702511696?pwd=VFIybkh4emhETHNITGV0dXRHS3pIZz09

Abstract

Elastic surfaces that can transform between multiple geometrical configurations is of great engineering value, with applications ranging from deployment of space-based PV arrays, erection of temporary shelters, realization of flexible displays, to understanding the encapsulation and release of viral RNAs. In general, it is not a trivial problem to ensure that a shape with a planar rest configuration can geometrically transform into a target 3D shape. This is compounded with the difficulty of physically realizing the local deformations necessary to achieve such global transformation. Here, we focus on the application of conformal mapping to abstract and rationalize the geometrical transformation of a number of microstructure designs. A conformal map is a function that preserves angles (and shape) locally, but not lengths. This differential geometry technique is often used by cartographers to map a globe to the plane. One observation of such mapping is that some regions are scaled (enlarged or shrunk) more than others. Conversely, to globally transform a physical surface to 3D, we can implement such local scalings as mechanical deformations. While it is difficult to control the relative deformations of natural materials, numerous meta-materials with designed microstructures exhibit such behavior regularly. We discuss several meta-materials with tunable yet isotropic expansion and contractions. They employ a wide spectrum of techniques ranging from kirigami, origami, hydrogel, linkages, serpentine, chirality, and so on. The design and fabrication of conformal transformable structures is a transdisciplinary challenge involving input from advanced manufacturing, computational design, material science, and mechanics. By recognizing that many natural and artificial materials exhibit isotropic expansion / contraction behavior, we hope to inspire researchers to adopt conformal mapping in the design of next generation surface-based engineering systems.

Bio

Tian “Tim” Chen is the Kamal Salama assistant professor at the University of Houston. Since joining UH in Sept. 2021, he established the Architected Intelligent Matter Laboratory to explore the notion of intelligent metamaterials. In particular, he aims to design materials that can either transform their shape or their physical characteristics on-demand. With such metamaterials, his goal is to provide a bridge between passive materials and powered robotics. Previously, his studied Engineering Science as an undergraduate at the University of Toronto, he obtained his Master’s degree in civil engineering from Delft University of Technology, and PhD in mechanical engineering from ETH Zurich where he received the ETH Medal in 2018. He was recently a post-doctoral scientist at EPFL in mechanical engineering and computer science.