Fall 2006

WIMS WORLD

University of Michigan Michigan State University Michigan Technological University

Director's Message

Many summers ago, I attended a Gordon Conference in New Hampshire, and one free afternoon, I took a drive through the beautiful countryside, where I stopped at a rural antique shop. Among the collectibles were a number of Civil War era copies of *Harper's Weekly*, and being a history buff I bought several of them. This 1861 portrait of Lincoln ("the first since he began to grow his beard") is from one of them. Recently, I watched a documentary on U.S. presidents and learned that one of Lincoln's immediate predecessors ranks first on a list of the worst presidents (and our Republic has endured some bad ones). Lincoln himself had not had a particularly successful political career but was drawn back into politics over the Kansas-Nebraska Act of 1854 and the issue of slavery. He set out only to *preserve* the Union, but as the magnitude of the struggle deepened, the sacrifices made by so many demanded more. He wound up *transforming* it, just as perhaps it transformed him. He was a master politician (in the best sense of the word), an engaging speaker, and a supremely eloquent writer who inspired an entirely new vision of what America could become.

President Lincoln, image from* Harper's Weekly, *April 27, 1861.

Now we are engaged in a great global struggle with many new challenges and are looking to technology for solutions. The development of microelectronics, viewed broadly from the telegraph through the telephone, radio, television, and computer to the wireless revolution of today, is perhaps the most transforming technological force ever, encompassing five of the ten most significant achievements of the last century. (The remaining five, as they stand today, would also be impossible without this technology.) Presently, microsystems, the confluence of embedded computing, wireless, and sensing technology, is poised to further transform the way we live. Microsystems will facilitate the *sensing*, *interpretation*, and *communication* of information almost anywhere anytime. They will indeed be transforming in their impacts on health care, transportation, food production, sustainable energy, security, and education. They will also be key in addressing problems of air pollution, water shortages, and global warming. In order to solve our global problems, we will need to manage our resources better than ever before in the face of a rapidly expanding population and the exploding energy demands of a rapidly developing world. And in order to manage, we must have information.

Transformations do not come easy. Lincoln was a relatively young man of 52 when this portrait was made, but the Civil War literally consumed him, so that four years later he looked old and spent. Working 16-hour days, 7 days a week, will do that (as many readers will understand all too well). Much has been written recently about some of the pioneers in microelectronics and what they did and didn't do right. Most, like Lincoln, simply responded when events unfolded to place critical decisions before them. And as they struggled with difficult problems, the decisions they made opened up entirely new possibilities. Those of us in MEMS have spent the last 40 years struggling to realize the dream of tiny microsystems that sense, interpret, and communicate accurate information from the environment at low cost, whether that environment is global or whether it is found within ourselves. Microsystem development is now a worldwide activity, and it will succeed simply because it has to. Individuals, and especially creative interdisciplinary teams, can make a real difference here, and in solving many of the problems we face in this century, we don't have much time. As we pursue sustainability for the WIMS ERC, it is important that we all keep that in mind. ■

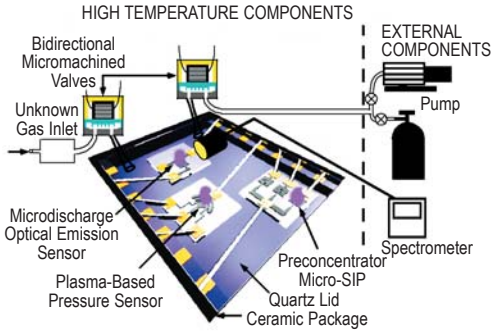
Ken D. Wise

Director, Engineering Research Center for
Wireless Integrated MicroSystems

Research Highlights

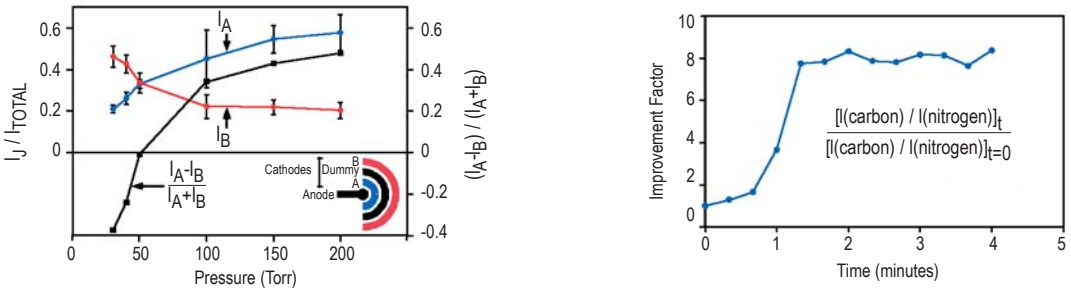
A Multiplasma Microsystem With Pressure Sensor, Gas Purifier, and Chemical Detector Designed for Harsh Environments

Scott A. Wright and Yogesh B. Gianchandani



Schematic of chemical detector.

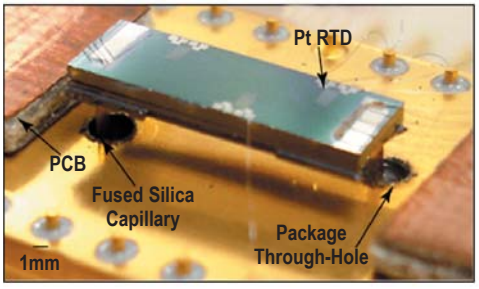
The costs of petroleum exploration, field development, and long-term geological monitoring potentially can be reduced through the use of microholes and MEMS sensors. In the pursuit of this goal, the WIMS ERC has developed a system for gas-phase chemical detection in harsh environments that uses three microplasma-based devices and operates at temperatures up to 200°C. A pressure sensor, gas purifier, and chemical detector operate through the creation of microplasmas between thin-film electrodes. A new pressure sensor design has been developed for this project that measures the change in microplasma current distribution with pressure and achieves a sensitivity of 9800ppm/Torr at 200°C. A gas-purifying microscale sputter ion pump is used to purify a sampled gas by selectively removing nitrogen and oxygen, and it achieves a 56.5x reduction in nitrogen concentration relative to helium. This purification enhances the ability of the harsh-environment sensor to detect trace amounts of gases. The chemical detector comprises a novel optical emission sensor that operates by fractionating and exciting gas species in a microdischarge for chemical spectral detection. Sample gases have been introduced into the system at 200°C, and an 8x spectral enhancement of carbon line emission intensity relative to nitrogen has been demonstrated, making the previously undetectable carbon detectable. ■

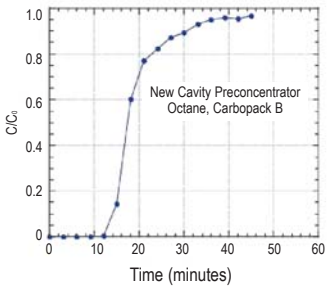


The change in microplasma current distribution with pressure in a plasma-based pressure sensor (left). Increased ability to detect carbon during gas purification in the sensor (right).

A Microfabricated Preconcentrator for Gas Chromatography

Helena K. L. Chan





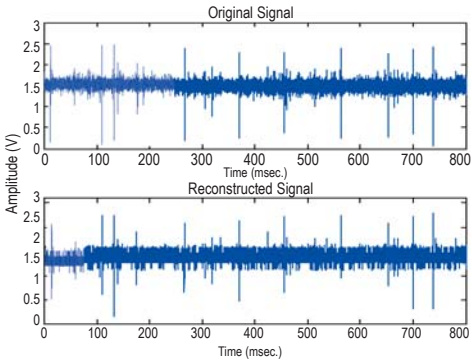
A quantitatively loaded microscale granular carbon preconcentrator mounted in a hybrid package with a 1mm air gap. At right, a breakthrough curve from the preconcentrator showing exhaustive extraction for an input of octane at 25mL/min with room-temperature adsorption on Carbopack B.

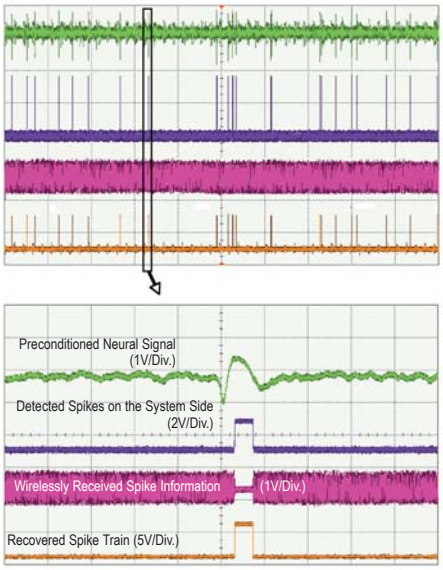
An important milestone was reached recently in the realization of a microfabricated preconcentrator for gas chromatography. The 44mm^3 preconcentrator performs exhaustive sample extraction and injection in a single unit. Using 180–212μm-diameter graphitized carbon black granules and carbon molecular sieves residing in 450μm-deep micromachined silicon cavities, the preconcentrator adsorbs volatile organic compounds (VOCs) at part-per-billion concentrations as an air carrier passes through the cavities. Injection can then be performed by rapidly heating the device to 300°C with 1.8 watts to desorb the VOCs into the separation column at part-per-million concentrations. This is the first granular adsorbent preconcentrator integrated at the wafer level and the first preconcentrator with proven exhaustive extraction and injection performance. Decane at 1μg/L is preconcentrated to 346μg/L; 1.13L of octane at 42.89μg/L and 25mL/min can be extracted before breakthrough. With 3:1 split-flow, an 8mL/min carrier, and 30s stop-flow heating to 300°C, 100ms injections have been demonstrated. ■

Wireless Chronic Recording With Cortical Microsystem

Amir M. Sodagar, Mayurachat N. Gulari, Gayatri E. Perlin, Ying Yao, James Wiler, and Kensall D. Wise

Our cortical microsystem continues to demonstrate increasing performance. Most recently, it was used to record wirelessly from the auditory cortex of two guinea pigs over a 30-day period. Two single-shank probes having sixteen 1250μm^2 IrO sites on 400μm centers were implanted in each animal, with cables leading to a printed-circuit-board version of the penny-size circuit module. Three of the cables were silicon; one was parylene. All were integrated monolithically with the probes and performed well. The neural activity was amplified 1000x, band limited (100Hz–10kHz), and fed to signal processing chips. In the Monitor Mode, the signal from the selected site was sampled at 31.25kb/s, converted to 8b words, organized into data packets, Manchester-encoded, and transmitted to the external world over an on-off-keyed 80MHz telemetry link. In the Scan Mode, the sites were continuously scanned, and when spikes were detected above a user-programmed threshold, the active site addresses were bundled into Manchester-encoded data packets and transmitted. An external system detected, demodulated, and displayed the recorded signals. For 32 sites analyzed statistically, an average 21% of the sites were active with an average signal-to-noise ratio of 4.1. ■





A comparison of the neural activity data at the recording site with the externally recovered signal in the Monitor Mode (left) and Scan Mode (above) for the cortical microsystem.

Recent Events

Industrial Advisory Board Given Research Update at Semi-Annual Meeting

The WIMS ERC Semi-Annual Industrial Advisory Board Meeting was held at the Kensington Court Ann Arbor on October 25–26, 2006. WIMS Director Ken Wise gave the ERC update. WIMS Thrust leaders highlighted the latest advances in their areas of research, and several students gave slide presentations featuring project details. The opportunity to exchange information allowed IAB members to review and comment on the Center's ongoing research.

This year, the Center has projects combining innovation in four research areas: micropower integrated circuits, wireless interfaces, sensors and actuators (MEMS), and advanced packaging. At four different poster sessions, IAB members had the opportunity to meet with graduate students, who hosted their posters and discussed the projects in greater detail. Presented with a significant level of detail, IAB members examined current results and considered upcoming directions. This one-to-one exchange also gave the graduate students the opportunity to meet directly with representatives of industry and make contacts for future endeavors. Strong and enthusiastic support from the IAB members was evident and appreciated.

One of the highlights of the IAB Meeting was the presentation of the Student Leadership Council's Outstanding Leadership Award. Matthew Johnson received the award for his dedication to WIMS and the Student Leadership Council, and for his generous service in helping others. ■

Jerry Rivard, featured speaker, studies student Tao Li's poster.

Rebecca Veeneman demonstrates the latest working version of the WIMS micro gas chromatograph.

SLC President Tzeno Galchev presents the Student Leadership Council's Outstanding Leadership Award to Matthew D. Johnson.

Luis Calderon, David Ortiz, and Giselle Bonilla from the University of Puerto Rico at Mayaguez demonstrate both the cochlear implant code and the micro gas chromatograph code software and hardware.

Education Highlights

Student Leadership Council Update

The goal of the WIMS ERC's Student Leadership Council (SLC) is to extend an engineer's education beyond traditional methods, by combining a service organization, a social club, and a student government into one multipurpose, student-run group. Currently, Tzeno Galchev is president and Tushar Bansal serves as vice president. Under their leadership, the SLC is now stronger than ever. In recognition of the SLC's community service mission, a local TV station recently showcased SLC members teaching third-grade students about robotics and WIMS on the MSU campus. Chao Yang is the SLC's MSU committee chairperson, and Angelique Johnson oversees educational outreach efforts.

2007 SLC Officers (L to R): Tzeno Galchev, Tushar Bansal, Mike Pinelis, Jae Yoong Cho, Angelique Johnson, Razi-ul Haque, and Mark Richardson (inset)



(L to R): Chao Yang (MSU Chairperson), Zongliang Cao (MSU Associate Chairperson), and P. Santosh K. Karre (MTU Chairperson)

The SLC's industrial committee, now led by Mike Pinelis, continues to foster a close relationship between students and industry, giving WIMS ERC students an additional advantage over traditional graduate students. Two noteworthy projects of this committee include (1) creating and distributing a brochure highlighting student research achievements and (2) maintaining a resumé booklet listing students available for internships or full-time positions. In a similar vein, the SLC has just established a public relations committee, with Mark Richardson as its first chairperson. This committee promotes awareness of WIMS research activities to the mass media and the student body at large by writing and distributing press releases to various media outlets. Not to be outdone by the other committees, the social committee, led by Razi-ul Haque, works hard to provide a social setting in which students from different disciplines and backgrounds can network, collaborate, and build friendships. The social committee was very pleased with its successful Information Day, where hundreds of students visited a booth that explained the Center, its research, and opportunities for students to become involved in WIMS. The SLC is open to all undergraduate and graduate students affiliated with the WIMS ERC. ■

Technical Director for Biomedical Microsystems Appointed

The WIMS ERC has appointed Dr. Amir M. Sodagar as Technical Director for Biomedical Microsystems. Amir replaces Jamille F. Hetke, who served as Biomedical System Integrator before joining industry to aid in commercializing neural probe technology developed at the University of Michigan. Amir has assumed responsibility for both our cochlear and cortical testbeds. He received a B.S. degree from K. N. Toosi University of Technology (KNTU), Tehran, Iran, in 1992, and M.S. and Ph.D. degrees from Iran University of Science and Technology (IUST), Tehran, Iran, in 1995 and 2000, respectively, all in Electrical Engineering. After receiving his Ph.D. degree, he joined the EECS Department at the University of Michigan as a Post-Doctoral Research Fellow. From 2002–2004, he was an Assistant Professor at KNTU and an Adjunct Professor at IUST. Since 2004, he has been with the WIMS ERC as a Visiting Associate Research Scientist.

Dr. Sodagar has also served as a Lecturer at S. Rajaee University (SRU), Tehran, Iran, (1995–2000), as a Design Engineer with Iran Telecommunication Research Center (ITRC) (1996–1997), as a Research Engineer with the VLSI Circuits and Systems Laboratory at the University of Tehran (1997–1998), and as a Senior Design Engineer with EMAD Semicon Co. (1998–2000). He was named the Outstanding EE Graduate Student at IUST in 1995 and received the IUST Best Ph.D. Research Achievement Award in 2000. He also received the SRU Distinguished Faculty Member Award for the 1998–1999 and 1999–2000 academic years. Dr. Sodagar has authored many technical papers and a textbook, *Analysis of Bipolar and CMOS Amplifiers* (CRC Press), currently in press. His research interests comprise mixed-signal integrated circuits and integrated circuit design for biomedical implantable microsystems. He played a key role in the development of our cortical testbed, designing its neural signal processor and wireless interface. We very much appreciate his stepping forward to take on these new responsibilities. ■

Recruiting Undergraduates for WIMS Research Opportunities

Each fall, the WIMS ERC organizes an open house, themed "Introduction to WIMS Undergraduate Research," with the goal to inform undergraduate students about the Center and possible undergraduate research opportunities available for both winter term and the spring-summer period. Each student accepted into the program works under the direction of a WIMS faculty advisor and receives mentoring from a highly motivated WIMS graduate student.

This year's open house, held on November 15, began with a WIMS Overview by Professor Khalil Najafi, Deputy Director of the WIMS ERC. The history, purposes, and future goals of the Center were given to inspire these undergraduate students to pursue courses in MEMS and WIMS and continue into graduate school in a WIMS-related field. Next, several WIMS Thrust leaders presented some of the specific research projects underway, followed by a question and answer period. Afterwards, several former undergraduate participants and graduate student mentors provided a panel discussion with comments and answers to questions from the audience. A poster session concluded the open house during which informal discussions were exchanged between graduate students, undergraduates, and faculty. ■

Presentations and Publications

Conference Presentations

International Symposium on Low-Power Electronics and Design (ISLPED), Tegernsee, Germany, October 2006

H. S. Deogun, R. M. Senger, D. Sylvester, R. B. Brown, and K. J. Nowka, "A Dual-VDD Boosted Pulsed Bus Technique for Low-Power and Low-Leakage Operation," pp. 73–78

S. Hanson, B. Zhai, D. Blaauw, D. Sylvester, A. Bryant, and X. Wang, "Energy Optimality and Variability in Subthreshold Design," pp. 363–365

S. Hanson, D. Sylvester, and D. Blaauw, "A New Technique for Jointly Optimizing Gate Sizing and Supply Voltage in Ultra-Low Energy Circuits," pp. 338–341

IEEE International Conference on Sensors, Daejeon, Korea, October 2006

A. M. Kamboh and A. Mason, "Comparison of Area-Power-Efficient Techniques for Neural Data Compression Using Discrete Wavelet Transform"

Y. Huang and A. Mason, "Post-CMOS Compatible Microfabrication of a Multi-Analyte Bioelectrochemical Sensor Array Microsystem"

C. Yang, D. Rairigh, and A. Mason, "On-Chip Electrochemical Impedance Spectroscopy for Biosensor Arrays"

C. Yang, A. Mason, J. Xi, and P. Zhong, "Configurable Hardware-Efficient Interface Circuit for Multisensor Microsystems"

The Society for Neuroscience Annual Meeting (SFN), Atlanta, GA, October 2006

J. Seymour and D. R. Kipke, "Ultra-Fine Structures on Neural Probes Reduce Cellular Encapsulation," 36, p. 354.16

M. J. Lehmkuhle and D. R. Kipke, "Neuromodulation of the Ventromedial Hypothalamus of the Rat Through Deep Brain Stimulation," 36, p. 566.10

R. J. Vetter, J. Seymour, R. M. Miriani, M. Velliste, G. W. Fraser, M. Wu, J. F. Hetke, and D. R. Kipke, "A Modular Multiprobe Cortical Neuroprostheses," 36, p. 148.17

H. Parikh, G. J. Gage, T. C. Marzullo, and D. R. Kipke, "Movement Prediction Using Coherency Between Local Field Potentials and Spikes in the Motor Cortex of Rats," 36, p. 256.9

J. Subbaroyan and D. R. Kipke, "Chronic Tissue Response Evoked by Variably Flexible Intracortical Polymer Implant Systems"

M. D. Johnson and D. R. Kipke, "Heterogeneous Dopamine Efflux and Local Field Potential Activity in Dorsal Striatum"

M. D. Gibson, M. D. Johnson, and D. R. Kipke, "Neural Biosensor Probes for Simultaneous *In-Vivo* Detection of Choline and Electrophysiological Activity in Rat Cortex"

T. C. Marzullo and D. R. Kipke, "Analysis of Field Potentials During Neuroprosthetic Tasks Using Spikes as the Control Signal"

Joint International Meeting of Electrochemical Society, Cancun, Mexico, October 2006

F. Albano, D. Blaauw, D. Sylvester, and A. M. Sastry, "Design and Optimization of Hybrid Power Systems for Fully Implantable Medical Devices"

Federation of Analytical Chemistry and Spectroscopy Societies Meeting (FACSS), Lake Buena Vista, FL, October 2006

E. T. Zellers, "Richard Sacks and the Path to a Micro GC"

IEEE International Ultrasonics Symposium, Vancouver, British Columbia, Canada, October 2006

C. T.-C. Nguyen, "Integrated Micromechanical Circuits Fueled by Vibrating RF MEMS Technology"

Personnel Focus

Andrew Mason is Assistant Professor of Electrical and Computer Engineering at Michigan State University.

Bridging the gap between micro/nano sensor technologies and miniaturized intelligent instruments, Dr. Mason's research delves into novel mixed-signal integrated circuits and new microfabricated structures to form highly integrated microsystems in several cross-disciplinary collaborations.

Within the WIMS ERC, Dr. Mason's team is expanding the utility of their universal microsensor interface (UMSI) chip by incorporating electrochemical instrumentation circuits, including their patent-pending technique for rapid electrochemical impedance spectroscopy for protein-based biosensors. In related work within the Center for Nano-Structured Biomimetic Interfaces, which is sponsored by the Michigan Economic Development Corporation (MEDC), novel protein-tethering molecular assemblies and microfabricated electrochemical array structures are being developed for on-chip protein characterization, drug screening, and other biosensor applications. Dr. Mason's team is also working to improve the sensitivity and accuracy of gas sensors, such as the WIMS μGC, using auto calibration and impedance-based techniques in a project sponsored by the Department of Homeland Security.

Ultra-efficient signal processing and communication circuits are also being explored for two different system platforms. In a project funded by the National Institutes of Health, a tiny, low-power, implantable chip is being developed to efficiently compress multichannel neural data and enable real-time wireless data delivery. With a recent MEDC award in collaboration with Evigia Systems, Dr. Mason's team is developing an ultra-low-power control circuit for a radio frequency identification (RF ID) tag that will facilitate multi-parameter environmental monitoring.

Dr. Mason is a Senior Member of the IEEE, serving on several technical and program committees for the Circuits and Systems Society and the Sensors conference. He currently supervises six graduate students and five undergraduate researchers while teaching courses in mixed-signal integrated circuit design and biomedical instrumentation. In 2006, he received Michigan State University's Teacher-Scholar Award in recognition of his contributions to science and innovations in education. ■

Presentations and Publications (cont)

The United States-Mexico Foundation for Science (FUMEC), Puebla, Mexico, October 2006

K. D. Wise, "MEMS-Based Sensors for Automotive Applications"

International Symposium on Micro-Nano Mechatronics and Human Science, Nagoya, Japan, November 2006

Y. B. Gianchandani, "From Antenna Stents to Wireless Geiger Counters: The Promise of Electrical Micro-Discharges in the Fabrication and Operation of Microsensors"

Proceedings of the Fourteenth International Cyrocoolers Conference, Chicago, IL, November 2006

D. W. Hoch, W. Zhu, G. F. Nellis, S. D. Schuetter, S. A. Klein, and Y. B. Gianchandani, "Progress Towards a Micromachined Heat Exchanger for a Cryosurgical Probe," C14-9-66, pp. 1–10

ASME Annual International Mechanical Engineering Congress and Exposition, Chicago, IL, November 2006

N. K. Gupta and Y. B. Gianchandani, "Modeling and Simulation of a Surface Micromachined Knudsen Pump"

International Conference on Miniaturized Chemical and Biochemical Analysis Systems (μTAS), Tokyo, Japan, November 2006

A. T. Evans, J. M. Park, R. P. Taylor, T. R. Brosten, G. F. Nellis, S. A. Klein, J. R. Feller, L. Salerno, and Y. B. Gianchandani, "A Low-Power, Micromachined Proportional Valve for Drug Delivery"

T. Li and Y. B. Gianchandani, "An Empirical Model for a Piezoelectric Tissue Contrast Sensor Embedded in a Biopsy Tool"

IEEE International SoC Design Conference, Seoul, S. Korea, November 2006

D. Sylvester, S. Hanson, B. Zhai, and D. Blaauw, "Design Strategies for Ultra-Low-Voltage Circuits"

The 25th Army Science Conference, Orlando, FL, November 2006

P. S. Karre, P. L. Bergstrom, G. Mallick, and S. P. Karna, "Effect of Tunnel Resistance in the Strong Tunneling Regime on the Conductance of Single Electron Transistors Fabricated Using Focused Ion Beam Etching"

Proceedings of the US-Korea Workshop on Smart Structures Technology for Steel Structures, Seoul, Korea, November 2006

Industrial Liaison's Report

WIMS Spring IAB Meeting May 15–16, 2007

The WIMS ERC is into its seventh year and is well along in achieving the technical goal that was set in 2000. The goal is a generic platform for sensor-driven microsystems capable of sensing non-electronic variables with high accuracy, interpreting the signals, and then communicating them over distances from a few centimeters to a few kilometers. The WIMS projects are organized around two testbed microsystems. The first testbed is a family of neural prostheses aimed at treating disorders such as deafness, paralysis, epilepsy, and Parkinson's disease. The second testbed is a wristwatch-sized system for monitoring environmental parameters, including air quality. The testbeds are not only addressing the technical challenges, they are offering students an opportunity to learn system design. As members of a team the students are learning to design their individual component(s) to enhance the performance of the system. As Ken Wise pointed out in our last newsletter, it is all too often counterculture in academia to take the system team view. We are developing not only new technology, but also an outlook that students will take with them as they move into industry and academia.

The challenge for all is to remember that the testbeds are a specific embodiment of the technology and application. The technology and components developed for the testbed can be applied to solve other problems.

The neural prosthesis testbed has developed a variety of technologies for producing low-power, flexible devices that can be remotely addressed. These technologies can be utilized, not only for other medical applications, but also for a variety of industrial applications. In point of fact, some medical implant sensors and automotive sensors are brothers.

Similarly, the environmental monitor micro gas chromatograph can be part of a system used to monitor air quality, detect chemical warfare agents, or monitor a patient. The nanotechnology used to produce the microsensor arrays can be used in a variety of sensor applications. To be sure, there will be some modifications for each application, but the testbed has shown the feasibility for all these embodiments.

Remember to mark your calendar and attend our May 15–16, 2007, Industrial Advisory Board meeting. Our Web site (www.wimserc.org) has the details.

If you, or one of your colleagues, is interested in sharing your activities with our students, please contact me at either (734) 615-3096 or giachino@eecs.umich.edu to schedule a seminar.

As always, please visit when in the Ann Arbor area so we can share our latest technical developments and progress with the laboratory expansion. ■

Joseph M. Giachino

Associate Director, Industry

R. A. Swartz and J. P. Lynch, "Redundant Kalman Estimation for a Distributed Wireless Structure Control System"

Computing Alliance for Hispanic Serving Institutions Annual Meeting, El Paso, TX, December 2006

G. S. Bonilla, A. C. Velez, S. Matos, J. A. Ortiz, A. Rios, and S. Gambaro, "Controlling Code for a Microgas Chromatograph With Low-Power Constraints"

Publications

D. F. Lemmerhirt, E. M. Staudacher, and K. D. Wise, "A Multitransducer Microsystem for Insect Monitoring and Control," *IEEE Transactions on Biomedical Engineering*, vol. 53, no. 10, pp. 2084–2091, October 2006.

K. Takahata, Y. B. Gianchandani, and K. D. Wise, "Micromachined Antenna Stents and Cuffs for Monitoring Intraluminal Pressure and Flow," *Journal of Microelectromechanical Systems*, vol. 15, no. 5, pp. 1289–1298, October 2006.

M. J. Lehmkuhle and D. R. Kipke, "Long-Term Neuromodulation of the Ventromedial Hypothalamus Effects Weight Gain in the Rat," *Biomedical Engineering Society (BMES)*, Chicago, IL, October 2006.

J. Lee, M. D. Johnson, and D. R. Kipke, "Simultaneous Neural Recording of Spikes and LFPs," *Biomedical Engineering Society*, Chicago, IL, October 2006.

M. Agah, G. R. Lambertus, R. D. Sacks, and K. D. Wise, "High-Speed MEMS-Based Gas Chromatography," *Journal of Microelectromechanical Systems*, vol. 15, pp. 1371–1378, October 2006.

M. D. Johnson, O. E. Kao, and D. R. Kipke, "Spatiotemporal pH Dynamics Following Insertion of Neural Microelectrode Arrays," *Journal of Neuroscience Methods*, November 2006.

C. Hsin and M. Liu, "Randomly Duty-Cycled Wireless Sensor Networks: The Dynamics of Coverage," *IEEE Transactions on Wireless Communications*, vol. 5, no. 11, pp. 3182–3192, November 2006.

D. Rairigh and A. Mason, "Analysis of On-Chip Impedance Spectroscopy Methodologies for Sensor Arrays," *Sensor Letters*, December 2006.

P. T. Bhatti and K. D. Wise, "A 32-Site, 4-Channel, High-Density Electrode Array for a Cochlear Prosthesis," *Journal of Solid-State Circuits*, vol. 41, no. 12, pp. 2965–2973, December 2006.

T. C. Marzullo, C. R. Miller, and D. R. Kipke, "Suitability of the Cingulated Cortex for Neural Control," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 14, pp. 401–409, December 2006.

M. U. Demirci and C. T.-C. Nguyen, "Mechanically Corner-Coupled Square Microresonator Array for Reduced Series Motional Resistance," *Journal of Microelectromechanical Systems*, vol. 15, no. 6, pp. 1419–1436, December 2006.

K. D. Wise, "Wireless Integrated Microsystems: Coming Breakthroughs in Health Care," Conference Plenary Address, *Digest IEEE Int. Electron Devices Meeting*, San Francisco, CA, pp. 3–10, December 2006.

Doctoral Dissertations

University of Michigan, 2006

Helena Kai Lun Chan, "A Micro-fabricated Preconcentrator for Sample Extraction and Injection in Microscale Gas Chromatography"
Postgraduate Position: Northrop Grumman
Advisor: Professor Kensall D. Wise

Harmander Deogun, "Power Conscious and Robust Design Methods for the Sub-90nm CMOS Digital Circuit"
Postgraduate Position: Advanced Micro Devices
Advisor: Professor Dennis M. Sylvester

Matthew D. Johnson, "Spatiotemporal Neural Interface Dynamics Elucidated With Multichannel Electrochemistry"
Postgraduate Position: Post-Doctoral Research Fellow, Cleveland Clinic Foundation
Advisor: Professor Daryl R. Kipke

Yang Li, "An Integrated Drug-Delivery Probe With In-Line Flow Measurement"
Postgraduate Position: Seagate Technology
Advisor: Professor Kensall D. Wise

André Snellings, "Optimizing Electrophysiological Techniques for Localizing Deep Brain Structures"
Postgraduate Position: Duke University
Advisors: Professors David J. Anderson and J. Wayne Aldridge

Jeyakumar Subbaroyan, "Quantification of Micromotion Induced Injury Response in Intracortical Implants Through Modeling and *In-Vivo* Experiments
Postgraduate Position: Post-Doctoral Research Fellow for Professor Daryl R. Kipke in BME Department at U of M
Advisor: Professor Daryl R. Kipke

Yu-Wei Lin, "Micromechanical Reference Oscillators for GSM Wireless Communications"
Postgraduate Position: Broadcom
Advisor: Professor Clark T. C. Nguyen

Faculty/Student Awards

Winners Announced for Fall 2006 Circuit Design Projects in EECS Course

Jonathan Brown, Francine Shammami, and John DeBusscher

University of Michigan EECS undergraduates Jonathan Brown, Francine Shammami, and John DeBusscher were awarded the best design project prize in EECS 413—Monolithic Amplifier Circuits: Introduction to Mixed-Signal Design. The prize, which carries a gift of $1000, is sponsored by National Instruments. The course is an introduction to CMOS analog and mixed-signal design and includes a major design project. With an enrollment of 40 students, this course is popular with both undergraduate and graduate students. It is taught by WIMS Wireless Thrust Leader Professor Michael Flynn.

Thirteen groups presented their design projects in December. The designs fell into four categories: Temperature Sensor, Cherry-Hooper Amplifier, Preamplifier, and Ethernet Line Driver. All designs were implemented in a commercial 0.25μm CMOS process and included complete layouts. The design process was aided by a full suite of industrial-grade CAD tools from Cadence. The students themselves selected the best project. ■

Seminar Series

*** October 3, 2006**
Professor Michel Maharbiz
University of Michigan
"A Thousand and One Things (Growing) in the Maharbiz Lab"

*** October 31, 2006**
Timothy L. Faley, Ph.D.
Samuel Zell & Robert H. Lurie Institute for Entrepreneurial Studies
"Joint CoE/RSB Entrepreneurial Education Initiative"

*** November 7, 2006**
Professor Rachel S. Goldman
University of Michigan
"Directed Seeding of Metal-Semiconductor Nanocomposites for Negative Index Metamaterials"

*** November 14, 2006**
Professor Michael Mayer
University of Michigan
"Applications of Ion Channels for Diagnostics and Affinity Sensors"

*** November 21, 2006**
Professor Anthony Grbic
University of Michigan
"Negative Refractive Index Materials Based on Transmission Lines"

*** December 5, 2006**
Professor Jason Clark
Purdue University
"SUGAR: The Spice for MEMS"

*** December 12, 2006**
Professor James R. Hellums
Texas Instruments
"Design of Low-Noise CMOS Amplifiers"

**Available for viewing on website*

Visit our Web site at http://wimserc.org to find out more information about these seminars and to view them on streaming video. You can also see a schedule of upcoming seminars, as well as a listing of publications.

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