Los Alamos Dynamics Summer School Program 2014

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Abstract

In the past two decades, a significant effort has been made by the research community to develop smart material-based engineering systems. Advances have been made in the discovery and creation of new *intelligent* materials, the development of mathematical modeling framework to describe the physics of these materials, and experimentation to validate these models. Smart materials (also known as intelligent materials or active materials) are materials that exhibit coupling between multiple physical domains, thereby allowing them to convert energy from one domain to another. This coupling has allowed engineers and scientists to develop sensors, actuators, and energy conversion devices using various intelligent materials. Smart materials are an enabling technology for cyber-physical systems in which a critical element is the ability to sense phenomenon locally. Many cyber-physical systems rely on wireless sensor nodes for feedback to complex computation algorithms, and smart materials can be used to sense various phenomenon as well as to convert energy to power sensors.

In this seminar, I will briefly introduce several smart materials and describe their respective transduction mechanisms. Examples of engineered intelligent material systems will be given. The use of smart materials to enable cyber-physical systems will then be discussed. Lastly, I will describe my research which focuses on *energy harvesting*, whereby smart materials are used to convert ambient energy surrounding a structure into useful electrical energy to typically power a low-power electronic device, such as a sensor node. Current projects include the exploration of embedding piezoelectric materials in total knee replacement units to create autonomous self-sensing implants, as well as the investigation of piezoelectret foam materials for energy harvesting.

Bio: Steven R. Anton is an assistant professor in the Department of Mechanical Engineering at Tennessee Technological University. Dr. Anton received the B.S. degree in Mechanical Engineering from Michigan Technological University (2006), and M.S. and Ph.D. degrees in Mechanical Engineering from Virginia Polytechnic Institute and State University (2008 and 2011, respectively). Following his graduate work, Dr. Anton held a two year postdoctoral position at Los Alamos National Laboratory. He is also an alumnus of the Los Alamos Dynamics Summer School (LADSS, 2006). His research interests include multifunctional and multisource energy harvesting using various transduction mechanisms, and structural health monitoring and damage detection and prognosis. His work in energy harvesting aims to create autonomous power supplies for low-power electronic devices, such as wireless sensors and embedded biomedical devices, by scavenging ambient energy surrounding the device.