School of Engineering

UCMERCED

Mechanical Engineering

Mechanical Metamaterials Seeking Synergy Dynamic Performance and Sensing through Configuration, Composition and Programmability

This talk will cover two topics on the use of mechanical metamaterials for use in vibration and shock applications. The first part of the talk is dedicated to the discussion of embedded flexibility of planar triboelectric nanogenerators (TENGs) in a metamaterial with complex geometries. The TENG conforms with any deformation of these structures. In return, the embedded TENGs function as either strain-sensitive active sensors or energy harvesters while negligibly affecting the structure's original mechanical. The second part of the talk will focus of metamaterials with programmable linear stiffness. Inspired by the concepts of binary and ternary coding in digital computers, digital stiffness (DS) elements are a novel concept to achieve programmable behavior in a mechanical metamaterial. The digital stiffness is achieved by having an equivalent spring constant that has two discrete states depending on the state of a mechanical switch. This is achieved by the confinement of the deformation of an elastomer host structure by insertion of a semi-rigid member that is stiffer than the base material either in the same direction or orthogonal to the structure's loading direction. The members can be inserted in-situ before loading or provided that the loading is not sufficiently large as to distort the topology of the elastomeric structure. The discrete nature of the inserts leads to a binary encoding of various geometric configurations of the metamaterial and its resulting effective stiffness, e.g., in compression this results in 2N unique force displacement relationships for a single metamaterial, for a material with N binary elements. The final portion of the talk will detail ongoing efforts to utilize material behavior specifically viscoelasticity to tune the desired dynamic and static response of a mechanical metamaterial..

Dr. James Gilbert

Associate Professor in the School of Mechanical Engineering, Purdue University

Friday, October 13, 2023 – 10:30 am – COB 110

Dr. James Gibert is an Associate Professor in the school of Mechanical Engineering at Purdue University. He received B.S., M.S., and Ph.D. degrees in Mechanical Engineering from Clemson University in 2002, 2004, and 2009, respectively. Previously he held a position Department of Mechanical and Aeronautical Engineering at Clarkson University as an Assistant Professor. Before joining Clarkson University, he was consultant for MOOG CSA, a Visiting Professor in the Department of Civil Engineering at Clemson University and a Postdoctoral Research Associate in the Department of Mechanical Engineering at Clemson University. He is a member of ASME and active in Smart Materials, Adaptive Structures, and Intelligent Systems (SMASIS) Division and the Design Engineering Division's Technical Committee on Vibration and Sound. Dr. Gibert has won several teaching and research awards including the 2022 NSF CAREER award. He is to co-author of a textbook, Statics: A Lecture Book. His research lies at the intersection of dynamics, smart materials, and manufacturing. His work is supported from organizations ranging from the National Science Foundation, the Army Research Lab, John Deere Inc, Wabash International, to the International Safe Transit Association (ISTA). Dr. Gibert is an advocate of diversity and inclusion and his thoughts have been published in the journal Science on the importance of considering diversity when developing new technology.