School of Engineering

UCMERCED

Mechanical Engineering

Leveraging vibrations, nonlinear dynamics, and wave phenomena: from energy harvesting and bioinspiration to metamaterials and ultrasound delivery

This talk will review our efforts on exploiting nonlinear dynamics, as well as vibration and elastic/acoustic wave phenomena, in engineering problems. First, we will discuss vibration energy harvesting using piezoelectricity for low-power electricity generation, with a focus on leveraging designed nonlinearities for bandwidth enhancement. Experimental results will be compared against model simulations using the method of harmonic balance. Multiphysics problems of energy harvesting from fluid-structure interaction, and multifunctional concepts such as energy-harvesting bioinspired robotic fish will also be presented. After that, we will discuss mechanical and electromechanical metamaterials and metastructures for vibration/wave attenuation, including a recently introduced general theory, followed by piezoelectric metamaterials with digital programming enabled by synthetic impedance circuits. Bandgap (attenuation frequency range) tuning, rainbow phenomenon, wave compression, wave mode conversion, and reciprocity breaking will be demonstrated for elastic waves through spatial and spatiotemporal programming. Nonlinear metastructures exploiting chaotic vibrations will also be introduced. Our recent efforts on using analog and digital piezoelectric shunt circuits will then be shown for vibration attenuation in structures via concepts like nonlinear energy sink and basic Duffing-type nonlinear circuits. Finally, if time permits, we will discuss examples on higher frequency problems including gradient-index phononic crystals lens designs for elastic and bulk acoustic/ultrasonic waves, wireless ultrasonic power and data transfer, and leveraging vibrations/vibroacoustics and guided waves in the human skull-brain system for transcranial ultrasound.

Alper Erturk, Ph.D.
Carl Ring Family Chair & Professor
G. W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

Biography Alper Erturk is the Carl Ring Family Chair & Professor in the Woodruff School of Mechanical Engineering at Georgia Tech. He began at Georgia Tech in 2011 as an Assistant Professor, he was promoted to Associate Professor with tenure in 2016 (and was named Woodruff Faculty Fellow in 2017), then became a full Professor (and was named Woodruff Professor) in 2019, and most recently he was awarded his current chaired professorship in 2022. His theoretical and experimental research interests are in dynamics, vibration, and acoustics of passive and active structures for a broad range of engineering problems. His publication/presentation record includes more than 130 journal papers, 220 conference papers/abstracts, 5 book chapters, and 2 books (total citations > 21,000 and h-index: 65). He is a recipient of many awards including an NSF CAREER Award (in dynamical systems), ASME C.D. Mote Jr. Early Career Award (in vibration & acoustics), ASME Gary Anderson Early Achievement Award (in adaptive structures & material systems), SEM James Dally Young Investigator Award (in experimental mechanics), and numerous journal/conference best paper awards including the Philip E. Doak Award of the Journal of Sound and Vibration. He served as an Associate Editor for various journals and was recently named the Editor-in-Chief of Smart Materials & Structures. He holds Invited/Adjunct Professor positions at Politecnico di Milano (POLIMI) and at Korea Advanced Institute of Science & Technology (KAIST). He is a Fellow of ASME and SPIE.

Friday, September 15, 2023 – 10:30 am – COB 110

Fall 2023 Seminar Series