Exploiting Dynamical Phenomena of Micro and Nano Systems for Superior Devices

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ABSTRACT: Miniature structures and devices have captured the attention of the scientific community for several decades for their unprecedented attractive features. Today, several micro-electro-mechanical systems MEMS devices are being used in our everyday life, ranging from accelerometers and pressure sensors in automobiles, radio-frequency (RF) switches and microphones in cell phones, and inertia sensors in video games. With the quest to boost sensitivity, reduce power consumption, and increase integration density, the past decade has witnessed the emergence of Nano-electro-mechanical systems NEMS.

Along with their great promise, micro and nano devices have brought new challenges and a wide spectrum of unexplained and less-understandable behaviors and phenomena. Because these devices employ moveable compliant structures, many of these challenges are related to their dynamical behavior, which is mostly nonlinear.

In this talk, we demonstrate that by developing a proper understanding and deep insight of the dynamics and nonlinear mechanics phenomena at the micro and nano scale, new technological solutions and innovative ideas can be realized leading to new generations of superior devices. The talk will first discuss the realization of smart switches triggered by the detection of a physical quantity (combining sensing and actuation into a single device). In one application, switches triggered by the detection of gas will be discussed. Toward this, electrostatically microbeams resonators are fabricated, then coated with highly absorbent polymers (MOFs), and afterward are exposed to gases. Such devices can be useful for instant alarming of toxic gases. In another application, we demonstrate switches triggered by shock and acceleration, which can be used for the deployment of airbags in automobiles and for earthquake safety actions. The second part of the talk will discuss the intriguing static and dynamic behavior of shallow micro and nano arches. We will discuss several interesting nonlinear behaviors of in-plane arches and their exploitation for logic, memory, filtering, and sensing applications.

BIO: Mohammad I. Younis received a Ph.D. degree in engineering mechanics from Virginia Polytechnic Institute and State University, Blacksburg, VA, in 2004. Since 2004, he has been serving as an assistant and then as an associate professor of Mechanical Engineering at the State University of New York (SUNY), Binghamton, NY. In 2013, he took a leave from SUNY to King Abdullah University of Science and Technology, Saudi Arabia, where he has served as an associate professor of Mechanical Engineering and a Director of the MEMS and NEMS Characterization and Motion Laboratory. Dr. Younis is a recipient of the SUNY Chancellor’s Award for Excellence in Scholarship and Creative Activities in 2012, the National Science Foundation Faculty Early Career Development Award in 2009, and the Paul E. Torgersen Graduate Research Excellence Award in 2002. He holds several U.S. patents in MEMS sensors and actuators. He serves as an Associate Editor of Nonlinear Dynamics, the Journal of Computational and Nonlinear Dynamics, and the Journal of Vibration and Control. He has authored more than ninety archival journal papers and a book, all on the fields of MEMS and NEMS statics and dynamics. He is a member of the American Society of Mechanical Engineers.