Announcing the Final Examination of Daniel Geiyer for the degree of Doctor of Philosophy

Time & Location: August 4, 2017 at 11:00 AM in Engineering II 202A
Title: Chaotification as a Means of Broadband Vibration Energy Harvesting with Piezoelectric Materials

Computing advances and component miniaturization coupled with stagnating battery technology have fueled growth in the development of high efficiency energy harvesters. Vibration-to-electricity energy harvesting techniques have been investigated extensively for use in sensors embedded in structures or in hard-to-reach locations like turbomachinery, surgical implants, and GPS animal trackers. Piezoelectric materials are commonly used in harvesters as they possess the ability to convert strain energy directly into electrical energy and can work concurrently as actuators for damping applications. To date, researchers have worked to improve harvesting capability through modifying material properties, altering geometries, creating more efficient harvesting circuits, and inducing nonlinearities. These techniques have partially mitigated the resonance excitation dependence for vibration-based harvesting, but much work remains.

In this work, an induced nonlinearity is used to destabilize a central equilibrium point, resulting in a bistable potential function governing the cantilever beam system. Depending on the environment, multiple stable solutions are possible, and can coexist. Contrary to typical modes of operation, treating chaos as an acceptable system solution allows for frequency content away from resonance to produce motion about a theoretically infinite number of unstable periodic orbits that can be stabilized through control. This work discusses the feasibility of such a method for vibration energy harvesting, displays stable solutions under various control algorithms, and implements a hybrid bench experiment with MATLAB and LabVIEW FPGA in which a stable orbit was attained.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2011, Rochester Institute of Technology
Master's of Mechanical Engineering, MS, 2011, Rochester Institute of Technology

Committee in Charge:
Jeffrey Kauffman, Chair, Mechanical & Aerospace Engineering
Tuhin Das, Mechanical & Aerospace Engineering
Faissal Moslehy, Mechanical & Aerospace Engineering
Bhimsen Shivamoggi, Mathematics

Approved for distribution by Jeffrey Kauffman, Committee Chair, on July 21, 2017.

The public is welcome to attend.