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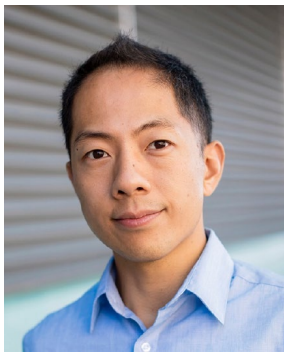
Geometric and material variations in programmable meta-materials



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Abstract

Metamaterials are designed to realize exotic physical properties through the geometric arrangement of their underlying structural layout. The design of metamaterials often imposes the following constraints a priori: 1) unit cells must be identical and can be tiled indefinitely, 2) once fabricate, the properties of the metamaterial shouldn't change. In this talk, I explore the rich design space afforded when we relax these constraints, and discuss how we encode geometric and material variations as well as on-demand programmability. In Bistable Auxetic Surface Structures, we aim to design a meta-surface with spatially varying unit cells that when deployed, transforms to a desired target shape. The geometric mapping between 3D and 2D exploits the unique characteristics of isotropic deformation of certain Kirigami geometries. Second, utilizing shape memory polymers as both the passive substrate and active structural elements, we demonstrate a self-deploying solar panel created using radially symmetric unit cells. Lastly, to address mechanical reprogrammability, we draw analogy to that of digital devices in which each unit can be written to or read from on-the-fly. Specifically, we propose a mechanical metamaterial with stable memory at the unit-cell level. I aim to explore this new field to design novel engineering devices at different length scales.

Speaker Biography

Tian "Tim" Chen is the Kamal Salama assistant professor at the University of Houston. Since joining UH in Sept. 2021, he has established the Architected Intelligent Matter Laboratory to explore the notion of intelligent metamaterials. In particular, he aims to design materials that can either transfer their shape or their physical characteristics on-demand. With such metamaterials, his goal is to provide a bridge between passive materials and powered robotics. Thus far, he has received a research grant from the Advanced Manufacturing Institute at UH, as well as three Provost's Undergraduate Research Scholars. He has pending grants in excess of one million dollars. His read Engineering Science as an undergraduate at the University of Toronto, M.Sc. 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 most recently a post-doctoral scientist at EPFL.