2007

2006/07 Research and Development

College of Engineering and Applied Sciences

Follow this and additional works at: http://scholarworks.wmich.edu/electrical-computer_news

Part of the Electrical and Computer Engineering Commons

WMU ScholarWorks Citation
http://scholarworks.wmich.edu/electrical-computer_news/2
Swarm Behavior - This project focuses on the programming of multiple mobile robots to seek goals and avoid obstacles through concerted effort. All of the robots have onboard infra-red sensors, which are used for obstacle detection. These sensors are also then used for inter-robotic communications. Anticipated applications range from bio-medical to transportation. This is an internally funded project. (Tanner)

Expanding Your Horizons @ WMU Engineering - The goal of the project is to motivate and prepare middle school students in the Kalamazoo Public Schools to take advantage of the Kalamazoo Promise and pursue college studies in the science, technology, engineering and mathematics fields. The project team will use both summer and academic-year programs to:

1. expand the horizons of middle school students the Kalamazoo schools;
2. create enthusiasm for engineering professions;
3. create enthusiasm for taking math, science and technology courses; and
4. create motivation for learning and growth and for thinking beyond current expectations.

The team will use information technology, robotics, bridge construction, field trips, interaction with engineering students, and personal development activities to accomplish its goals. Dr. Ikhlas Abdel-Qader and her team members received $245,000 from the Presidents Innovation Fund to establish the WMU-Kalamazoo Promise Partnership: Promoting Engineering Careers to Female, Minority and Disadvantaged Middle School Students. (Abdel-Qader)

PRECISION ELECTRODE SPRAY OF NANO-SIZE COMPOSITE POWDER PARTICLES - Investigate, Demonstrate, Develop, And Validate An Electrode Spray System To Pump Nano-Size Composite Powder Paint Particles Using A High Speed Circulating Nozzle. Funding being sought. (Asumadu)

HARMONIC ANALYSIS OF PWM WAVEFORMS USING WAVELET FUNCTIONS - Development of a new voltage modulation technique named "wavelet pulsewidth-modulation (WPWM)" for harmonic elimination and analysis, and for efficiency measurements in a polyphase voltage-source inverter VSI. Funding being sought. (Asumadu)

Design of a Reconfigurable Digital Architecture for Fuzzy Automata: The aim of this project is to design a hardware implementation of the Hybrid Fuzzy-Boolean Finite State Machine (HFB-FSM) model. An application area for the HFB-FSM is automatic fault detection and identification and recovery from faults in complex industrial control systems. This project is part of a broader research effort to develop a hardware accelerator for a reconfigurable HFB-FSM and to investigate different reconfigurable hardware algorithms and architectures. (Janos Grantner)

Rehabilitation Engineering - The major thrust of activity in these studies relates to veering of visually impaired individuals. Veering is the drift from ones intended path of travel and it happens to most persons when position feedback is absent. One of the major efforts in these studies has been the development of a device to train blind individuals to better walk a straight path without veering in short missions such as crossing a street or walking across a parking lot. Such a device, an Anti Veering Training Device (see Photo), has been developed and is waiting field-testing. Other activity in this area focuses on the development of a Veer Analyzer, a device which, when coupled to a veering individual, will measure and record, in two dimensions, the trajectory of the individuals movement. The recorded trajectory is then analyzed in an effort to decompose the trajectory into a rotational and a translational component. If successful, the analysis will be useful in developing programs to reduce veering. Thus far, hardware has been developed to record the trajectory and progress is being made on analytical techniques to extract the rotational and translational components. John Gesink heads this effort and the National Institute of Disability Rehabilitation and Research funds it. (Gesink)
Dr. Atashbar has been appointed to a three-year term as Associate Editor (AE) and member of the Editorial Board of the *IEEE Sensors Journal*. In addition Dr. Atashbar has been serving at Associate Editor capacity for the International Journal of Simulation and Modeling.

Dr. Atashbar was granted one academic year, Fall 2007 and Spring 2008, *sabbatical leave* to support his research activities based on a proposal entitled “MEMS-based Energy Scavenging and Power Generation, and Fundamental Research on Quasi-1 Dimensional, Switchable Chemical Sensing Nanostructures.” Dr. Atashbar will spend his sabbatical at the University of Michigan, Ann Arbor.

During 06-07, Dr. Atashbar has published one book chapter, one journal paper, four refereed conference papers, and submitted three journal and conference papers currently under review.

**Integrated Smart Wireless SAW Sensors and Systems:** In many applications, sensors and data collection processing must be distributed and placed in inhospitable or inaccessible environments. This complicates sensor and system design by requiring devices with small size, rugged construction, efficient power supply for active components, communications for derived information, and simple installation with a minimum amount of infrastructure and overhead. In this project we are developing integrated smart wireless surface acoustic wave (SAW) sensors and systems composed of distributed wireless SAW sensors, sensor communication transceivers, and a centralized host. New generations of SAW microsensors provide measurements of a wide range of physical and chemical parameters, including: temperature, pressure, chemical concentration, gas concentrations, etc. Compatible with integrated circuit-processing techniques, SAW devices can and will be combined with active ASIC circuitry into integrated smart SAW sensors (Dr. Massood Atashbar collaborating with Professor Brad Bazuin and PhD candidate, Ms. Sridevi Krishnamurthy).

**Conductive composite:** In this project we are synthesizing and fabricating Organic-inorganic composite thin films of P3HT poly-(3-hexylthiophene) composite. Applications of this composite are aimed at microsensor and Thin Film Transistor and flexible integrated electronic circuits. (Dr. Massood Atashbar collaborating with Professor Sberveglieri, Italy).

**Early Detection of Prostate Cancer:** In the project we are developing the novel concept of acoustic based sensors. According to the American Cancer Society Facts and Figures, there would be an estimated 220,000 new cases of prostate cancer (CaP) in the year 2003 with around 28,000 men succumbing to the disease. Two assays will be performed simultaneously. One assay will use a monoclonal antibody that recognizes both fPSA and PSA-ACT (Mab PSA399) to determine the concentration of tPSA. The other assay, which will measure fPSA, will use Mab PSB999, which recognizes an epitope present on fPSA but masked on PSA-ACT. The binding of antigen to the immobilized antibodies will alter the mass of the sensor membrane thus causing a drop in the wave velocity, which is correlated to the resonance frequency of the device. Acoustic based sensor will have distinct advantages over previously established assays, as it will allow for increased sensitivity to reliably detect very low concentrations of PSA-ACT. Furthermore, a device will also be cheaper to operate, allow for the development of a small hand held device and not use radioactivity. ELISA kits used to detect PSA require separate steps, each with separate reagents. Each ELISA analysis requires a separate distinct reaction and, in addition, requires a label for detection of the analyte. Our proposed method needs no label or distinct reagents and is therefore, much easy and simpler to implement (Dr. Massood Atashbar collaborating with Professor Bruce Bejcek for Biology department and Dr. Hardin, West Michigan Cancer Center).

**Three Dimensional Simulation and Modeling SAW devices:** Surface Acoustic Wave (SAW) devices have been extensively used as high frequency filters and in bio/chemical sensing applications. It is extremely important to model and simulate the device prior to its actual fabrication in order to gain a better understanding of the device performance and optimizing its design parameters. In this work the 3-dimensional Finite Element (FE) modeling and simulation for SAW devices using CoventorWare® (CW) are performed. 3D transient analysis performed on the devices to study the acoustic wave propagation and characterize the device in time and frequency domain. The normalized displacements at the output node are presented together with a 3D view of the SH-SAW wave propagation on the substrate. Also, a comparison is provided between the measured and simulated frequency response (Dr. Massood Atashbar).

**Nanowires and Nanoparticles Microsensors:** In this project we have synthesized and fabricated parallel arrays of Palladium nanowires using nanotemplate manufacturing approach for hydrogen gas detection. These sensors also can have applications in Auto Industry, and Fuel cell systems. These sensors can be modified for detection of chemical warfare agents for applications of homeland security. We have studied the morphology of the deposited nanoparticles using an Atomic Force Microscope (AFM) in non-contact mode. (Dr. Massood Atashbar)
Magnetic Nanowires and Nanoparticle: In this project we have synthesized and fabricated nickel nanodots and arrays nanowires using nanotemplate manufacturing. Magnetically manipulated nickel nanoparticles and nanowires have also been prepared which have the potential to revolutionize current data storage technologies and cell recognition. We have studied the morphology of the deposited nanoparticles using an Atomic Force Microscope in non-contact mode (Dr. Massood Atashbar).

Generic Encapsulated Fuzzy Automaton Software Agent - The objective of this project is to test a previously developed software module (GEFASA V1.0) using real-time data. The GEFASA V1.0 module has been developed and tested using dummy input data. The plan is to connect the Intelligent Fuzzy Controllers Lab in the ECE Department to an ABB R & D lab in Sweden through the Internet. The ABB Lab will pass real plant data collected from a cold rolling mill to the GEFASA V1.0 and then the output of the current controllers for the plant will be compared with the output data produced by the GEFASA V1.0. The GEFASA V1.0 module will be fine-tuned to advise the supervisory controller to detect faults and potentially recover from faults caused by Ontological De-synchronization. (Janos Grantner and George Fodor, of ABB Automation Technologies, Sweden)


Michigan Space Grant Consortium (MSGC) conference provides research opportunities to WMU students - Attendees at this year’s consortium were ECE professors Dr. Brad Bazuin, Dr. Damon Miller; Dr. Giuseppe Grassi (visiting professor) and Dr. Frank Severance, who is the Director of WMU’s MSGC Program, along with MAE professor Dr. Kapseong Ro and CCE professor Dr. Jun-Seok Oh; ECE graduate student Jeff Leverton; undergraduate students Josh Armstrong, David Kirklewski, Aaron Linenthal, Donovan Squires, Carrie Sutton, Stephen Westbrook; and Kalamazoo Area Math and Science Center (KAMSC) high school students Erin Campbell and Teshia Trevhaft. All are currently working on projects. "These projects focus on topics such as mobile robotics, chaos theory, and the effect of neurons on training capacities," Severance said. He and Sutton are working on an autonomous micro-mouse project. Miller, Grassi, Kirklewski, and Squires are working with chaos theory. Severance, Miller, Leverton, Armstrong, and Westbrook are trying to train neurons to control things. "We’re classically trained in artificial neuron networks, but we want to make that physiological," Severance said. "So we’re busy learning a lot of biology.” The KAMSC students work as mentees in ECE neurobiology research. MSGC was created 17 years ago to foster education and awareness of space-related science and technology in Michigan. As a branch of the much larger National Space Grant College and Fellowship program, it is part of a network of consortiums representing each of the 50 states as well as the District of Columbia and Puerto Rico. Each individual state consortium is allocated funding, which is dispersed among qualifying individuals who submit an application. (Severance)
Students Build BroncoBot for Micromouse Contest - The student branch of the IEEE has been on a bit of a mobile robotics binge. Over the past year, officers Carrie Sutton (president) and Lawrence Kalisz have been pushing the membership to compete in everything from to Legos Mindstorm events to the international favorite MicroMouse competition. Interest has been strong throughout the membership, so not to be outdone, Carrie and Lawrence decided to design an entry for Micromouse, which is to be held at Disneyland in Anaheim, California this year. Their entry is called BroncoBot, which sports an appropriate brown and gold color combination. It is totally autonomous and goes from start to the "cheese", then back again without human interaction or interaction. In fact, Carrie’s interest continues to be high that she is considering a MSEE degree and doing a thesis in maze-mapping techniques for mobile robotics. Good luck, Carrie!

Radio Frequency Identification (RFID): Dr. Bradley Bazuin and the RFID Laboratory is collaborating with Dr. Margaret Joyce and a large team of faculty, post-docs and students from the Paper Engineering, Chemical Engineering, and Imaging (PCI) department on a state of Michigan the 21st Century Jobs Fund initiative award of $966,000. Titled Printed RFID Tags on Packaging Materials, the research involves the design, development and testing of printed RFID antennas and RFID Tags directly on various printed substrates using different inks, substrates and printing processes. In support of this work, an antenna testing range has been set up in the RFID Lab to quantify the performance of printed RFID antennas as shown in the following pictures.

Additional tests already underway or to be performed on the printed antennas include DC micro-ohm impedance measurements, RF input impedance measurements (S11) and dynamic burst response to an RFID reader command. This project has also funded the acquisition of additional test equipment for research and educational use, including a DAMS 5000 antenna platform and test software, DC and LF micro-ohm impedance measurement systems, a field portable Tektronix spectrum analyzer, and a Tektronix Real-Time Spectrum Analyzer.

For more information on the RFID Laboratory and RFID technology, see Dr. Bazuin’s WMU RFID Lab web site at: http://homepages.wmich.edu/~bazuinb/RFID_Lab.htm. (Brad Bazuin)
NONLINEAR CIRCUITS AND SYSTEMS - Dr. Giuseppe Grassi, a distinguished researcher in chaotic systems, was a Visiting Professor at WMU in the Fall 2006 semester. Dr. Grassi and his family lived on campus in the Elmwood Apartments. Dr. Grassi taught ECE 2100 Circuit Analysis and collaborated with Professors Bazuin, Miller, and Severance during his visit.

Drs. Damon Miller and John Gesink at Dr. Giuseppe Grassi's end of semester luncheon.

This collaboration led to:

• submission of a journal paper entitled "Generation of a Four-Wing Chaotic Attractor by Two Weakly-Coupled Lorenz Systems" to the journal Bifurcation and Chaos in Applied Sciences and Engineering" by Grassi, Severance, Emil Mashev (graduate student), Bazuin and Miller;
• a senior design project by undergraduate students Chris Bommarito, Paul Kokeny, and Donovan Squires to implement a circuit to generate a four-wing chaotic attractor;
• submission of a journal paper entitled “Recovery of Successively Induced Discrete-Time Chaotic Oscillator Perturbations via Cascaded Nonlinear Observers” by Grassi and Miller to the journal Bifurcation and Chaos in Applied Sciences and Engineering;
• presentation of a poster entitled Electronic Implementation of a Chaotic Logistic Map by Miller, current or former undergraduate students David Kirklewski, Mark Lyons, and Donovan Squires, and Grassi at the annual 2006 NASA Michigan Space Grant Consortium (MSGC ) conference in Ann Arbor, Michigan. Donovan and David won the Fall 2006 WMU IEEE student branch paper contest for a work describing their contributions to this project and will represent WMU at the EIT conference in Chicago, Illinois. (Miller)

Drs. Grassi and Miller and undergraduate students David Kirklewski and Donovan Squires at the 2006 annual MSGC conference.

Dr. Grassi also presented his work in generating and shaping chaotic attractors at a WMU Analysis Seminar hosted by Dr. Yuri Ledyaev in the Department of Mathematics.

Dr. Bazuin has received a NASA MSGC research seed grant to study use of chaotic signals to reduce EMI of digital systems. A senior design group consisting of Andrew Cochran, Richard Courtade, and Daniel Mulkey is investigating this concept to reduce EMI in digital systems by chaotically dithering clock signals to spread the clock energy across a wider spectrum. Donovan Squires was awarded an undergraduate research fellowship, also from the NASA MSGC, to study applications of chaos in spread spectrum communication systems under the guidance of Miller and Bazuin. This builds on work by undergraduate student Jason Lillrose and graduate student John Stahl. Dr. Severance is the WMU representative to the NASA MSGC. The MSGS supports many of our students and faculty in their research work.
A paper entitled "Projective synchronization via a linear observer: Application to time-delay, continuous-time, and discrete-time systems" by Drs. Grassi and Miller has been accepted for publication by the prestigious journal *Bifurcation and Chaos in Applied Sciences and Engineering*.

**Hybrid Biological and Electronic Systems:** Dr. Miller in collaboration with Drs. Gesink and Severance and undergraduate students Josh Armstrong, Nicole McCaskey, Joseph John Packaral, Amrith Ranganathan, Preston Vandeusen, and Stephen Westbrooks and graduate student Jeff Leverton, are working to establish a new research program in investigating using biological neuron cultures to control engineering systems. Josh and Stephen were both awarded an undergraduate fellowship from the NASA Michigan Space Grant Consortium (MSGC) to help setup a laboratory in this area. Severance, Miller, and Gesink submitted an internal proposal to partially fund this lab. A poster entitled *Developing a Neurophysiology Laboratory for the Study of Neuron Cell Cultures* by Armstrong, Leverton, Westbrooks, Gesink, Miller, and Severance was presented at the *annual 2006 NASA Michigan Space Grant Consortium (MSGC)* conference in Ann Arbor, Michigan.

**Retention and Recruitment Initiatives** – With the focus moving towards recruitment and retention the ECE Faculty have stepped into many new roles over this past year.

**Freshmen Orientation** – In the summer of 2006 ECE held approximately 20 freshmen orientations. The orientations were arranged so the families stayed overnight. On the first day they would visit the main campus and a mixer for the parents and faculty was held. The next day the students were brought to the engineering campus and the ECE students were greeted by ECE Student Ambassadors, upper level ECE students who provided tours of our campus and help guide the future freshmen from one area to the next as they registered for their fall courses. The ambassadors talked to the future students about their experiences here in the ECE Department and about the outside activities available. The ECE Faculty provided one on one advising with the students and their families in the Parkview Care, the ECE Faculty advisors and student ambassadors were available to the students throughout lunch.

The ECE Department held its first Meet and Greet this Fall. It was scheduled around the beginning ECE courses ECE 2500 and ECE 2510 to encourage attendance of the ECE students. A continental breakfast was provided approximately 60 students attended giving the faculty and staff the opportunity to visit and meet the students.

**Tours** – throughout the academic years have been provided to various groups of students the ECE faculty have often provided lab experiences for the visiting students and are available to meet with the students and their families to answer questions about the programs and curriculum. The ECE faculty has provided many different formats and labs for the visitors.

**ECE Prof in a Bunny Suit!** – Western Michigan University’s Chapter of Etta Kappa Nu (HKN), the Electrical and Computer Engineering honorary society held it’s first fund-raiser. ECE faculty volunteered to allow students, faculty and staff to vote for them by donating money to HKN. The professor with the most money in their jar wins. What did they win? A bunny suit for a whole day in April, Eta Kappa Nu was allowed to select the day. The fundraiser was a success. Special thanks to the ECE faculty that volunteered to participate in the contest! They were Drs. Johnson Asumadu, John Gesink, Hossein Mousavinezhad, Damon Miller, Ralph Tanner, Massood Atashbar and Liang Dong. Dr. Tanner was the big winner, and he wore the bunny suit to his lectures and meetings on April 3rd. HKN looks forward to running the contest again!