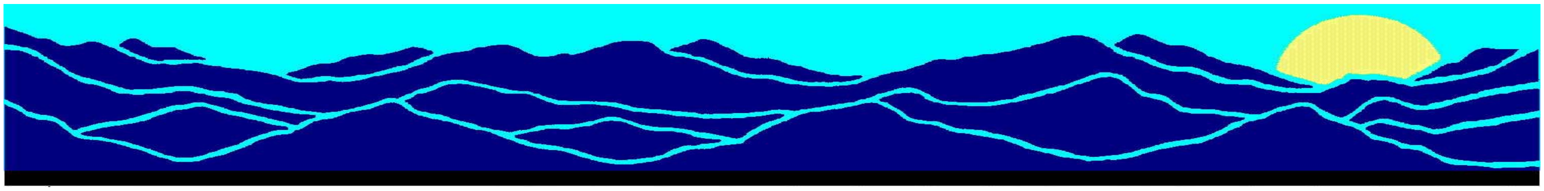


# VIRGINIA MOUNTAIN SECTION NEWSLETTER

**IEEE Region 3, Council 09, Section 65 — February 2006**


## Thursday, February 16, Clarion Hotel Roanoke Airport

# Student Paper Contest

**Presentation of Papers by Undergraduate Students**
**From VMI and Virginia Tech on**

***Leg Development and Kinematics for an Octopedal Robot***
***Fuzzy Sensors for Robot Navigation Control***
***"Lab-in-a-Box" AC Experiments for Introductory EE Courses***
***CMOS Delta Sigma Circuit for Resistance Measurement in Nano-Sensors***

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| Date: Thursday February 16, 2006 | | |
| Social: | 6:15 PM | |
| Dinner: | 6:45 PM | |
| Talks: | 7:45 PM | |
| Cost: Member or Guest | | $15.00 |
| Student | | $ 8.00 |

Reserve by **5 PM** **Monday** **Feb. 13**
**Dr. Jan-Helge Bohn (540) 231-3276**, bohn@ieee.org
Please specify number of attendees.

**Directions to**
**Clarion Hotel Roanoke Airport**
2727 Ferndale Drive NW
I581 Exit 3 Hershberger Rd West
1st Rt. onto Ordway Drive,
¼ mile, Rt. Into Parking Lot.

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### Leg Development and Kinematics for an Octopedal Robot

*Zachary Huson and John Lento, VMI*

As the initial stage of a project to create an eight-legged walking robot, a three-jointed robot leg was built, with a servo-motor controlling the angle of each joint. Driving the servo-motors to produce a useful gait required solving the inverse-kinematics problem of deriving joint angles for a desired end-effector (foot) position, which is highly under-determined. The two most promising candidate solutions, involving neural-network controllers for the motors, failed because of an inadequate appreciation of the limitations on the possible positions of the foot. An analytic solution was subsequently obtained by artificially limiting the joint angles, resulting in a useful if limited gait. Taken together these results suggest that a broader range of solutions may be obtained with a neural-network or other non-analytic approach that respects the inherent geometry of end-effector positions.

*Cadets Zack Huson and John Lento are both juniors at VMI majoring in Electrical and Computer Engineering and minoring in Computer Science. Zack Huson was born in McLean Virginia. He is a cadet ranker and a student member of the IEEE. Zack currently plans to enter graduate school after graduating. John Lento is a native of Pittsburgh, PA. He is a student member of the IEEE and plans on government service after graduation.*

### Robot Navigation Control Through The Use of Fuzzy Sensors

*Dennis Crump,VMI*

Fuzzy logic was developed by Dr. Lotfi Zadeh at the University of California, Berkeley in the 1960's and is an expansion of traditional Boolean logic. Traditional Boolean algebras utilize a discrete on or off, 1 or 0. Fuzzy logic or the use of fuzzy sets handles the concept of partial truths and utilizes a continuum of values between completely true or completely false. Fuzzy logic is very intuitive; individuals describe their surrounding world in terms of fuzzy values such as "large" or "almost." Using fuzzy logic, one can create a controller for an autonomous system.

The problem of robot navigation is one that lends itself to fuzzy control. Magnetic sensors are used to detect a current-carrying wire denoting the robot's path of travel. The sensors are used to determine the location of the robot relative to the path. While experimenting with the Autonomous Tick Rover, a previous VMI project, it was discovered that the output from the two magnetic sensors exhibited fuzzy properties. When the sensor output was plotted versus the distance the robot was off track, the output resembled two fuzzy output sets. The sensor output levels vary based on the geometry and the attitude of the robot. By normalizing the sensor output signals, the information from the sensors can be isolated from the geometrical effects. Using the normalized fuzzy sensor values, a proportional controller was developed. The uniqueness of these sensors gave us the ability to directly represent the proportional component of the fuzzy control system.

*Dennis Crump is a senior at VMI and will commission in the US Navy as a nuclear propulsion officer on a submarine. He is currently the team captain of VMI's NCAA Rifle Team and is a Student Member of the IEEE.*

**Lab-in-a-Box: AC Experiments in Electronic Circuits That Support Introductory Courses for Electrical Engineers**

*William C. Headley, Robert B. Lineberry, Robert W. Hendricks, VT*

The objective of Lab-in-a-Box is to give students in introductory circuit's courses hands-on experience with wiring and analyzing simple circuits. The key advantage of Lab-in-a-Box over a standard laboratory environment is the ability for students to work wherever they feel most comfortable while using inexpensive equipment and materials. This also allows for elimination of the costs of staffing and maintaining a standard laboratory on campus. The Lab-in-a-Box concept was first applied at Virginia Tech to the DC Circuit analysis course during the 2004-2005 school year. In response to positive feedback, it was decided to extend Lab-in-a-Box to the AC Circuit analysis course starting in 2005-2006. In adding Lab-in-a-Box to the AC Circuit Analysis curriculum, many changes needed to be made to the fundamental design of the Lab-in-a-Box kit. This included the need to find a new, more powerful, software oscilloscope that was both inexpensive and was able to perform the functions needed for a beginning AC Circuit course. Also, the trainer board itself needed to be redesigned in order to accommodate a function generator that allowed varying amplitude and frequency values.

The experiments designed for the AC circuit analysis course were chosen to cover key areas of the curriculum. The experiments designed cover phasor analysis, Kirchhoff's laws in the phasor domain, building a simple Wien-bridge oscillator, complex power, introduction to transformer properties, simple active and passive filters, and electromagnetic interference. Using these experiments, the objective was to give students an opportunity to greatly increase their understanding of the material by building and experimentally verifying some of the circuits and concepts covered in the text book and lectures.

At the end of the Fall 2005 semester of AC analysis a survey was given to the students in order to discover their thoughts on the new board, new experiments, new oscilloscope, and whether they felt the Lab-in-a-Box concept was successful in helping them learn the material of the course. Using the information gathered from the survey, changes will be made to provide a better experience for the students in future sections of the course.

*Chris Headley is from Danville, VA. He went to Danville Community College where he received an associates degree in Liberal Arts. He is now a senior at Virginia Tech majoring in Electrical Engineering and minoring in Mathematics, and plans to graduate in December 2006.The work in this paper was supported by an NSF grant obtained by Professor Hendricks for independent research over the summer of 2005.*

**CMOS Delta Sigma (∑-Δ) Readout Circuit to Measure Resistance in Nano-Sensors**

*Abbas Hussain and Sanjay Raman, Wireless Microsystems Lab., VT*

A readout circuit for measuring the resistive state of a selected sensor, which is part of an array of nano-sensors, is designed in the research effort. This specific readout circuit is designed using a mixed signal Delta-Sigma (Δ-∑) modulation (DSM) circuit. Two reference voltages; $V_{dd}$ (3.3V) and $V_{dd}/2$ (1.65V) are used in the design of this circuit. The resistive sensor (R) is connected to the positive input (bit line) of an op-amp and the $V_{dd}/2$ reference voltage. The DSM circuit tries to hold the bit line at precisely the voltage reference used by the comparator. The comparator reference voltage used is Vdd/2 plus a small offset voltage. The small offset voltage allows a small current to flow through the resistor. Depending on the size of the resistance the circuit produces a varying frequency pulse at the output. In the ideal case an open circuit (R= infinite) would simply give a string of zeros and a short circuit would give a string of ones. This project is part of a much larger research effort in the development of distributed wireless sensor networks for chemical and biological sensing.

The CMOS based circuit was designed using the TSMC 0.35um technology. The circuitry for a clocked op-amp, and the delta-sigma was designed and simulated in Cadence. Simulation results have successfully shown the dependence of the output frequency on the resistance of the sensing resistor. As the resistance increases it was shown that the output frequency decreases. The layout for the designed circuit is currently in progress.

*Abbas H. Hussain is a senior electrical engineering student at Virginia Tech with a concentration in microelectronics. He is of Pakistani origin but was brought up in Dubai, United Arab Emirates where he spent the first 18 years of his life before* *moving to the United States in 2002 and entering Virginia Tech where he is now a senior electrical engineering student with a concentration in microelectronics. This work was an independent study project to fulfill the requirement for the microelectronics minor under the guidance of Professor Sanjay Raman in the Wireless Microsystems Laboratory (WML) at Virginia Tech. This project is part of a much larger research effort in the development of distributed sensor networks for chemical and biological sensing, involving faculty from both Virginia Tech and Penn State.*

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**NEWS from IEEE-USA**

WASHINGTON (1 February 2006) -- IEEE-USA commends President George W. Bush for the American Competitiveness Initiative announced during his State of the Union address Tuesday night. The initiative is designed to spur U.S. innovation and better equip our nation to compete in the global marketplace.

"We are at a crucial crossroads in our nation's future" IEEE-USA President Ralph W. Wyndrum Jr. said in response to the initiative. "The United States can no longer take for granted the competitive edge that our scientific and technological capabilities have provided us in the past. The President's remarks indicate that he understands this, and plans to take definitive steps towards protecting and preserving our global leadership in innovation and competitiveness."

President Bush mentioned several key proposals that IEEE-USA endorses, including doubling federal spending on basic physical science and engineering research over the next 10 years; permanently extending theresearch and development tax credit; and significantly improving math, science and technological education in our nation's schools. Similar bipartisan legislation addressing American competitiveness has been introduced in the U.S. Senate. Sens. Pete Domenici (R-N.M.), Jeff Bingaman (D-N.M.), Lamar Alexander (R-Tenn.) and Barbara Mikulski (D-Md.) introduced the Protecting America's Competitive Edge (PACE) Act last week; and Sens. John Ensign (R-Nev.) and Joseph Lieberman (D-Conn.) introduced the National Innovation Act in December.

IEEE-USA has endorsed both the PACE Act and National Innovation Act, and continues to offer guidance and counsel to Senate staff as the bills work their way through Congress.

For more on the American Competitiveness Initiative, go to http://www.whitehouse.gov/news/releases/2006/01/20060131-5.html.

According to the White House, the American Competitiveness Initiative commits $5.9 billion in FY 2007 and more than $136 billion over 10 years. Other key points include encouraging up to 30,000 math and science professionals to become adjunct high school teachers; fostering a business environment to encourage entrepreneurship and protect intellectual property; and providing self-managed Career Advancement Accounts of up to $3,000 that workers and prospective workers can use for training and other employment services.

The "PACE Act" will implement 20 recommendations contained in the National Academies of Science and Engineering report, "Rising Above the Gathering Storm," released last October. The National Academies warned that "the scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength." According to the report, "because other nations have the competitive advantage of a low-wage structure, the United States must compete by optimizing its knowledge-based resources, particularly in science and technology."

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