ME Seminar

Vibration Techniques Applied to Soft Materials, Space Structures, and Nonlinear Energy Harvesting

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ABSTRACT

Several engineering and natural structures are often subjected to dynamic environments resulting in vibrations. In this talk, I will present our developed novel methods in a broad range of fields utilizing vibration techniques for:

- Mechanical characterization of synthetic soft materials with potential applications in the fields of tumor diagnoses, robotics, and food processing.
- Fully coupled partial differential equation (PDE) model developments to study the dynamics of cable-harnessed beams with applications to space structures,
- Nonlinear dynamic mechanisms for energy harvesting with applications to renewable energy.

Application of traditional techniques to characterize soft materials can be challenging and time-consuming due to their multi-phasic nature. Their mechanical properties are ever-changing dependent on temperature, humidity and osmolarity etc. First, I will discuss vibrations of dehydrating soft materials and the procedure to identify mechanical properties from model, and experiments. I will discuss correlation between fracture properties and fracture-induced surface wave propagation experiments in soft materials. The techniques will result in rapid characterization that is useful in practical settings.

Second, conducting experiments on large space structures with cabling prior to mission is often challenging. I will discuss coupled PDE development to study the vibration of cable-harnessed beams and with emphasis on the effect of cabling on resonant frequencies. The simulation results and experimental observations will be presented. Last, to harness renewable energy opportunities, I will present an internally resonant pendulum-based ocean wave energy harvester. The advantages of nonlinear dynamic mechanisms will be demonstrated through coupled nonlinear ODE model development and prototype experiments. Building upon these topics, I will present some of the current and future research directions. I will conclude my talk by highlighting my teaching and outreach interests.

ABOUT THE SPEAKER

Dr. Karthik Yerrapragada is a postdoctoral research associate in the Department of Mechanical Engineering at the University of Wisconsin-Madison, USA under the guidance of Prof. Melih Eriten and Prof. Corinne Henak. Prior to joining UW-Madison, he obtained his Ph.D in Mechanical Engineering from the University of Waterloo, Canada under the guidance of Prof. Armaghan Salehian. His research focus is in the areas of vibrations, nonlinear dynamics of wide range of structures ranging from soft to metals, and energy harvesting mechanisms encompassing analytical, numerical, and experimental techniques.

Dr. Karthik presented at several international conferences and published several international peer-reviewed Journal papers. His basic research work on soft material characterization also resulted in the National Science Foundation (NSF) I-corps and Partnership For Innovation (PFI) entrepreneurship grant programs. Additionally, Dr. Karthik has initiated and maintains several national and international collaborations. He has also enjoyed teaching courses in the broad area of dynamics and vibrations and participated in mentoring and outreach activities to showcase experimental techniques.

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