WIMS² Newsletter

Summer 2017

WIMS² Wireless Integrated MicroSensing & Systems

Partnering With Industry in Microsystems Research

Awards

NSF CAREER Award

Prof. Becky Peterson received the NSF CAREER Award for research in Amorphous Semiconductors for Next Generation Electronics.*[Full Story]*

SPIE Fellow

Prof. Xudong (Sherman) Fan received this honor. Each year, SPIE promotes members as new Fellows of the Society. Fellows are Members of distinction who have made significant scientific and technical contributions in the multidisciplinary fields of optics, photonics, and imaging. They are honored for their technical achievement, for their service to the general optics community, and to SPIE in particular.

David Blaauw Honored With SIA/SRC University Research Award

Prof. David Blaauw was presented with the University Research Award by the Semiconductor Industry Association (SIA), in consultation with Semiconductor Research Corporation (SRC), in recognition of his outstanding contributions to semiconductor research in the area of design research. He was presented with the award by the SIA

WIMS² News & Events

Babak Parviz: Pioneer in Technological Innovations

Electrical engineer and Google Glass creator Babak Parviz is widely recognized for revolutionizing communication technology through advances in optics, self-assembly, and miniaturized electronics. Dr. Parviz, who lives in Seattle, holds a B.S. degree in electrical engineering from Sharif University of Technology in Tehran and a B.A. in literature from the University of Washington (UW). He studied micro-electro-mechanical systems at the University of Michigan, where he earned a M.S.E degree (1997) and Ph.D. (2001) in electrical engineering and a M.S. degree (2001) in physics. He completed a postdoctoral fellowship at Harvard University in chemistry and chemical biology and developed self-assembly techniques to fabricate nano-scale devices and systems as a UW faculty member. He continues to serve as an affiliate professor in UW's Department of Electrical Engineering. In 2010, two years after developing a bionic contact lens prototype, he joined Google, where he initiated and led the Glass project until 2013. He also founded Google's robotics surgery initiative, which became Verb Surgical, an independent company, and co-founded Google's Smart Contact Lens program. Dr. Parviz joined Amazon in 2014, and, in 2015, was elected a SPIE fellow by the International Society for Optics and Photonics. He has received many accolades, including Time magazine Best Inventions of the Year honors in 2008 and 2012, the Institute of Electrical and Electronics Engineers Circuits and Systems Society Industrial Pioneer Award, Design News Golden Mousetrap Lifetime Achievement Award, National Science Foundation Career Award, and U-M College of Engineering Alumni Society Merit Award in Electrical and Computer Engineering.

For his pioneering technological innovations that augment human potential, and thus improve peoples' lives, the University of Michigan presents to Babak Parviz its Bicentennial Alumni Award. *[Full Story]*

Novel Collaboration to Probe Brain Activity in Unprecedented Detail

Board on September 21, 2016 in San Jose, CA. *[Full Story]*

ProQuest Distinguished Dissertation Award Winner

Azadeh Ansari, Electrical Engineering and Computer Science, won the ProQuest Distinguished Dissertation Award which recognizes exceptional and unusually interesting work produced by doctoral students. [Full Story]

Azedeh also received a faculty position at Georgia Tech starting Fall 2017.

Michael Flynn Earns U-M Faculty Recognition Award

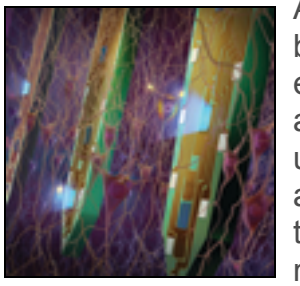
Prof. Michael Flynn has received a Faculty Recognition Award for his accomplishments in research, teaching, and service to the University. Prof. Flynn is one of the world's premier scholars in the area of analog and mixed-signal integrated circuits and systems, analog-to-digital conversion (ADC), and other interface circuits. His pioneering research and designs have improved the performance and energy efficiency of analog-digital interfaces and transformed the field. *[Full Story]*

College of Engineering Award

Prof. Kamal Sarabandi received the Stephen S. Attwood Award, for "extraordinary achievement in teaching, research, service, and other activities that have brought distinction to the College and University."

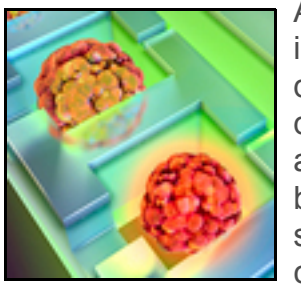
The College of Engineering Monroe-Brown Foundation Research Excellence Award

Prof. Xudong (Sherman) Fan received this award which is bestowed upon a College of Engineering Faculty member who has demonstrated sustained excellence in



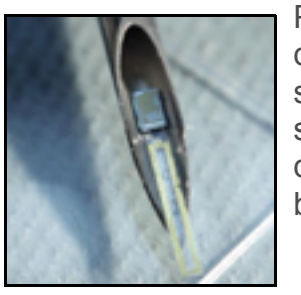
A pilot program led by Prof. Euisik Yoon will regularly bring together researchers with complementary expertise from different universities to collaborate on advancing research that may lead to a better understanding of the human brain and diseases that affect it. Yoon has been leading a key development of the Michigan Probe, a revolutionary tiny solid-state microsystem developed at U-M that can be used to probe the inner workings of the brain. *[Full Story]*

Cancer Stem Cells: New Method Analyzes 10,000 Cells at Once



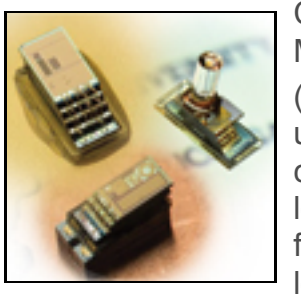
A new device for studying tumor cells can trap 10,000 individual cells in a single chip. The technique, developed by Prof. Euisik Yoon's group, could one day help screen potential cancer treatments based on an individual patient's tumor and help researchers better understand so-called cancer stem cells. It also shed light on a controversy: are large cells or small cells more likely to be cancer stem cells? *[Full Story]*

Injectable Computers Can Broadcast From Inside the Body



Profs. David Blaauw and David Wenzloff are designing millimeter-scale ultra-low-power sensing systems that can be injected into the body through a syringe. Unlike other radios of this size, these new devices are able to broadcast through the human body to an external receiver. *[Full Story]*

CubeWorks: Solving Problems With the Worlds Smallest and Lowest-power Computers



CubeWorks, founded by the team at University of Michigan that developed the Michigan Micro Mote (M^3), the worlds smallest computer, has been flying under the radar since late in 2013. This startup company specializes in the worlds smallest and lowest-power sensing technology. With its first outside funding from Intel, the CEO of CubeWorks is now looking two years into the future, when he hopes to be manufacturing millimeter-scale computing devices for their first customers. *[Full Story]*

The Future of Remote Sensing

Researchers are exploring the fundamental capabilities of remote sensing through a program that aims to create theoretical models and tools for

research and related scholarly activities.

2016 EECS Department Outstanding Achievement Award

Prof. Anthony Grbic received the award for inspirational teaching, dedicated mentoring of graduate students, and innovative research in metamaterials and wireless power transfer.

Prof. Mina Rais-Zadeh received the award for outstanding contributions to research in high frequency MEMS and piezoelectric semiconductor transducers, and for excellence in teaching and service.

2017 EECS Department Outstanding Achievement Award

Prof. Euisik Yoon Prof. Euisik Yoon "For outstanding contributions to micro electro mechanical systems (MEMS), and innovative research and leadership in biomedical microsystems and neurotechnology." Euisik and other award winners will be recognized, along with other faculty awards and accomplishments from the past year, at the upcoming Faculty Recognition Dinner on Saturday, February 11th at 6:00 pm in the Rogel Ballroom at the Michigan Union.

WIMS^2 Seminars

Available to Members Only. Login Required.

NOVEMBER 18, 2016
The Last Untapped Spectrum Speaker

Speaker: Prof. Eshan Afshari

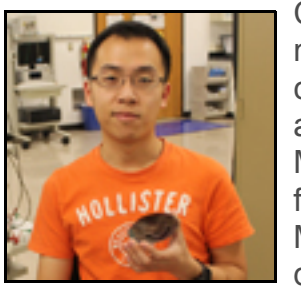
future remote sensing of ice and snow. This research, directed by Kamal Sarabandi, Rufus S. Teesdale Professor of Engineering, could feed into the development of new sensors for a variety of remote sensing applications.

"The idea of this program is to look into the future," said Prof. Sarabandi, "determine what new types of measurement can be done remotely, and develop the science and theory for what is and isn't possible." Based on the theory, researchers can determine the best ways to monitor the earth, particularly ice and snow levels which have serious ecological consequences.

Prof. Sarabandi has long been a strong proponent for pursuing this type of theoretical research. "Everything we know now was begun 10-20 years ago," he explained. "You have to first figure out what can and can't be done before you develop the sensors and tools for measurement."

The research is funded by NASA as part of their Remote Sensing Theory for Earth Science program. *[Full Story]*

A New Tunable Filter for Wireless Communication



Compact and low-loss tunable filters are used in many wireless communication devices, including cognitive radios, anti-jamming systems, and advanced transducers. Currently, solid-state or RF MEMS switches are among the most popular options for the tunable components in wireless modules. Prof. Mina Rais-Zadeh and doctoral student Muzhi Wang developed a filter using a new material that demonstrates competitive performance in a number of factors, while being easier to fabricate.

The filter operates in the x-band frequency range and uses germanium-telluride (GeTe) phase change switches. This is the first implementation of a tunable filter to use GeTe switches. Their performance, power handling, switching speed, and ease of integration into different circuits was comparable to MEMS switches, with the added bonus of a simpler fabrication process. The GeTe switch also had a faster response time and required smaller voltage pulses for actuation than some existing MEMS tunable filters.

Muzhi earned a Best Paper Award at the *2016 IEEE Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems (SiRF),* part of Radio & Wireless Week, for the paper, "An X-Band Reconfigurable Bandpass Filter Using Phase Change RF Switches." *[Full Story]*

New High-Resolution micro-g Accelerometer and High Density Accelerometer Arrays

OCTOBER 20, 2016

Degradation Analysis of Li-ion Batteries and New Materials Development

Speaker: Prof. Wei Lu

JULY 18, 2016

Motionless Heat Pump – A New Application of Thermal Transpiration

Speaker: Ko Kugimoto
Researcher
Toyota Central R&D Labs, Inc.

JUNE 2, 2016

Progress in Development of GHz Operating Acoustic Devices Based on Micromachining and Nanoprocessing of GaN/Si

Speaker: Alexandru Müller

FEM Models for GaN Based Surface Acoustic Wave Structures

Speaker: Alexandra Stefanescu

[Video]

APRIL 15, 2016

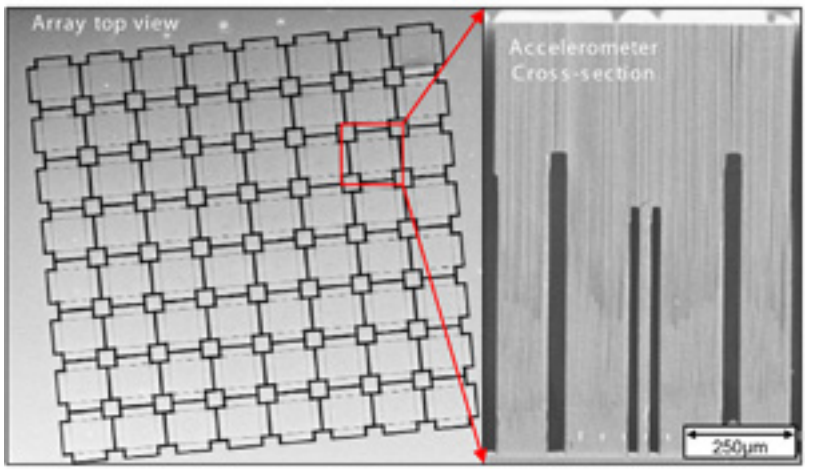
Glassy Electronics: Exploiting the Amorphous Phase

Speaker: Becky Peterson

[Video]

APRIL 8, 2016

GaN Integrated Micro-systems for RF Applications & Piezoelectric Fused Silica Resonators for



WIMS^2 researchers, Prof. Khalil Najafi and doctoral student Stacey Tang, have developed a new type of multi-axis, capacitive, MEMS accelerometer made from thick silicon. The new accelerometer can achieve sub-µg resolution (<1µg/vHz) and high areal sensitivity (1pF/g per 1mm^2). It has a 3D, vertical, biomimetic hair-like structure, and is microfabricated from a thick silicon wafer using a new 2-gap microfabrication process that is also compatible with CMOS device integration.

The novel process circumvents some of the stringent requirements on deep reactive ion etching (DRIE) when etching thick (>500µm) layers. It enables the fabrication of large proof-mass (1mm tall, >2.33 milligram/mm^2), high aspect-ratio (HAR) narrow sense gaps (<3 µm wide, >250 µm tall), and a large sense/feedback electrode area (>250 µm tall). The result is a MEMS accelerometer with an area smaller than any previous precision accelerometers with similar performance. Further, the electrodes are split into groups to enable fully symmetric differential readout, and provide force feedback for closed-loop operation.

This technology is especially suited for forming MEMS transducer arrays and offers the following advantages: 1) hundreds or thousands of small-footprint high-sensitivity devices can be integrated on a single chip to provide multiplicity of functions (greater dynamic range, fault-tolerance, reconfigurability, etc.); and 2) MEMS devices can now be integrated on top of CMOS circuitry to perform local signal processing for individual elements in the array.

Large arrays of these MEMS transducers can potentially be used in several emerging applications, including: 1) high performance inertial measurement units that require large dynamic range, high resolution, as well as robustness and fault tolerance; and 2) large arrays of miniaturized detectors and actuators with high temporal and spatial resolution, analogous to high-density CMOS imagers.

The research was funded by the Micro Autonomous Systems & Technology (MAST) Program of the Army Research Lab (ARL).

2016 Research Review and Industrial Advisory Board Meeting

Timing References

Speakers: Azadeh Ansari, PhD Candidate
and *Adam Peczalski, PhD Candidate*
[Video]

Conferences

IEDM 16 (International Electron Device Meeting)

San Francisco, California, December 3-7, 2016

H. Zhu, A. Ansari, W. Luo, M. Rais-Zadeh, "Observation of Acoustoelectric Effect in Micromachined Lamb wave delay lines with AlGaN/GaN heterostructure," *Proc. IEEE International Electron Device Meeting (IEDM'16)*, San Francisco, CA, pp. 26.6.1-26.6.4, December 2016.

PowerMEMS 2016 (International Conference on Micro and Nanotechnology for Power Generation and Energy Conversion Applications)

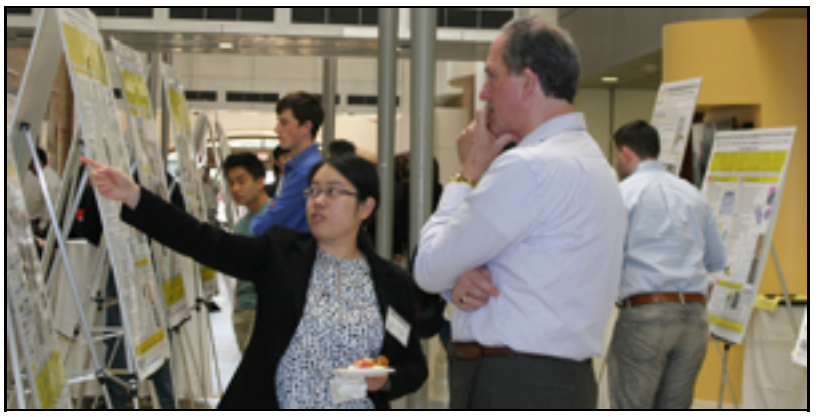
Paris, France, December 6-9, 2016

E. E. Aktakka, K. Najafi, "Multi-axis inertial energy harvester based on piezoelectric crab-legs with partitioned electrodes," *16th Int. Conf. on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS'16)*, Journal of Physics: Conference Series 773, 012002, December 2016.

MEMS'17 (IEEE International Conference on Micro Electro Mechanical Systems)

Las Vegas, Nevada, January 22-26, 2017

J. Cho, T. Nagourney, A. Darvishian, and K.



On May 19 and 20, members, students, faculty and invited guests met in Ann Arbor for two days of meetings, which included faculty research presentations, two invited speakers, reports of seedling projects, a student poster session, a networking reception, one-on-one meetings with faculty, and the formal Industrial Advisory Board Meeting.

Fall 2016 Research Review

The Fall 2016 event was held in Santa Clara, CA. Attendees included members, faculty, invited guests, plus several investors and venture firms. The event was held in conjunction with a University of Michigan Alumni Reception, where Prof Emeritus, Ken Wise gave a special presentation, "Microelectronics in the "More Than Moore" Age: Becoming a Truly Pervasive Technology."

Research Review Presentations Viewable Online

The presentations given at the Spring 2016 and Fall 2016 Research Reviews (May 19 and September 16) are now available on our website.

They include: Center Overview; Micropower Circuits; Wireless Interfaces; Advanced Materials, Processes, and Packaging; High Frequency MEMS; Biomedical Sensors and Subsystems; Environmental Sensors and Subsystems; and Infrastructure Monitoring.

All of these presentations report new results from ongoing research projects.

Najafi, "Ultra Conformal High Aspect-Ratio Small-Gap Capacitive Electrode Formation Technology for 3D Micro Shell Resonators," *IEEE 2017 International Conference on Micro Electro Mechanical Systems (MEMS'17)*, Las Vegas, NV, January 2017.

Q. Cheng, Y. Qin, and Y. Gianchandani, "A Bidirectional Knudsen Pump with Superior Thermal Managament for Micro-Gas Chromatography Applications," *IEEE 2017 International Conference on Micro Electro Mechanical Systems (MEMS'17)*, Las Vegas, NV, January 2017.

Y. Tang, A. Sandoughsaz, and K. Najafi, "Ultra High Aspect-Ratio and Thick Deep Silicon Etching (UDRIE)," *IEEE 2017 International Conference on Micro Electro Mechanical Systems (MEMS'17)*, Las Vegas, NV, January 2017.

Spring 2016 Presentations [login req'd]

Fall 2016 Presentations [login req'd]

WIMS^2 Four-Session Workshops: Writing and Speaking in Professional Contexts

A Customized Series of Workshops for Graduate Students and Post Docs in EECS

The motivation for these workshops, which were held in September and October, is to enable graduate students and post docs, through discussion, taught sessions and practice, to become more confident and skilled writers and speakers in their academic discipline. Each of the 4 sessions included both instructor led and group and pair interaction, with the first two sessions focusing on writing, and the second two on speaking. Sessions were structured as two hours of instructor led work and the third hour either a visiting speaker or an interactive form of practice (such as a simulated social networking session). Prof. Judy Dyer from the U-M English Language Institute is the instructor in these workshops.

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