



Events

Please contact Chuck Farrar (farrar@lanl.gov, 663-5335) for more information.

- **Fall 2010 UCSD courses (Instructor)**
 - ◆ Detection Theory (ECE254, William Hodgkiss), Tu/Th 9:00-10:20 am
 - ◆ Filter Banks and Wavelets (ECE251C, Truong Nguyen), Tu/Th 3:00-4:20 pm
 - ◆ Verification and Validation of Computer Models I (SE207, Francois Hemez), Tu/Th 4:30-5:50 pm

EI Annual Workshops

EI hosts an annual workshop with focus on the broad areas of predictive modeling, advanced sensing and information technology. The reports from these workshops are available on our website. We also work with other LANL organizations to co-host workshops. For more information, please contact Chuck Farrar at farrar@lanl.gov, 663-5330.

Engineering Institute News Letter October 2010



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Engineering Institute



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The Engineering Institute

The Engineering Institute (EI) is a collaboration between LANL and the University of California at San Diego (UCSD) Jacobs School of Engineering whose mission is to develop a comprehensive approach for 1) conducting mission-driven, multidisciplinary engineering research and 2) recruiting, revitalization and retention of the current and future staff necessary to support LANL's national security missions.

The components of the Engineering Institute are 1) the Los Alamos Dynamic Summer School 2) a joint LANL/UCSD degree program, 3) joint LANL/UCSD research projects, 4) annual workshops, and 5) industry short courses.

Contact:

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Farinholt Awarded LDRD / Early Career Research Project

Kevin Farinholt (AET-1) was recently awarded an Early Career Research project through the LDRD Office for his proposed research entitled "Multi-Source Energy Harvesting for Remote Power Applications." Kevin first joined the Laboratory in 2007 as a postdoctoral research associate at the Engineering Institute, and he is currently a staff member with the Applied Engineering & Technology Division, working in the areas of active materials and energy harvesting technologies.

Kevin received a B.S. in Mechanical Engineering from Virginia Tech in 2000, and subsequently went on to pursue a M.S. and Ph.D. with the Center for Intelligent Material Systems and Structures at Virginia Tech under the advisement of Dr. Donald Leo. His graduate research was in the areas of active acoustic control and active material systems. Kevin was selected as a National Defense Science and Engineering Graduate (NDSEG) Fellow and a Virginia Space Grant Consortium (VSGC) Fellow for his doctoral research on the modeling and characterization of ionically conductive electroactive polymers. In addition to his graduate studies, Kevin spent four years working as a research scientist with NanoSonic Inc. in Blacksburg, Virginia. In this role, he served as a principal investigator on numerous SBIR and STTR programs in the areas of sound mitigation for launch vehicles as well as advanced energy harvesting concepts. While a postdoc with the Engineering Institute, Kevin was involved in a number of research projects related to embedded sensing and structural health monitoring. He has also been actively involved as a mentor and lecturer for the Los Alamos Dynamics Summer School for the past four years.

The research that is to be funded in this LDRD effort stems from Kevin's previous research in embedded sensing hardware, specifically systems designed for deployment on civil or energy-related infrastructure. In many cases the use of hardwired sensing components is too costly or impractical

given the operational environment or location, and in such circumstances the use of wireless, battery-powered systems is often more amenable. However, such systems inherently come with O&M issues related to the replacement or recharge of an onboard power supply. To address these concerns, this research will focus on the development of a robust energy harvesting solution that can provide supplemental or exclusive power to the embedded hardware. While

most systems to date focus on single source energy harvesting strategies, they are intrinsically dependent upon the availability of one specific source of energy. The proposed concept will collect energy from a variety of ambient and operational sources and condition this within a short-term storage medium before using it to power the desired electronics. The investigation will focus on three principal tasks: (1) the identification, modeling, and characterization of novel transducers that convert energy between mechanical, thermal, and electrical domains, (2) the development of a power optimized conditioning circuit that collects energy from multiple dissimilar sources while providing regulated output power, and (3) the fabrication of a robust

energy harvesting system that will be demonstrated in the laboratory, and ultimately deployed in field demonstrations to power a small wireless sensor network. The result of this research will be the characterization and development of new cost-effective, robust energy solutions that can be adapted by the end user to provide sustainable power for the long-term deployment of embedded sensing hardware.

In addition to his activities at LANL, Kevin is a member of the ASME Technical Committee on Adaptive Structures and Material Systems, is Chair of the Industrial & Commercial Applications of Smart Structures Technologies Conference at SPIE's Smart Materials & NDE Symposium, and was recently invited as a participant in the National Academy of Engineering's U.S. Frontiers of Engineering Symposium.



UCSD Course Sequences

Signal Processing

Digital Signal Processing
Array Processing
Detection Theory
Parameter Estimation
Stochastic Processes
Sensor Networks
Random Processes

Embedded Systems

Introduction to Embedded Systems
Software for Embedded Systems
Validation and Testing of Embedded Systems
Design Automation and Prototyping for Embedded Systems

Parallel Computing

Large Scale Computing
Parallel Computation

Controls

Linear Systems Theory
Nonlinear Control Systems
Approx Identification and Control
Applied Structural Control

NDE/SHM

Experimental Mechanics and NDE
Structural Health Monitoring

Structural Dynamics

Structural Dynamics
Advanced Structural Dynamics
Nonlinear Mechanical Vibration
Random Vibrations
Wave Propagation in Elastic Media
Wave Propagation in Continuous Structural Elements

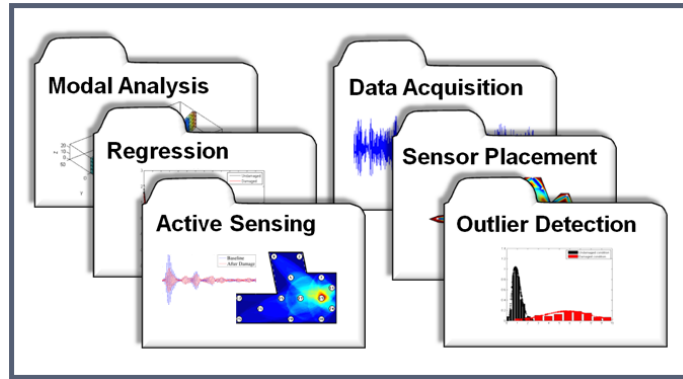
Applied Mechanics

Theory of Elasticity
Theory of Plasticity/Viscoelasticity
Structural Stability
Solid Mechanics for Structural and Aerospace Engineering
Mechanics of Laminated Composite Structures

Computational Mechanics

Numerical Methods
Finite Element Analysis I & II
Computational Fluid Dynamics
Model Verification and Validation

If you are interested in having any of these classes or a class sequence offered at LANL, please contact Kathie Womack (Womack@lanl.gov, 663-5206)



As of August 3rd of 2010, the Engineering Institute announces the public beta release of SHMTools, a free, open-source set of educational MATLAB software tools for Structural Health Monitoring research. The software package includes

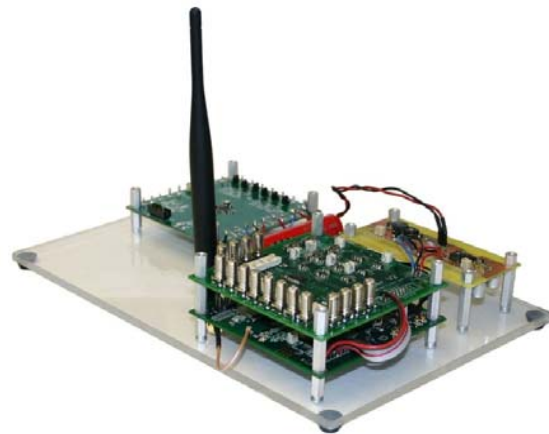
- ◆ A library of compatible SHM algorithms for Data Acquisition, Feature Extraction, and Feature Classification
- ◆ A set of fully documented usage examples demonstrating complete SHM processes
- ◆ mFUSE: an interface for the graphical assembly of custom SHM processes
- ◆ Test structure data sets for benchmarking SHM algorithms

The SHMTools project is the beginning of a larger effort to collect, ar-

rchive, and share various approaches to SHM with the research community. SHMTools (0.2.0 beta), mFUSE (0.2.00 beta), and the associated documentation can be downloaded for free at:

<http://institute.lanl.gov/ei/software-and-data/SHMTools/>.

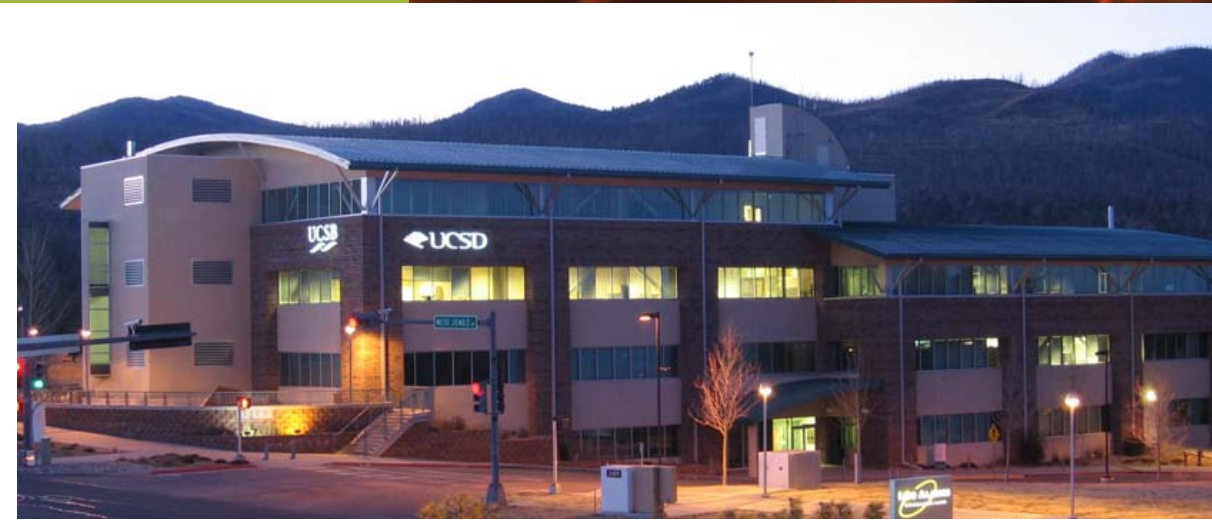
The development of this software is led by EI GRAs, Eric Flynn, Dustin Harvey, Eloi figueiredo, and Samory Kpotufe. The concept behind this software is to allow a user to assemble statistical pattern recognition functions into a SHM process in the same manner as assembling a puzzle. The project developed from simple graphical interfaces to a modern piece of software that provides easy user interaction expandability, and is easy to maintain. The design



Release of SHMTools

of the package is very modular, which makes it easy to assemble and test customized SHM processes. In addition, various assembly points are provided: these are a set of command line and GUI tools that can be used to navigate the package and assemble custom detectors by combining pieces from various modules. Since its release, this software has been downloaded more than 500 times. As part of the SHMTools project, EI is trying to establish an online forum for SHM research collaboration, including the sharing, validation and discussion of SHM algorithms and datasets.

SHMtools is not the first software that was developed by EI for the research community. In the past, several tools have been developed, including DIAMOND, and DIAMOND II, for experimental modal analysis, finite element model updating, damage identification based on changes in modal properties, and statistical pattern recognition based SHM.

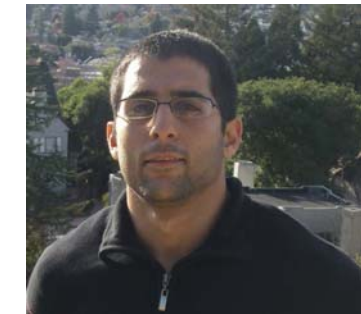


Student's Highlight— Nima Ghods

Nima Ghods is a PhD student in the Department of Mechanical and Aerospace Engineering at UCSD, under the supervision of Prof. Miroslav Krstic (UCSD) and Dr. Charles R. Farrar (EI). Nima is part of the team in the joint EI project in contaminant plume source tracking and boundary tracing. He received his B.S. in Mechanical Engineering and M.E. in Aerospace Engineering degree from UCSD in 2006 and 2007, respectively. His main research activities are the development of unmanned aerial vehicles as well as the design

of control algorithms for detection and tracking of contaminant plumes and other distributed and spatial-temporally evolving processes. From 2008 to 2010 he led the UCSD team in the international autonomous underwater vehicle competition. He is currently involved with two key projects in autonomous vehicles at UCSD. One focuses on contaminant plume tracking with LANL and the other is utilizes olfactory sensing and localization under a large Multi-University Research Initiative grant from the Office of Naval Research. During his four years at UCSD, he has advised

a number of undergraduate projects, which include the building and controlling of a magnetic levitation and propulsion system, controlling an antenna position to maximize signal strength, and building and controlling an axial flux motor. In 2010, he was the recipient of the UCSD Outstanding Graduate Student Award.



Engineering Institute Laboratory Tour

EI has been well known for its extensive educational and outreach programs. EI regularly hosts lab tours for all levels of visitors (from high school students to scientific experts and program managers) and offers opportunities to see an overview of EI research activities on structural health monitoring, smart materials and structures, controls, and many other challenging engineering applications. The recent visitors include Congressman Ben R. Lujan (D-N.M.), and DOE new assistant secretary for the Office of Energy Efficiency and Renewable Energy, Cathy Zoi. Community leaders are also regular guests of EI each year. During the visit, they receive hardware and software demos of engineering re-

search, such as wind energy, energy harvesting, and sensor & actuator technology. For additional information or scheduling, contact Chuck Farrar (farrar@lanl.gov, 663-5335)



Photo Courtesy of LANL Today (August 24, 2010)

Advisory Board for EI

The EI has formed an internal advisory board to help guide its educational and research activities. The purpose of this Board is to maximize the positive impact the EI's recruiting, training and retention activities have on LANL engineers and maximize the number of line organizations impacted by these activities.

The roles and responsibilities of the EI Advisory Board include

- Represent their respective line organization's needs in terms of recruiting, training and retention to the EI staff.
- Guide the collaborative research projects and educational activities of the EI
- Help to define other EI activities such as workshops and development of proposal writing teams
- Bridge a gap between line organization and EI for summer internships, for post-doctoral research appointments, or for staff hiring.

The following members will serve on this advisory board for a two-year period,

Frank Addressio (T-3)
Don Hush (ISR-2)
Doug Kautz (WCM-2)
Thomas Mason (W-6)
Evelyn Mullen (IAT-DO)
R. Alan Patterson (MST-DO)
Ray Guffee (AET-1)
Daniel Rees (AOT-RFE)
Angela Mielke (ISR-3)