Recent NDE Lab Theses and Dissertations

Prof. Mark Hinders **http://as.wm.edu/Nondestructive.html**

1. **Alison Pouch, BS 2007: *Ultrasonic Classification of Emboli,*** (Now at U. Penn)
   Alison developed a sophisticated mathematical model of the interaction of medical ultrasound with bubbles and other emboli in the bloodstream, which resulted in algorithms to allow a new medical device to more accurately size emboli during cardiac surgery. Some fraction of people undergoing heart bypass surgery aren't quite right mentally afterwards, due to emboli blocking blood flow to parts of the brain, but the new EDACS device developed by a local company can now detect and size emboli during the surgical procedure.

2. **Danielle Dumond, BS 2007: *Mobile Robot Sensor Fusion*** (Now at Dartmouth)

Danny's work involved exploring the usefulness of thermal infrared (IR) imaging for robotic navigation. Our second Ectobot, ***rMary*,** has an IR camera which reflects off a 45-degree mirror to image the heat patterns of objects in front. Using our knowledge of the recent temperature, weather, etc. along with an understanding of the physics of how various everyday objects (trees, fences, brick walls, hedges, etc.) store and radiate heat, we define abstract features that can be extracted automatically via computer image processing from the IR imagery. Assessment of what an object might be is then done in some abstract mathematical feature space. Oh, and by the way, it works in perfect darkness.

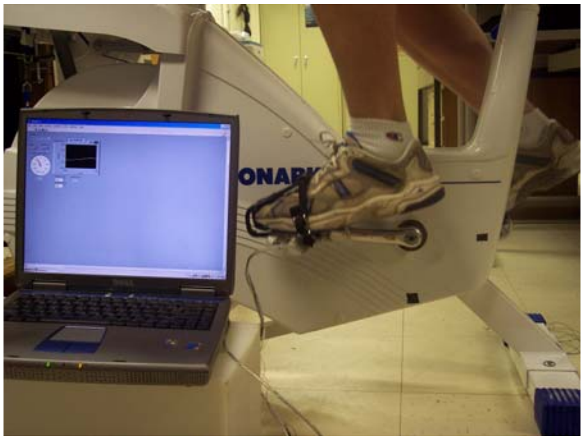
3. **Kevin Rudd, PhD 2007: *Three Dimensional Finite Integration Time Domain Simulations of Ultrasonic Propagation and Scattering*** (Now at Naval Research Laboratory in DC)

In his dissertation, Kevin presented two parallelized 3D simulation techniques for three-dimensional acoustic and elastic wave propagation based on the finite integration technique. He demonstrated their usefulness in solving real-world problems with examples in the three very different areas of nondestructive evaluation, medical imaging, and security screening. More precisely, these include concealed weapons detection, periodontal ultrasography, and guided wave inspection of complex piping systems. He employed these simulation methods to study complex wave phenomena and to develop and test a variety of signal processing and hardware configurations. Simulation results were compared to experimental measurements to confirm the accuracy of the parallel simulation methods.

4. **Corey Miller, BS 2008:** ***Intelligent Structural Health Monitoring,*** (Now at NASA LaRC)

The purpose of Corey's project was to evaluate a promising technique for the structural health monitoring of aluminum airplane stringers. By sending guided ultrasonic waves throughout the length of a stringer, we are able to examine the structural health of the aluminum. We have recorded waveforms produced with two different transducers in both an incremental milling and an accelerated corrosion sequence, and have thoroughly analyzed the milling waveforms. In order to interpret the signals received from the transducers we used a dynamic wavelet fingerprinting technique which provides us with a simple visual way to view areas of interest within the signal. We found that we are able to accurately extract mode arrivals from the fingerprint images using both a nanopulser np3 and a toneburst source along with shear transducers in SV mode at 1MHz. Using these mode arrivals, we were able to produce group velocity values that agreed with values determined from the measured thickness values to within 4% accuracy.

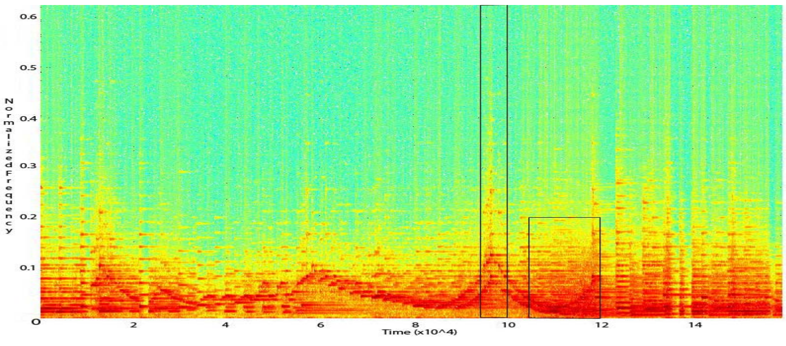
5. **Mark Cohey, BS 2008:** ***A Gage for Measuring Pedal Forces on a Stationary Bicycle,*** (Now at EVMS)



Mark investigated, created, and tested a device used to measure the pedal forces on a stationary bicycle. Such devices have uses in the medical, biomechanical, and sports sciences. This study encompassed researching previous devices to determine the most effective technique, building a device capable of retrieving useful data, and testing the device in a live experiment with human test subjects. Initial research found that most previous designs created pedals that could measure forces with high precision, but usually involved costly components or bulky computers. The primary focus on the experimental design was to create an effective device that not only took force measurements, but that was small enough that it could be incorporated into a non-stationary bicycle and low cost enough that it could be reproduced easily and available for larger studies.

6. **Jori S. Byrne-Diakun, BS 2008:** ***Automatic Repair of Physical Flaws in Recorded Music,*** **BS** (Now in DC)

Recording music in any form often produces artifacts that are not pleasing to the ear. Reducing these artifacts is the focus of millions of dollars in research for music companies every year. However, despite this research, there is still a considerablevolume of work that requires special attention, and historic non-commercial recordings are often never cleaned up enough to be sold, or even provided, to the general public because of the great amounts labor each recording demands. The goal of our research is to develop an automated process to clean up the damage to this piece of human history.



7. **LtC William L. Fehlman II, PhD 2008:** ***Classification of Non-Heat Generating Outdoor Objects in Thermal Scenes for Autonomous Robots*** (Now at US Military Academy in West Point)

Bill's dissertation describes a physics-based adaptive Bayesian pattern classification model that uses a passive thermal infrared imaging system to automatically characterize non-heat generating objects in unstructured outdoor environments for mobile robots. In the context of this research, non-heat generating objects are defined as objects that are not a source for their own emission of thermal energy, and so exclude people, animals, vehicles, etc. The resulting classification model complements an autonomous bot's situational awareness by providing the ability to classify smaller structures commonly found in the immediate operational environment. Since GPS depends on the availability of satellites and onboard terrain maps which are often unable to include enough detail for smaller structures found in an operational environment, bots will require the ability to make decisions such as "go through the hedges" or "go around the brick wall." A thermal infrared imaging modality mounted on a small mobile bot is a favorable choice for receiving enough detailed information to automatically interpret objects at close ranges while unobtrusively traveling alongside pedestrians. The classification of indoor objects and heat generating objects in thermal scenes is a solved problem. A missing and essential piece in the literature has been research involving the automatic characterization of non-heat generating objects in outdoor environments using a thermal infrared imaging modality for mobile bots. Seeking to classify non-heat generating objects in outdoor environments using a thermal infrared imaging system is a complex problem due to the variation of radiance emitted from the objects as a result of the diurnal cycle of solar energy. The model that we present will allow bots to "see beyond vision" to autonomously assess the physical nature of the surrounding structures for making decisions without the need for an interpretation by humans.

Applied Science is an interdisciplinary graduate department which offers M.S. and Ph.D. degrees in the physical and biological sciences. Courses are offered cooperatively by the core faculty of Applied Science along with affiliated faculty from the Departments of Biology, Chemistry, Computer Science, Mathematics, Physics, and the Virginia Institute of Marine Sciences (VIMS), as well as from the NASA Langley Research Center (LaRC) and the Thomas Jefferson National Accelerator Facility (Jefferson Lab). In Applied Science we use the tools, the techniques, and the understanding involved in a wide range of sciences in order to solve complex scientific and technical problems. The Department has state-of-the-art facilities in: (1) theoretical and computational analysis of physical and biological systems, (2) cellular and systems neurophysiology, (3) materials synthesis and characterization of small molecules, polymers, inorganics, and composites, (4) modification and evaluation of interfaces, (5) processing of materials and surfaces, and (6) imaging technology and theory from nano to planetary scales. While Applied Science does not offer an undergraduate major, several courses in the department are particularly suitable for undergraduate students of physics, mathematics, chemistry, computer science, and biology. An undergraduate minor is offered with a track in Materials Science.

The NDE Laboratory at William & Mary is at 116 Jamestown Road, across from the Wren Building. On the web: http://as.wm.edu/Nondestructive.html