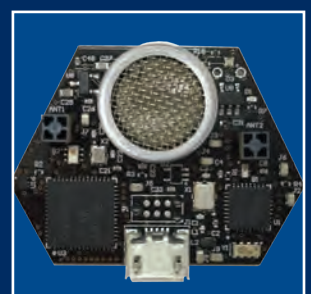
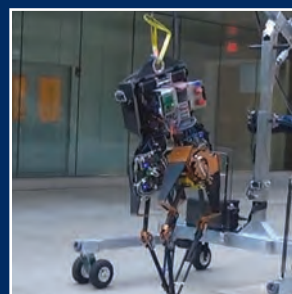
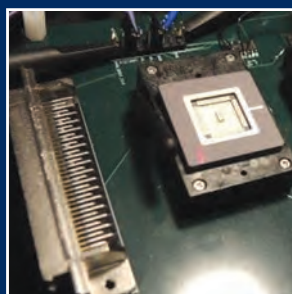
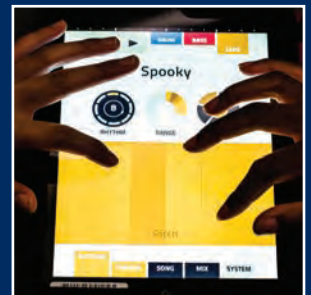
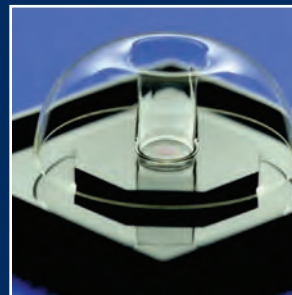
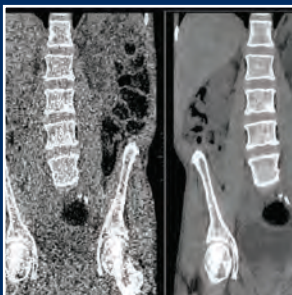
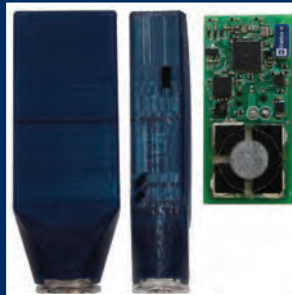
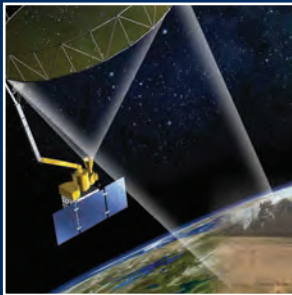
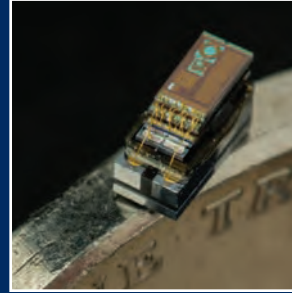
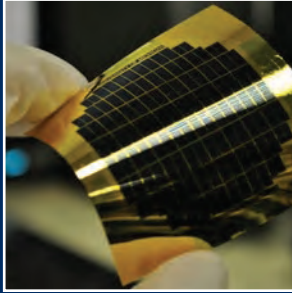
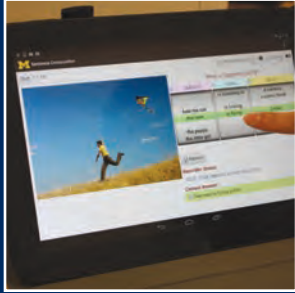


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Department of Electrical Engineering and Computer Science

THE UNIVERSITY OF MICHIGAN





Electrical Engineering and Computer Science

Electrical and Computer Engineering

1301 Beal Avenue
Ann Arbor, MI 48109-2122

Computer Science and Engineering

2260 Hayward Street
Ann Arbor, MI 48109-2121

EDITORS:

Catharine June, ECE
Steven Crang, CSE

CONTENT CONTRIBUTORS:

Danielle Hicks, Zach Champion

GRAPHIC DESIGNER:

Rose Anderson

PHOTOGRAPHERS:

Steven Crang, Catharine June,
Anthony Absi, Hyoving Won Baac, Zach Champion,
Danielle Hicks, Blake Livingston, Joseph Xu

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The Regents of the University of Michigan

Michael J. Behm, Grand Blanc
Mark J. Bernstein, Ann Arbor
Laurence B. Deitch, Bloomfield Hills
Shauna Ryder Diggs, Grosse Pointe
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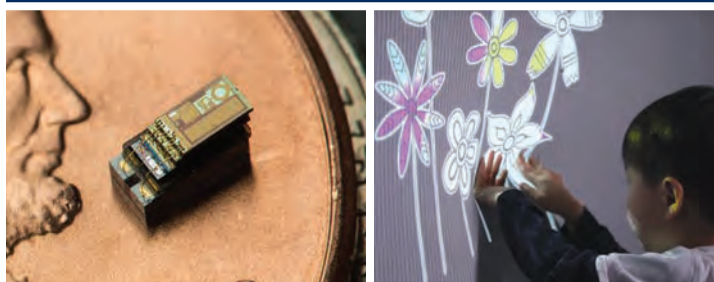
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Khalil Najafi, Chair
Electrical and Computer Engineering

Message from the Chairs



Marios Papaefthymiou, Chair
Computer Science and Engineering

Dear Alumni and Friends,

We hope you enjoy this latest review of what's been happening in the world of Electrical Engineering and Computer Science at Michigan. There's a lot to read and see – even more than usual because it's been two years since we last sent you our news magazine. Some of you have already told us you missed us!

The size of this publication gives tangible evidence of the challenges of dealing with the massive amount of data available to us. As EECS engineers, we are of course partly guilty of generating “too much data.” We have built the sensors that are capturing some of this data – and worked them into the world's smallest computers! Called the Michigan Micro Mote, they are currently on display at the Computer History Museum in CA, and being sent to researchers around the world to further research in this area.

But, we are also finding solutions to this problem through developing the databases, algorithms, architectures, and application tools that will allow us to harness and process mixed media data more effectively. One example is Sirius, an open source, end-to-end intelligent personal assistant that is enabling us to model future data processing requirements. Also in the realm of big data, the EECS Department and its faculty are part of two new initiatives to prepare students to enter this field while advancing research. A new undergraduate program in Data Science is launching this Fall in collaboration with the Statistics Department, and many EECS faculty are involved in the newly-launched Michigan Institute for Data Science (MIDAS).

We're excited to report on the Center for Dynamic Magneto-Optics (DYNAMO), where faculty from Michigan and several partner institutions will explore the magneto-electric conversion process more fully to see what may be possible. Can light really generate electricity without any thermodynamic loss? This is also the International Year of Light - and our Optics students and friends across campus are celebrating with year-long activities focused on outreach activities. As part of the celebration, we are hosting a Symposium on November 20, 2015 to celebrate 150 years since Maxwell's Equations.

Michigan's Mcity - the world's largest and most advanced test facility for the testing of automated vehicles - has gotten a lot of press lately. At EECS, researchers are working on a variety of projects that bring together artificial intelligence, vision systems and sensors, and other technologies that will help us to realize a future enabled by a more efficient transportation system. We

report on early projects here, and expect that you will hear much more about this activity in the future.

Fourteen new faculty have joined the department since our last newsletter, and more are coming even as we write. From young to senior faculty, they have already enriched our environment with expanded research and course offerings. Please welcome Mosharaf Chowdhury, Jason Corso, Reetuparna Das, Ronald Dreslinski, Cynthia Finelli, Odest Chadwicke Jenkins, Danai Koutra, Walter Lasecki, Harsha Madhyastha, Christopher Peikert, Vijay Subramanian, Leung Tsang, Jenna Wiens, and Louise Willingale!

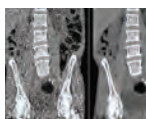
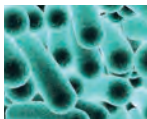
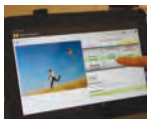
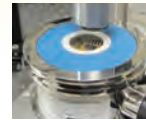
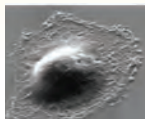
Enrollment has skyrocketed in the past couple years, especially in the area of computer science. Still, both divisions of EECS are committed to expanding the pool of young people interested in engineering, and to that end we have initiated pre-college summer camps with a focus on computer science and electrical engineering, respectively. With waiting lists for most of the classes and hundreds of happy campers, we are looking forward to expanding our efforts next summer.

Our students bring distinction to Michigan every day. From traveling abroad to help communities with their unique combination of compassion and engineering expertise, to reaching out to underrepresented minorities, to organizing new and maintaining existing student groups, and by winning awards and helping our interdisciplinary student teams be victorious, there is no way to adequately convey all that they do.

The same is true of our ~21,000 alumni. We would, however, like to specially congratulate Michael Stonebraker (MSE EE '66, PhD CICE '71) on receiving the 2014 ACM A.M. Turing Award, the Nobel Prize of computing, for his contributions to modern database systems. We have greatly expanded our efforts to connect all of our alumni with each other through regional events, and will be in touch with additional initiatives. We've briefly profiled a number of alumni in this publication and you are invited to follow links online to read full stories.

And to our colleagues and friends, we greatly appreciate our collaborations with many of you across the country and the globe. Solving the biggest problems we face will take all of us working together. Thank you all – alumni, colleagues, research partners, and friends – for being part of the Michigan Team!

Research Briefs



Integrated Systems and the Internet of Things

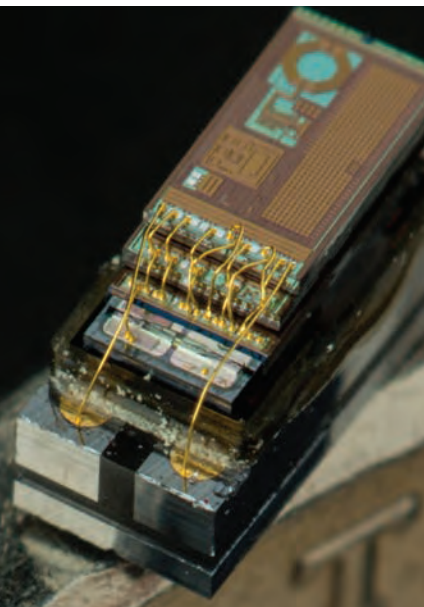
Michigan faculty are worldwide leaders in integrated circuits and systems, especially in the areas of energy-efficient circuits and complete miniature low-power systems. They have continued to break new ground by building the world's smallest computer, called the Michigan Micro Mote (M³). Key contributors to the M³ are Profs. David Blaauw and Dennis Sylvester for ultra-low power chip design and overall system design; Prof. David Wentzloff for low-power wireless communication; and Prof. Prabal Dutta for the integration interconnect and software programming environment.

M³: The World's Smallest Computer and the IoT

The Michigan Micro Mote has opened the door to a new class of computing with seemingly limitless applications. As fully autonomous computing and smart sensing systems, these devices are helping usher in the era of the Internet of Things (IoT), where people are connected to things and other people through the cloud.

Worldwide exploration of this line of research is being aided by the dissemination of hundreds of M³'s for trials in innovative applications. Michigan has been inundated with requests to adapt these devices for use in applications from monitoring concrete or oil wells to researching the behavior of snails.

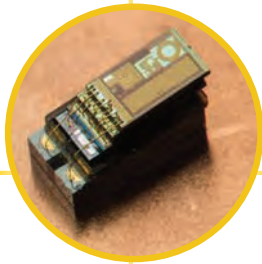
Full story + video: eecs.umich.edu/n/m3



M³ Computer with Imager

Millimeter-Scale Computing

The Michigan Micro Mote (M³) is the first fully autonomous computing system that measures less than a centimeter. It has the ability to accept input, process data, and provide output. The M³ acts as a smart sensing system. Multiple units can be used together to tackle bigger monitoring and sensing applications.



M³ Computer with Temperature Sensor

A Breakthrough in Power

M³ boasts ultra-low operating voltage and a unique standby mode with average power consumption of only 500pW. With a 1mm² solar cell producing 20nW, the device can harvest enough energy under ambient light to run perpetually.



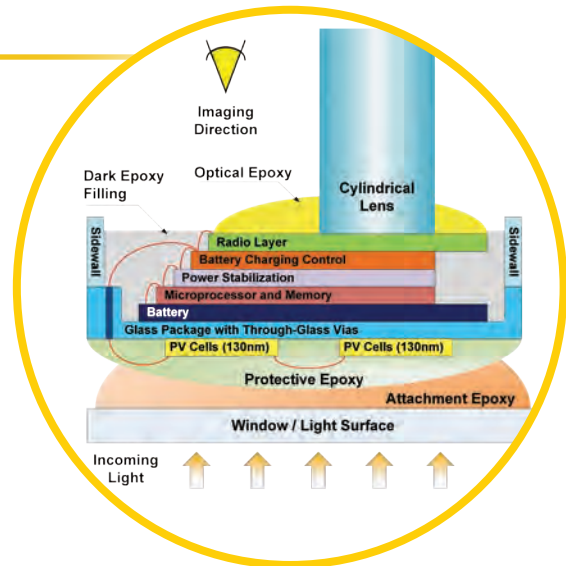
M³ Computer with Pressure Sensor

Sensors and the Internet of Things

The M³ computers can collect and transmit data as far as 2m, with planned ranges of up to 20m. This line of "smart dust" devices includes computers equipped with imagers, motion detection, temperature sensors, and pressure sensors. Several startups formed out of the M³ group seek to expand these applications and make the technology pivotal in realizing ubiquitous computing and the Internet of Things.

Each M³ Computer Contains the Following Layers:

1. Solar cell and optical communication photo cell
2. Harvester control electronics layer
3. Radio layer
4. Sensor interface layer (temp sensor and capacitive interface electronics)
5. Layer with capacitors for stabilizing the power supplies ("decap" layer)
6. Processor + memory + power regulation layer
7. Battery
8. Optional layer for specific applications, such as sensing pressure, temperature, taking photos, etc.



Communication between the various layers of the Michigan Micro Mote is enabled by the MBus interface.

Imagine Other Applications

Medical: Detecting Blood Vessel Blockage, Detecting Glucose Levels, Energy Management, Air and Water Quality, Monitoring Wildlife, Transportation, Machine Operation Status, Traffic Control, Environmental, Safe Drilling, Smart Home Systems, Industrial, Atmospheric Readings, Security, Home Automation, Chemical Composition.

More Uses

Mud-Fueled Smart Sensors for the Bottom of the Ocean

What else can you do with computers that need almost no electric power to run? Profs. David Blaauw and Dennis Sylvester, in collaboration with the Navy, created a system using M³ technology that allows them to monitor what's going on at the bottom of the ocean. The device is powered only by the miniscule levels of electricity generated from biological organic reactions of bacteria.



The Michigan Micro Mote has taken its place among other revolutionary accomplishments in the history of computing at the Computer History Museum in Mountain View, CA. It is currently on display, and is a big hit with K-12 visitors.



End of the Road for Von Neumann Architecture? Not Yet.

On the evening of December 16, 2014, computer architecture researchers assembled in the debating chamber of the University of Cambridge Union for a hot debate on whether or not the end of the road has been reached for the Von Neumann Architecture. The discussion was held as a part of MICRO-47, the premier forum for presenting, discussing, and debating innovative microarchitecture ideas and techniques for advanced computing and communication systems.

Bredt Family Professor of Engineering Trevor Mudge chaired the debate. The Motion was: This House believes that it is the End of the Road for the Von Neumann Architecture. After prominent researchers argued for and against it, the vote was against the motion.

Full story: eecs.umich.edu/n/vn

Prof. Trevor Mudge chairs the debate as U-M alumnus Kunle Olukotun addresses the assembly.

Can Our Computers Continue to Get Smaller and More Powerful?

From their origins in the 1940s as sequestered, room-sized machines designed for military and scientific use, computers have made a rapid march into the mainstream, radically transforming industry, commerce, entertainment, and governance while shrinking to become ubiquitous handheld portals to the world. It's progress that – until now – has been driven by our ability to pack more circuitry into smaller spaces.

In a project funded by the National Science Foundation, the Semiconductor Research Corporation, and the Air Force Research Laboratory and published in *Nature*, Prof. Igor Markov has reviewed limiting factors in the development of computing systems, asking “What are these limits, and are some of them negotiable? On which assumptions are they based? How can they be overcome?”

Limits that he identifies in the paper and expands upon include:

Limits related to materials and manufacturing – As we are now dealing with materials that are just a few atoms thick, further design shrinks will lead us to the realm of quantum physics.

Limits related to engineering – This includes design decisions, technical abilities, and the ability to validate designs, which can be aided by new software.

Limits related to power and energy – Energy can be saved by temporarily turning off parts of chips, and energy scavenging can power devices. But moving forward, silicon chips will not maintain the pace of improvement seen previously without radical changes.

Limits related to power and space – Traveling through copper wires and silicon transistors, a signal can no longer traverse a chip in one clock cycle today. Alternatives to copper wires must be developed now that transistors are faster than interconnections.

Several key **limits related to information and computational complexity** have been reached by modern computers, some of which are conjectured to be so difficult to solve that no proposed technology, not even quantum computing, promises consistent advantage.

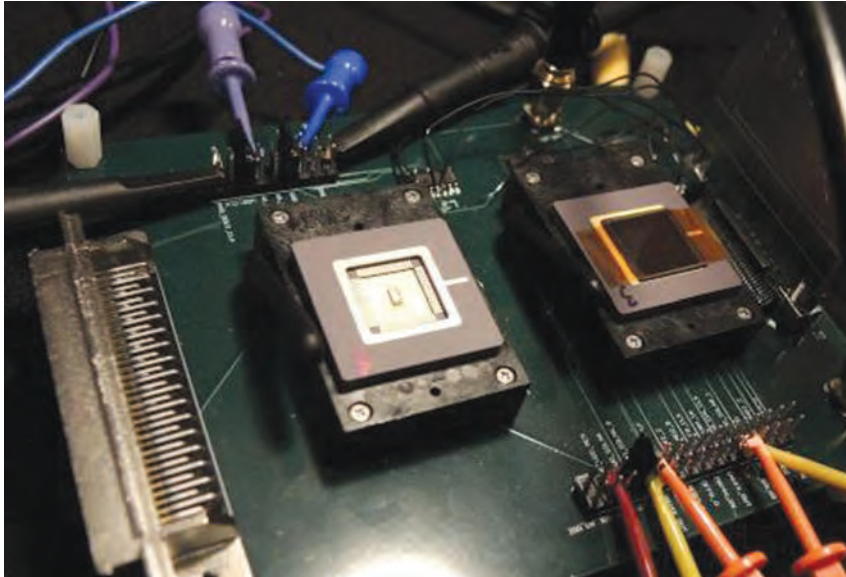
“Understanding these important limits,” says Prof. Markov, “will help us to bet on the right new techniques and technologies.”



Michigan Integrated Circuits Lab (MICL): Leaders in VLSI Circuits and Systems

Faculty of the Michigan Integrated Circuits Lab (MICL) are investigating very-large-scale integrated (VLSI) digital circuits, analog and mixed-signal circuits, wireless/radio-frequency (RF) circuits, as well as sensing systems built out of these components. They are the primary contributors to the Michigan Micro Mote, and are worldwide leaders in VLSI Circuits and Systems.

During the past eight years, MICL faculty have published the most papers of any single institution at the two leading circuits forums (*International Solid-State Circuits Conference on VLSI Circuits*). In 2014, they presented seven papers at the *Symposium on VLSI Circuits*, more than any other academic institution or company, and in 2015 that number rose to 13 papers. Topics ranged from image sensors, to bio circuits, and of course, low power circuits. Contributing faculty in 2015 include Profs. David Blaauw, Michael Flynn, Marios Papaefthymiou, Dennis Sylvester, David Wentzloff, Euisik Yoon, and Zhaohui Zhang – with Profs. Blaauw and Sylvester contributing to nine of those papers.



The chip is an ARM Cortex-M0+ running off a 0.09mm² solar cell that puts out 400 picowatts, thanks to novel circuits designed to suppress power leakage. Electronics360 also previewed the work, calling it a stand-out paper.

The paper, “Low Power Battery Supervisory Circuit With Adaptive Battery Health Monitor,” by Inhee Lee, Dr. Yoonmyung Lee, Prof. Dennis Sylvester, and Prof. David Blaauw, was selected as a 2014 Symposium Technical Highlight.

At the 2014 *VLSI Symposium*, Prof. Blaauw presented the talk, “Overview and Advances in Energy Efficient Digital Design” as part of a Short Course on Advanced Energy Efficient Digital Design, and Prof. Sylvester co-chaired a session during the past two years on Medical Imaging and Image Sensors.

This past year at the *International Solid-State Circuits Conference*, *EE Times* showcased a chip by Prof. Blaauw, Prof. Sylvester, and graduate student Wootae Lim in their review of some of the most interesting and cutting-edge products and research shown at the event.

5 in 5: Five major startup companies from MICL faculty and students in the past five years



Ambiq Micro

www.ambiqmicro.com

Ultra-low-power chip design

Founded: 2010

Founders: David Blaauw, Scott Hanson, Dennis Sylvester



Psikick

www.psikick.com

Ultra-low-power wireless sensor platforms

Founded: 2012

Founders: David Wentzloff, Benton Calhoun (U. Virginia)



Stryd

www.stryd.com

Wearable power meter

Founded: 2015

Founders: Robert Dick, Li Shang (U. Colorado)



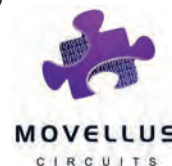
CubeWorks, Inc.

www.cubeworks.us

Millimeter-scale computing

Founded: 2013

Founders: David Blaauw, Prabal Dutta, Yoonmyung Lee, Dennis Sylvester, David Wentzloff



Movellus Circuits

www.movelluscircuits.com

Mixed-signal and ultra-low-power products

Founded: 2014

Founders: Muhammad Faisal, Jeffrey Fredenburg, David Wentzloff

Monitoring Sustainability With Low Cost Sensors

Prof. Prabal Dutta has been awarded a grant for his research in using scalable sensors to monitor resource consumption in buildings. Under the program, Dutta will develop advanced sensor technologies that will help to create progress toward the current Federal sustainability goals that mandate that 50% of U.S. commercial buildings become net-zero energy by 2050. A range of options exists to achieve this goal, but financial concerns require a data-driven, empirically-validated approach.

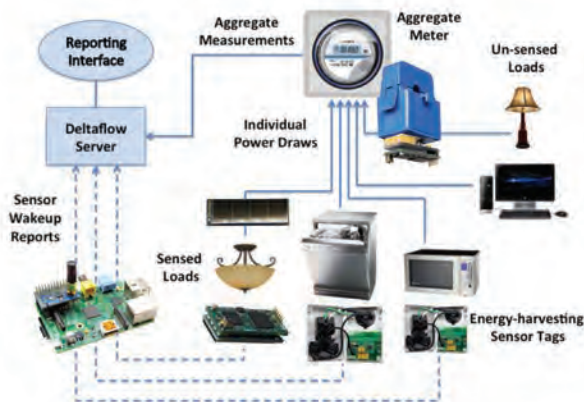
He will develop a class of low cost, networked “peel and stick” sensors that can be affixed to everyday objects to infer their contributions to whole-building resource consumption. The sensors will monitor the ambient conditions around

a load and, using statistical methods, correlate those conditions with readings from existing electricity, gas, or water meters, providing individual estimates without intrusive metering. The sensors will not require external power and will enable scalable deployment and widespread adoption.



An Eye on Securing the Internet of Things

Prof. Prabal Dutta is a founding participant in the Secure Internet of Things Project, a cross-disciplinary research effort between computer science and electrical engineering faculty at Stanford University, UC Berkeley, and the University of Michigan. The project will be focused on the new security threats that are emerging now that our phones, homes, hospitals, offices, ovens, planes, trains, and automobiles are on the Internet. The project will focus on producing analytics for IoT big data, the security of pervasive sensing and analytics systems, and the hardware and software systems that will make it easier to develop new intelligent and secure IoT applications.

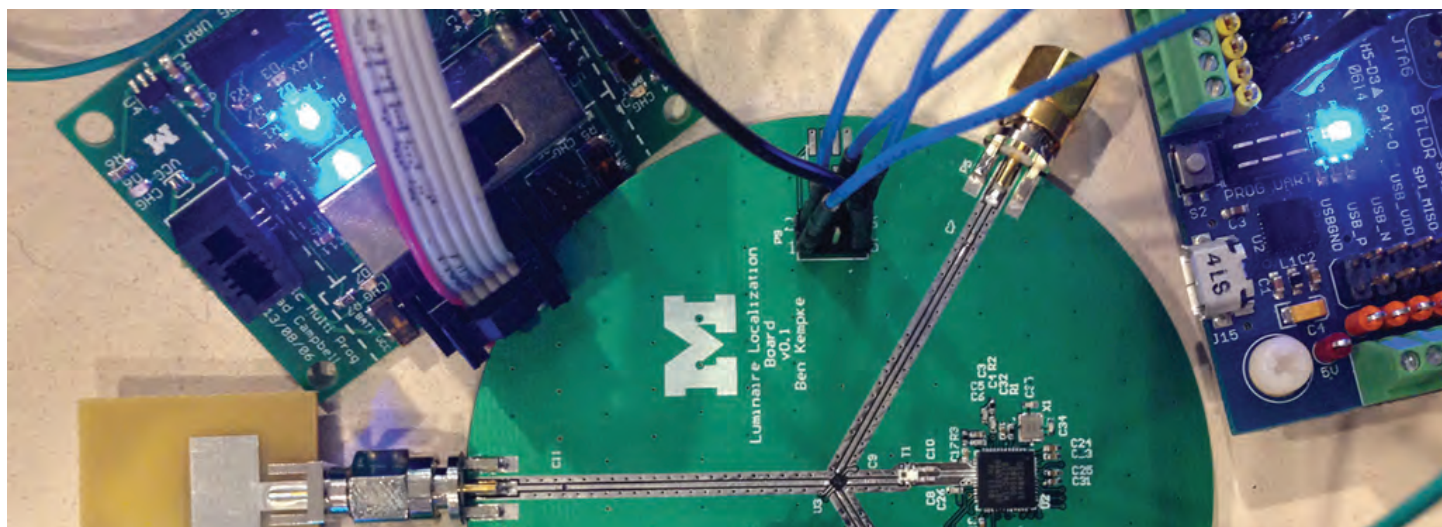


CE Research Lab to Explore the Bounds of Computer Integration

The new Computer Engineering Lab (CE Lab) at EECS is home to researchers who are looking to stretch the definition of how computational systems are designed and employed. The CE Lab is the successor to the Department’s Advanced Computer Architecture Lab (ACAL), which has long been the hub for multidisciplinary research into processor and system architectures, compilers, system reliability and runtime correctness, quantum information processing, CAD & VLSI, and related investigations.

According to lab director Prof. Valeria Bertacco, as computer systems have evolved both in terms of form factor and in functionality, the notion of architectural research no longer reflects the range of activity that takes place in exploring the future of computing systems. The CE Lab expands its vision as a home for investigators whose work ranges from the design of minute, networked, and energy-harvesting “smart dust” systems to full warehouse-scale systems that efficiently process massive amounts of rich and mixed data.

Full story: eeecs.umich.edu/n/celab





C-FAR Center Adds Investigators With Expertise in Processing Bigger Chunks of Data

The Center for Future Architectures Research (C-FAR), headed by Prof. Todd Austin, has added four new principal investigators to its membership. Profs. Mohit Tiwari (UT Austin), Martha Kim (Columbia), Daniel Sanchez (MIT), and Vikram Adve (UIUC) bring with them expertise in various fields of computer architectures research, including highly parallel and multicore systems.

C-FAR is focused on innovation to create future generation scalable computing systems and to enable whole new application areas. The \$28M, 5-year center opened in 2013 and is supported by the Semiconductor Research Corporation and other major firms.

Determining Sources of Error in SOC Systems

Researchers led by Brett Family Professor of Engineering Trevor Mudge have tackled the problem of determining sources of error in the testing of highly complex system-on-chip (SOC) computing systems, which generally include CPUs, caches, I/O and memory controllers, GPUs, and accelerators on a single chip.

Because of their complexity, SOC's are expensive to prototype, causing computer architects to rely upon simulation to evaluate new ideas in a timely and cost-effective manner. However, there is a tradeoff between a simulator's performance, accuracy, and flexibility that inherently leads to some amount of experimental error, and this error is



Prof. Trevor Mudge, Anthony Gutierrez, and Prof. Ron Dreslinski.

hard to account for. This makes it difficult for small research teams to validate and maintain complex simulators, and has resulted in a widespread use of open-source projects that may not be validated or are validated only for a specific purpose.

The researchers investigated sources of error in gem5 – a state-of-the-art computer simulator – by validating it against a real hardware platform: the ARM Versatile Express TC2 development board. While prior work typically considered only runtime accuracy, the researchers extended their investigation

to include several key microarchitectural statistics as well, showing that they can achieve accuracy within 20% on average for a majority of them. Their work in this area was recognized with a Best Paper Award at the 2014 IEEE International Symposium on Performance Analysis of Systems and Software.

PowerBlade: An Ultra-Miniature, Wireless Power Meter

AC plug load power monitoring can be used to reduce power consumption, but current implementations of plug load devices are often too large to be realistic for dense deployments. Graduate student researchers Sam DeBruin and Branden Ghena, together with their

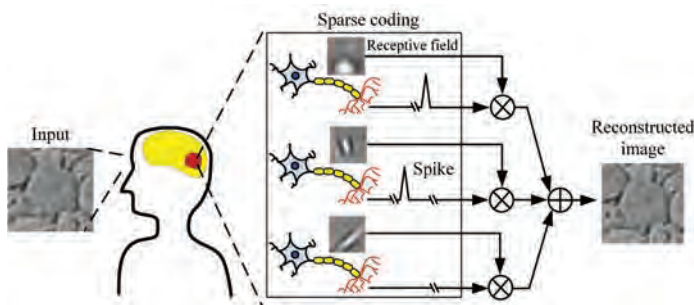


advisor Prof. Prabal Dutta and postdoctoral researcher Ye-Sheng Kuo, have developed PowerBlade to address this challenge. PowerBlade fits over an AC power plug and wirelessly provides power meter data.

PowerBlade is a single PCB that sandwiches in between a typical AC plug and a wall outlet. There are slots on the PCB face through which the plug's AC prongs slide before plugging into the outlet, and flexible tabs inside the slots make contact with the prongs. This allows PowerBlade to both acquire power for its operation and monitor the power supplied to the AC load. PowerBlade provides data wirelessly and in real-time, and multiple Powerblades can monitor a large installation.

Due to the direct relationship between power supply size and output current, miniaturization requires also reducing the power consumed in the device itself. Because PowerBlade's size is reduced to an extreme in order to fit between the plug and the wall, current draw for its operation was reduced to a budget of less than 1mA. PowerBlade operates using Bluetooth Low Energy (BLE), which can be read by commodity smartphones.

PowerBlade won the Best Environmental Impact Award in the Texas Instruments Innovation Challenge of 2015.



Smarter Processing for Computer Vision Applications

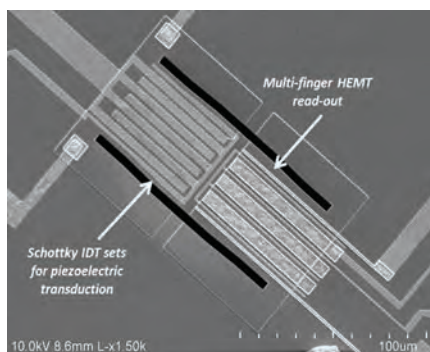
Great strides have been made in the field of computer vision by understanding how the human brain processes information and the role of neural networks in this process. Computer vision is used in a wide range of applications, including mobile devices and sensor nodes for context-aware image recognition, security cameras, and micro unmanned aerial vehicles (UAV) for wide-area surveillance.

One important difference between the way human neural networks and computers work is the way they process information. Neural networks operate in parallel to solve problems, whereas computers operate through a series of single instructions.

Implementing artificial neural networks on a computer for practical problems has not shown great promise due to interconnect complexities and the need for extremely high memory bandwidth.

Prof. Zhengya Zhang and his group are working to improve upon artificial neural network design through a process called sparse coding. Basically, if you keep the activity of the artificial neural network very sparse, sending only very important information, then you don't need to process as much information at a time, which enhances efficiency and saves power.

Prof. Zhang's group designed custom hardware architectures for efficient and high-performance implementations of a sparse coding algorithm called the sparse and independent local network (SAILnet). They also developed a 65nm CMOS ASIC to improve the process for feature extraction, a key problem in image processing.



Scanning electron microscope (SEM) of a GaN-based phonon trap with Schottky input electrodes and transistor based read-out.

New Materials to Power Sensing Systems

Prof. Becky Peterson is developing thin film transistors for power supplies that could potentially be used in a wide variety of wireless sensing and actuation systems, including those that deal with security and monitoring of the environment and medical conditions. She is investigating alternative approaches and materials with the goal of reducing the cost and complexity of manufacturing these devices.



Thin film transistors (left) and Schottky diodes (right) made in Prof. Becky Peterson's lab using amorphous Zn-Sn-O semiconductor layers.

"These devices could enable DC-to-DC converters (switched mode power supplies) for inexpensive microsystems using an ink-based, 'electronics-on-anything' heterogeneous integration approach," explains Prof. Peterson. "Such circuits are essential to power wireless sensing and actuation systems that must be ubiquitous, low-cost and lightweight, such as those used in equipment and supply tracking, security, medical and environmental monitoring." This research was funded by a DARPA Young Faculty Award.

Bringing Parallel Programming to Mainstream Programmers

Parallel circuits and processors have brought us more computing bandwidth. To make this more accessible, Prof. Satish Narayanasamy is bringing the power of parallel programming to mainstream programmers. Under his NSF CAREER grant, he is investigating solutions that span from processors to languages to shrink the space of legal thread interleavings in a parallel program and thereby simplify the task of the programmer in ensuring correctness. Eventually, by restricting the space of legal thread interleavings of a parallel program to the behavior of its equivalent sequential program, he may be able to get the best of both worlds: sequential semantics and parallel performance. If he could get there, programming for parallel processors may become as easy as it is now for sequential processors.



Developing Integrated Circuits for Specialized Sensors

Prof. Mina Rais-Zadeh is developing a Monolithic Microwave Integrated Circuit (MMIC) with GaN material that can be integrated with specially developed micro-resonators, filters, and oscillators with other GaN integrated circuits. The resulting devices are expected to enable sensors for use in harsh environments and high-speed wireless communications, among other uses. A key part of the research lies in understanding the phenomenon that results from the simultaneous presence of piezoelectricity and conductivity in the same crystal, using GaN resonators as test vehicles. This research was funded under the ONR Young Investigator Program.

Smarter Computer Processing Hardware for Intelligent Data Exploitation and More

As computer “brains” are able to process information more like human brains, which fire up multiple connections related to a piece of information all at once, they will be capable of faster and more advanced processing. Taking inspiration from how the human brain works, Prof. Wei Lu and his group have been developing memristor devices for neuromorphic computing. They are looking at how neurons are interconnected and share signals in order to replicate that process with memristive devices. The result will range from improved feature detection in video and images, to newer and improved techniques for chip design.

Memristors, named for their blend of memory and resistor, are electrical devices that remember, in a sense, when and how much current passes through them. That makes memristor devices ideal in hardware designs for intelligent computing.

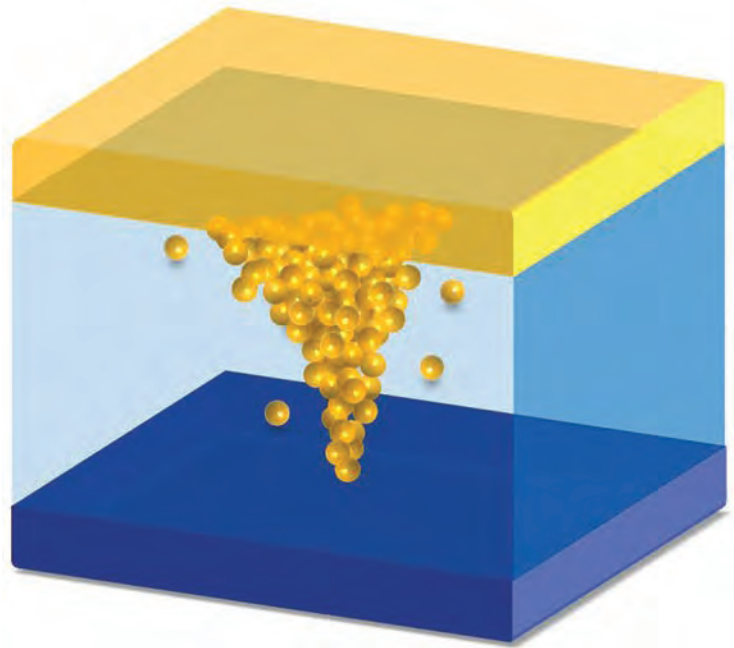
Prof. Lu is currently leading a large research effort, entitled “Sparse Adaptive Local Learning for Sensing and Analytics (SALLSA),” to build alternative computer hardware incorporating memristor devices that could process images and video 1,000 times faster with 10,000 times less power than today’s systems—all without sacrificing accuracy. Collaborators on this project include Prof. Zhengya Zhang and Prof. Michael Flynn at U-M, Dr. Garrett Kenyon at Los Alamos National Lab, and Prof. Christof Teuscher at Portland State University.

Dr. Lu expects the high-performance, power-efficient computer hardware developed in this program to find a wide range of applications from real-time processing of images and videos to other data-intensive tasks.

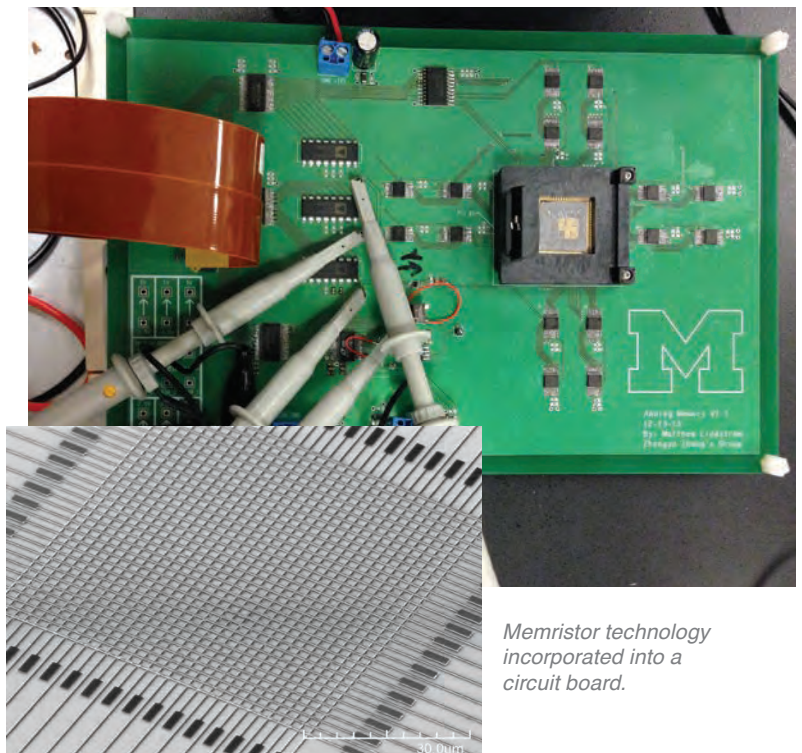
In related work, Prof. Lu and a team including colleagues at U-M and the Electronic Research Centre Jülich in Germany showed for the first time exactly how memristors “remember.” It was shown that the metal particles in memristors don’t stay put as previously thought.

“Most people have thought that you can’t move metal particles in a solid material,” said Prof. Lu. “In a liquid and gas, it’s mobile and people understand that, but in a solid we don’t expect this behavior. This is the first time it has been shown.”

In addition to advancing memristor technology, these results could lead to a new approach to chip design—one that involves using fine-tuned electrical signals to modify the physical connections in integrated circuits after they’re fabricated.

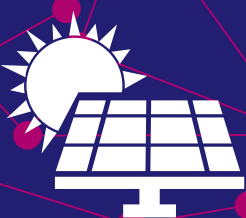
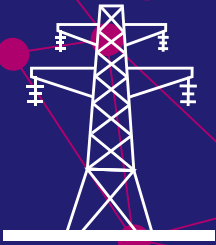


An illustration of metal particles moving to form a conducting filament in a memristor, which is a next-generation computer component that combines memory and logic functions.



Memristor technology incorporated into a circuit board.

Controlling Our World With Cyber-Physical Systems



economic markets

transportation

healthcare

building design and automation

emergency response

agriculture

energy

manufacturing

Through a rapidly expanding matrix of embedded sensors and networks, electronic devices are measuring the conditions of our world. Based on that information, these devices are making decisions that impact physical devices. Complete systems that consist of physical objects and cyber/computational elements, with continual communication between the two, are known as Cyber-physical systems.

Cyber-physical systems (CPS) are smart networked systems with embedded sensors, processors and actuators that are designed to sense and interact with the physical world (including human users). They support real-time and guaranteed performance in safety-critical applications.

CPS are expected to impact most every area of interest to society

They are found in the automated processes embedded in modern automobiles (such as automatic cruise control), and in the components used for electrical power generation in various transportation systems (airplanes, automobiles, trains). In fact, they are being proposed for virtually all large systems that can be monitored and controlled electronically, including energy distribution on the grid, transportation systems, and even energy markets.

Faculty at Michigan are working on several NSF-funded CPS projects that impact specific systems, while developing a more generalized theory that will allow for increased scaling of cyber-physical elements in any cyber-physical system.

From Adaptive Cruise Control to Driverless Cars

Each year, automotive manufacturers add features of convenience as well as safety to the already complex interplay of electronics found in today's vehicles. These features incorporate a complex mashup of software, sensors, and control algorithms that allow an automobile to read the physical relationship between it, other traffic, and the road – and then act in a split second to maintain a safe following distance or keep the car centered in its lane.

One safety feature, electronic stability control, or the ability of a car to automatically detect when steering control has been compromised, has been required for all new cars since 2012. The U.S. National Highway Traffic Safety Administration (NHTSA) estimates that this feature may prevent up to one third of all fatal car accidents.

Adaptive cruise control (ACC), or the ability of the vehicle to automatically keep a safe distance from a vehicle in front of the car, is another form of automation that improves driver safety. However, adding this and more advanced features, such as ACC plus lane keeping, adds enormous challenges for the control engineers who must integrate all of the vehicle's automation features. The process already involves extensive, time-consuming testing and re-testing. With more features, there's no way to do enough testing to make the system safe.

Achieving the ultimate goal of driverless cars will require a new paradigm in how engineers design these systems.

Prof. Jessy Grizzle and Prof. Necmiye Ozay, with colleagues in Mechanical Engineering as well as UCLA and Texas A&M, are taking a fresh approach to the problem of how to incorporate increasingly complex automated features into an existing cyber physical system. They are doing this by combining formal methods, control theory, and correct-by-construction software synthesis.

In addition, their goal is to have clear and public specifications of a system so that two different automotive suppliers, for example, would be able to design the same type of software system for the same vehicle. Currently, there's no guarantee that the software of one system will work well when placed in the same vehicle with another system because all design and testing is done in-house by each car company. There is no sharing of information. With clear specifications, automobile software systems could be mass produced for many different automobile manufacturers.

“We’ve had cyber physical systems in cars that helped them run more efficiently. But this didn’t impact safety,” said Jessy Grizzle, who is the Elmer G. Gilbert Distinguished University Professor and Jerry W. and Carol L. Levin Professor of Engineering. “But now we’re deploying systems where any failure in the software design means you get hurt. And that’s changing things in a hurry.”



Theory: Ensuring Efficiency and Safety in CPS

Cyber-physical systems are dynamic, ever-changing systems. There might be an infinite number of possible actions that could impact how we want a system to respond. With the advent of inexpensive, reliable, sensitive, and compact sensors ready to detect changes in a system or environment, researchers are aggressively pursuing ways to incorporate these sensors into automated systems.

But as more and more automated features are added to a cyber-physical system, the system itself often becomes less reliable. Also, the lack of a proven theory means developers of new systems must rely on an extremely time-consuming stage of testing and verification.

“Cyber-physical systems consist of discrete and continuous entities in the same system,” said Prof. Necmiye Ozay. “There are communications protocols, computing, dynamics, and moving objects. We have tools to analyze different pieces of the puzzle individually, but there’s no single theory as to how to put them all together.”

Prof. Ozay, Prof. Stéphane Lafortune, and other faculty at the University of Michigan are creating new mathematical principles, even new paradigms, for how to build a CPS that is safe for society in a reasonable period of time.

“We’re trying to formulate things using mathematical models so that we can do analysis and verification, and discover potential bugs prior to these systems being implemented,” Prof. Lafortune explained. Verifying and correcting with certainty any dangerous potential glitches in controllers will facilitate the safe application of CPSs in transportation, medicine, energy markets, and any other potentially hazardous or sensitive areas.

Prof. Necmiye Ozay is attempting to develop algorithms that will actually design the controllers and software for us. This theoretical work in algorithmic synthesis of controllers is called correct-by-construction. Correct-by-construction is a means of developing control software that is mathematically guaranteed to function correctly simply by virtue of the manner in which it was designed.

“Instead of analyzing a manually-designed controller for a system, I develop and analyze algorithms that can design controllers,” said Prof. Ozay. “I analyze the algorithms and try to prove that the algorithms will always be correct.”

It is critical that these algorithms are always correct, with cyber-electrical components being introduced into airplanes, ships, trains, and spacecraft as well as automobiles. Specifically, hydraulic, pneumatic, and mechanical systems are being replaced with cyber-electrical components used for electrical power generation and distribution.

However, just like with automated safety features in automobiles, incorporating these elements while ensuring system safety has been enormously challenging. The lack of a systematic approach cost Boeing billions of dollars due to long delays associated with development of the Boeing 787.

“If we can reduce the time it takes to test complex systems, such as the Boeing 787, and prove some parts analytically,” said Prof. Ozay, “maybe we can shorten the time for a product to go into the market from a year to perhaps a month.”



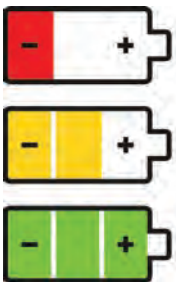
Smart Intersections

According to the U.S. Department of Transportation Federal Highway Administration, intersections represent a disproportionate share of traffic safety issues and are a national, state, and local priority. Prof. Stéphane Lafortune is trying to help drivers get through intersections safely by developing a system that will sense all of the traffic approaching an intersection and provide each driver with a range of speed at which they can safely traverse the intersection. Using control theory called discrete event systems (DES), he developed collision avoidance algorithms to manage the system. The two key conditions of the algorithms are that the control laws must be provably correct, because lives are at stake, and that the control systems allow maximum driver independence.



The more drivers that are equipped with sensors and embedded computational and communication resources, the more successful his approach will be. Yet his algorithms were already shown to work in scenarios in which not all drivers were so equipped.

“We’re trying to formulate the control software for smart intersections using mathematical models so that we can do analysis and verification, and discover potential bugs prior to these systems being implemented,” said Prof. Lafortune. “The system works like creating virtual traffic lights. Before you get to the intersection, your car would talk to a traffic controller, and you tell the controller what you plan to do. You are then given a range of speed to maintain in order to make it safely through the intersection.”



Vehicle Electrification: Keeping Those Batteries Going

Hundreds or even thousands of cells are currently used to power electric and hybrid-electric vehicles. The longer we can extend the battery life in those systems, the more useful and less expensive these automobiles will become to the average consumer. Kang Shin, Kevin and Nancy O'Connor Professor, is taking a cyber-physical perspective to optimizing battery life in electric vehicles by integrating and coordinating physical dynamics and adaptive controls.

Prof. Shin and collaborators developed an improved battery management system by focusing on battery discharge/charge rate, which has been reported to be among the most critical components to battery life. For example, a continuous exposure to high discharge current,

which occurs upon acceleration, will degrade the capacity of the battery relatively quickly, which in turn shortens battery life.

The researchers developed a new battery discharge/charge rate management scheme that significantly outperforms existing battery management schemes.

In related work, Prof. Shin is looking at other issues that impact battery life, such as temperature and the impact of weak battery cells on the stronger cells. The same battery management system must be adaptable to a car running in the middle of summer in Phoenix, AZ as well as a car in Anchorage, Alaska. And, it should bypass weak fuel cells at specific times of operation or recharging in order to take advantage of the strength of the good cells.



A Smart-er Grid

The U.S. power grid was named the greatest engineering achievement of the 20th century by the National Academy of Engineering. However, by 2003, the year of the U.S. and Canadian blackout, it was deemed “aging, inefficient, and congested, and incapable of meeting the future energy needs of the Information Economy” by the U.S. Department of Energy.

The blackout was caused by a sagging power line and some overgrown trees that set off a chain reaction that turned out the lights from New York City to Ontario. The fatal cascade of tripped circuit breakers and straining power lines overloaded the grid and put 50 million people in the dark.

The cascade was exacerbated when alerts from the grid’s alarm system failed to get through to system operators. If the operators had recognized the warning signs at the outset of the cascade they could have shifted generator output, leveraged storage, or altered load levels to mitigate overload on other transmission lines.

While advanced power electronics are helping modernize the physical backbone of the grid, faculty like Ian Hiskens, Vennema Professor of Engineering, are making improvements from a cyber-physical perspective to ensure this doesn’t happen again.

“One of the things I’m looking at,” said Prof. Hiskens, “is what to do when a transmission line is taken out of service – whether by a storm or something more sinister. A sensor would recognize that there is a problem, and then figure out how to maximize the available resources in order to maintain service to customers.”

Prof. Hiskens created a working model for electricity distribution in the face of grid problems that takes into account customer demand, power supply available from renewable sources, temperature, even weather forecasting. Solutions minimize the overload on other lines, perhaps by using stored energy or altering load levels, while making sure the temperature of the conductors doesn’t rise enough to cause the transmission lines themselves to begin to sag.

His model addresses not only physical interruptions in a line, but any event that causes the system to fail, including an overload in demand. He is also creating algorithms to deal with smaller problems in localized areas.

More recently, Prof. Hiskens has been investigating how to deal with problems specifically in the communications network. “If the algorithms are making certain control decisions and transmitting that information but it’s never being received by the control center of the large-scale communications network, then wrong decisions might end up being made – which could cause a cascade of problems,” he said. The ultimate goal is to implement a robust CPS that ensures the grid’s continued economy while simultaneously improving its resiliency in the face of any problems.



A Fair Price for Energy

The \$220B electricity industry, once a government-controlled monopoly, has been adapting to the effects of deregulation since the 1990's. The impact on consumers has been mixed – some consumers have benefited, while others in different areas of the country have even tried to ban deregulation in the face of rising costs, skyrocketing demand, and insufficient supply. The introduction of renewable energy sources, such as wind and solar, into the current infrastructure that was originally designed for conventional energy sources, only adds to the complexity of the energy market.

“The energy-generating companies want to maximize their profits, even at the expense of using clean renewable energy,” said Prof. Demos Teneketzis. “Our research is trying to create regulatory rules that reward companies for generating electricity, but also incentivize them to align their interests with the social good.” This generally means maximizing renewable energy sources while keeping costs down for consumers and profits reasonable to sustain the industry.



Prof. Teneketzis is working on the problem from the perspective of marketplace incentives. Models for determining market costs for either renewable or conventional energy sources have been in existence, but he is looking at the problem from the unique perspective of an energy seller who has the capability to deliver energy from both sources. To create new models, he has integrated control theory, the theory of incentives, and game theory.

“Coupling control with game theory and the theory of incentives is something that has not been considered within the context of CPS before,” Prof. Teneketzis said.

Game theory is about strategic decision making using logic and mathematics to help determine the best strategies for securing optimal outcomes for all participants. The “games” in question always involve a situation in which there is a conflict between the self-interest of each participant, and the interdependence necessary to achieve optimal outcomes for all.

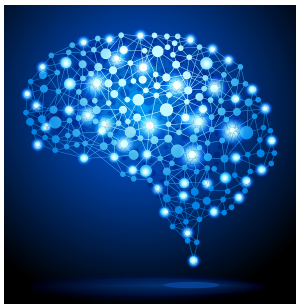
Prof. Teneketzis devised an auction format that takes into account the amount of energy produced, the price per unit companies intend to charge, the variable nature of alternative energy sources, and even, indirectly, the private information held by companies. Based on the interplay of these and related factors, a fair price is determined that allows the grid to operate at peak efficiency.

Cyber-Physical Security

The information generated by sensors in a cyber-physical system is often sensitive. We may not want others to know our location, or our health history, or where energy is coming from and going to on the grid. When that data is attached to a computer that's impacting a physical object, like a car, the issue of security becomes acute for one's own personal safety.

Several EECS faculty are working to secure the data collected and transmitted in a CPS. Prof. Necmiye Ozay is working to make sense of the non-homogeneous and high-dimensional data that feeds into these systems, drawing from system theory to improve monitoring, diagnostics, anomaly, and change detection in CPS. Profs. Alex Halderman and Stéphane Lafortune are addressing privacy concerns in cyber-physical systems through their work with the TerraSwarm Research Center based at UC-Berkeley. TerraSwarm is addressing the huge potential (and associated risks) of pervasive integration of smart, networked sensors and actuators into our connected world. Prof. Atul Prakash is working on projects that involve the collection of sensitive data, and devising strategies to secure the data. And Prof. Prabal Dutta is helping secure sensing and analytics as a founding member of the Secure Internet of Things Project with faculty from Stanford and UC-Berkeley.

Health and Medicine



In 2013, the White House called for a national project to unlock the mysteries of the brain, called the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative.

“The challenge is to map the circuits of the brain, measure the fluctuating patterns of electrical and chemical activity flowing within those circuits, and understand how their interplay creates our unique cognitive and behavioral capabilities,” stated the BRAIN Initiative Working Group.

Researchers in the field have long believed that new ways to treat, cure, and even prevent brain disorders such as Alzheimer’s, Parkinson’s Disease, and Epilepsy, will be possible once we have a better understanding of how the brain works. Technology is now at a point where this is becoming possible.

Mapping the Brain With Light

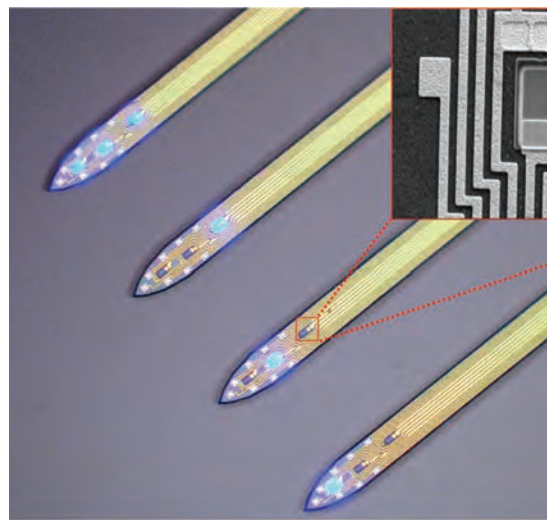
Researchers are developing next-generation neural probes in an attempt to unlock the secrets of neuronal networks in the brain. The probes make use of a revolutionary new technique known as optogenetics to control neurons through the application of light.

With a network of around 100 billion individual neurons powering the human brain, understanding how neurons work together is a monumental task. Nevertheless, “Until you understand how the neural circuits work,” says Prof. Euisik Yoon, “you won’t know how to go about treating a disease.”

“We’re trying to map specific locations in the brain in order to treat different conditions,” explained collaborator Prof. Kensall D. Wise, William Gould Dow Distinguished University Professor Emeritus. “This research is about one day understanding and treating Alzheimer’s, blindness, and

deafness – it is about reactivating paralyzed limbs or detecting the onset of an epileptic seizure and suppressing it before it becomes apparent. That is our dream for this technology.”

The research is being enabled through the BRAIN Initiative. Also collaborating on the project is György Buzsáki, Biggs Professor of Neural Sciences at the New York University of Medicine.



Revealing the Brain’s Secrets

Prof. Raj Nadakuditi is pursuing research that will impact our ability to investigate the structure of brain circuits through the use of optical imaging techniques. He is developing a method that will mitigate the loss in image quality due to the multiple scattering of light in non-transparent media. This method involves exploring the theoretical limits of imaging using highly-transmitting eigen wave fronts, and then designing specially created algorithms that will enable dramatic gains in transmitting power and penetration depth. “The increased transmitted power will amplify the optogenetic or fluorescent effect,” says Prof. Nadakuditi, which are typical methods used to reveal the basic structure and operation of the brain deep below the brain surface. To test and refine his theoretical predictions, Prof. Nadakuditi is collaborating with Prof. Eric Michielssen, a renowned expert on computational electromagnetics. In theoretical research directly related to this research, Profs. Raj Nadakuditi, Eric Michielssen, Stephen Rand, and graduate student Curtis Jin developed theory and algorithms that can mitigate or even overcome loss in transmission power due to the scattering of light in non-transparent media. Their research was motivated by bio-imaging applications such as brain imaging. This research was funded by an NSF CAREER Award.



Fighting Lung Cancer With Faster Image Processing

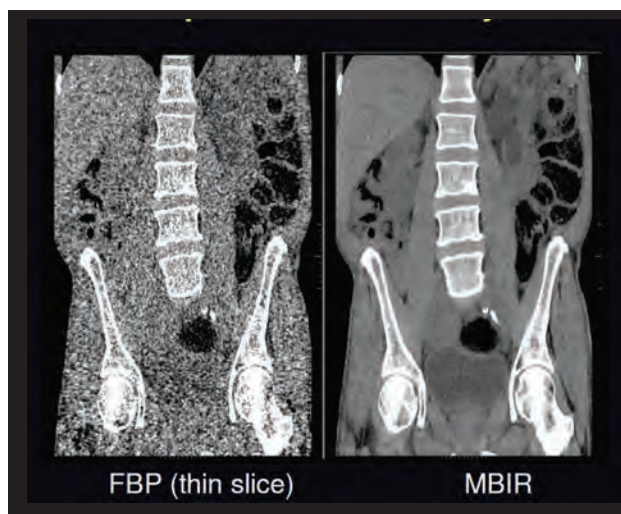
A new \$1.9 million research program led by Prof. Jeff Fessler seeks to make low-dose computed tomography scans a viable screening technique by speeding up the image reconstruction from half an hour or more to just five minutes. The advance could be particularly important for fighting lung cancers, as symptoms often appear too late for effective treatment.

In December 2013, the U.S. Preventative Services Task Force recommended lung cancer screens for everyone between 55 and 80 years old who has been a smoker within the past 15 years. Roughly 90 percent of cases are related to smoking, and the health care costs are approximately \$12 billion per year in the U.S.

Unfortunately, the CT scans that reliably identify tumors by creating 3D images of the lungs also expose the patient to an X-ray dose comparable to about five to eight months' worth of natural background radiation.

"It's known that a radiation dose can increase the risk of cancer, but nobody knows exactly how much," said Prof. Fessler. "Reducing the radiation is like setting a very short shutter speed on your camera. You'd get a grainy picture, but you could use Photoshop to try to get a better image. The data processing needed for low-dose X-ray CT is far more complicated."

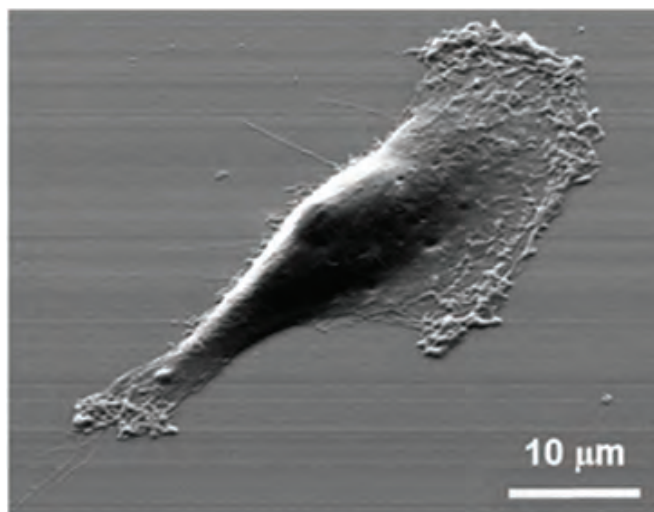
At present, it takes 30-60 minutes to reconstruct the low-dose images for diagnosis. That is impractical when the scans themselves take just a few minutes. Through this new project, Prof. Fessler and collaborator Prof. Thomas Wenisch aim to cut that processing time down to five minutes by taking advantage of multicore computing.



What Makes Cancer Cells Spread?

Cancer becomes deadly when it spreads, or metastasizes, yet not all cells have the same ability to travel through the body. Prof. Euisik Yoon and his team are collaborating with faculty and students with expertise in general medicine and oncology to understand the difference between cells that stay put, and cells that break out of a tumor and move throughout the body.

"Using advanced micro-fabrication technologies, we can create micro-structures comparable to the size of cells. Living cells can then be manipulated on-chip at single-cell resolution. Using this technology, we can investigate the differences among individual cancer cells, while conventional approaches can study only the collective average behaviors," says Dr. Yu-Chih Chen, a postdoctoral researcher working with Prof. Yoon.



In a test using aggressive metastatic breast cancer cells, the researchers were able to sort the cells based on their motion, collect the sorted cells and send them through the specially engineered device again. The cells maintained the same highly mobile characteristic upon repeated testing. The researchers also found that the more mobile cells had the characteristics and appearance under the microscope of metastatic cells and expressed significantly higher levels of markers associated with metastatic cancer.

After further testing, the device is expected to be used in the field to increase our understanding of why some cancer cells leave the primary tumor. With this understanding, doctors can begin to develop anti-metastatic strategies.

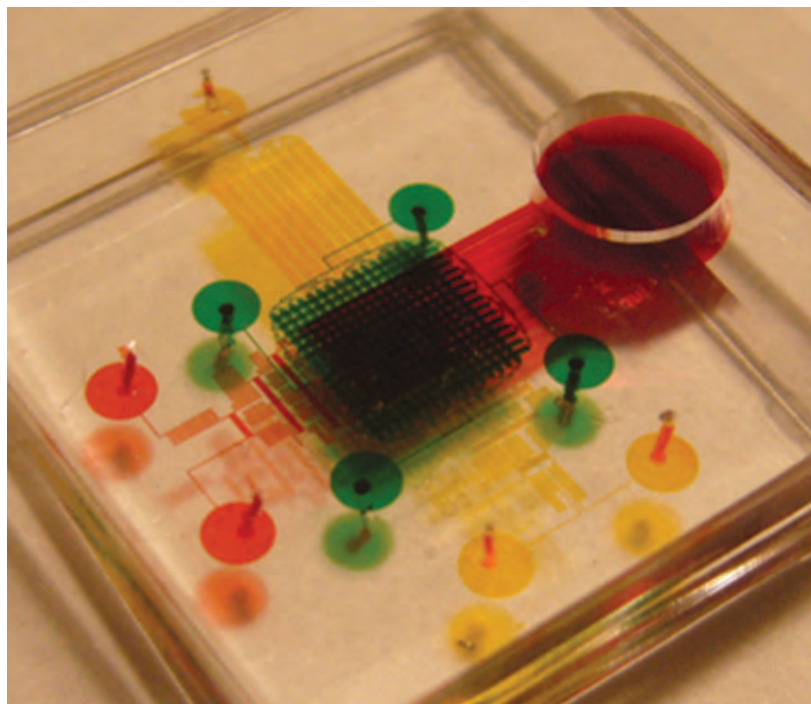
Full story: eecs.umich.edu/n/cancer

Biochips for Better Cancer Therapy

Prof. Eusik Yoon and his group are working to dramatically accelerate progress in a form of cancer therapy known as photodynamic therapy (PDT). PDT combines light, oxygen, and a photosensitive drug to attack cancerous tumors and lesions in a targeted region of the body by selective optical illumination. To accomplish this feat, the group is using a “lab-on-a-chip” measuring about the size of a quarter, with a 5x5mm testing area. This lab-on-a-chip will test the interaction of the drug, light, and oxygen simultaneously, generating results in a fraction of the time of current testing practices.

“In cancer research, doctors are always looking for better drugs,” explained Dr. Xia Lou, a postdoctoral fellow in Prof. Yoon’s group. “But there has always been a lack in the ability to efficiently test new drugs. We are providing more precise drug test conditions to insure that the results we are getting will more closely match the actual results from cancer treatment.”

Full story + video: eecs.umich.edu/n/biochips

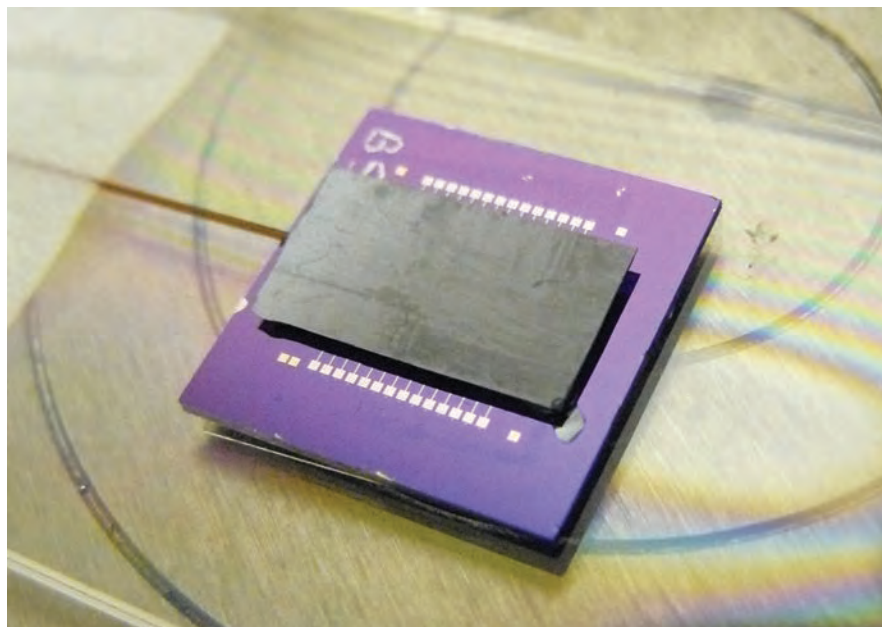


New Graphene Sensor Technology for Personal and Environmental Health

A new wearable vapor sensor being developed by Prof. Zhaohui Zhong and Prof. Sherman Fan (Biomedical Engineering) and their students could one day offer continuous disease monitoring for patients with diabetes, high blood pressure, anemia, or lung disease. It would likely be the first wearable device to pick up a broad array of chemical, rather than physical, attributes.

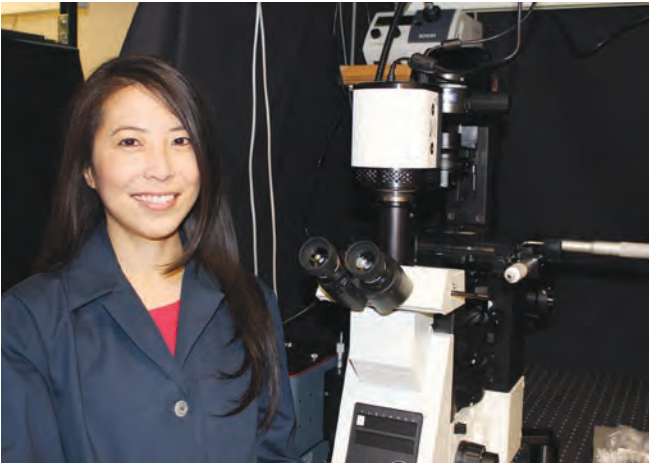
The sensor can detect airborne chemicals either exhaled or released through the skin. Chemicals it could detect include nitric oxide and oxygen, which are measured to detect high blood pressure, anemia, or lung disease.

The sensor would also be able to register the presence of hazardous chemical leaks in a lab or elsewhere, or provide data about air quality. “Instead of detecting molecular charge, we use a technique called heterodyne mixing, in which we look at the interaction between the dipoles associated with these molecules and the nanosensor at high frequencies,” said graduate student Girish Kulkarni.



This technique, made possible through the use of graphene, results in extremely fast response times of tenths of a second, as opposed to the tens or hundreds of seconds typical in existing technology. It also dramatically increases the device’s sensitivity. The sensor can detect molecules in sample sizes at a ratio of several parts per billion. The researchers are working with NSF’s Innovation Corps program to move the device from the lab to the marketplace.

Full story + video: eecs.umich.edu/n/graph2



Smart Nanodevices for Tunable Nanomedicine

Prof. Somin Eunice Lee is developing improved methods for gene therapy by delivering corrected genes directly to the cell nucleus of damaged genes more efficiently and with greater control than is currently possible.

Current research has focused on viral and non-viral techniques to transport genes, each of which have critical drawbacks. Prof. Lee aims to develop configurable plasmonic nanoantenna architectures to deliver genes efficiently and specifically to the cell nucleus, without impacting neighboring cells, using optical transport, or light. This method for efficient and specific delivery of corrected genes should lower required dosages and minimize unwanted side effects.

This research will also provide a better understanding of tissue formation, and may one day lead to new strategies to engineer functional replacement tissues, such as lungs, organs, and glands. This research was funded by an NSF CAREER Award.

Will I Get Sick?

Prof. Al Hero has been applying big data analysis to an ongoing project related to personalized health and early detection of symptomatic infection. In a collaboration with faculty from various fields and institutions, he was able to find a wide gap in immune responses of people who did or didn't get the flu after exposure after discovering hidden patterns in a large amount of genomic, proteomic and metabolomic data from a cohort of individuals. A new project, funded by DARPA, will continue this line of research by collecting an unprecedented diversity of data from healthy individuals whose state is perturbed by exposure to a virus. The individuals will be continuously monitored with wearable electronic devices that are able to detect a wide variety of physiological signals including motion, temperature, heart rate variability and electrodermal conductance. This data will be combined with molecular, clinical and cognitive data to derive a baseline of health and characterize multimodal host immune response.



Apps for Health

Prof. Jasprit Singh believes mobile apps can help change lives for the better, and he's built platform technology to help make it happen. Singh and his colleague John Hinckley have consulted with a number of U-M researchers on the development of mobile apps, and by creating a general platform, they can reduce costs and turnaround time.

"It's still relatively unknown to many that you don't have to be a coder to get into the area of app production," said Prof. Singh. "And you don't need \$100,000 to create an app. If you have good ideas and a small amount of funding, you can create an app for as little as \$5,000."

Prof. Singh helped Prof. Daniel Eisenberg, Department of Health Management and Policy, build Tinyshifts, an app that actively prompts users to answer questions about their mental health issues. Based on their responses, the app then recommends short videos, some of which are produced by U-M students.



The Growing Role of Data in Healthcare

The use of data is reshaping the realm of healthcare in dramatic ways, with big data techniques such as machine learning, image processing, and new ways of querying databases allowing us to extract new and actionable knowledge from patient records and other data repositories.

EECS researchers are increasingly forming collaborations with medical and public health researchers in a data-driven effort to create a more holistic, predictive, secure, and interactive model of patient and population health – one in which diagnosis, care, and patient outcomes are significantly improved.



DISCOVERY

Building a Database That Works the Way Medical Researchers Do

Databases are home to lots of medical big data, from electronic medical records to diagnostic and monitoring data. The ability to query and investigate that data is critical, but medical data is often “noisy,” inaccessible, or incomplete: there can be missing records, some data is not always entered or transcribed consistently, and there are privacy concerns.

Traditional databases operate from the assumption that data is clean and the person querying it knows exactly what they want, but much of what medical data researchers do – including searching for previously unnoticed connections – calls for a different type of querying experience than traditional databases tend to support.

In a study being conducted with Prof. Ivo Dinov at the U-M School of Nursing, Prof. Barzan Mozafari is developing a process called Stochastic Query Processing which allows databases to be queried in new ways.

Traditional databases use a number of heuristics to determine what plan will take you to the data you need. They examine equivalent query possibilities and pick one approach to execute with the assumption that all paths lead to the same answer. Stochastic Query Processing intentionally pursues multiple plans with the idea that they may provide different answers. By comparing and combining this range of results, answers can be provided more quickly and more accurately while compensating for missing data.

Prof. Mozafari published findings on a system for Stochastic Query Processing at the *Conference on Innovative Data Systems Research*, which shows that a system that pursues varying approximations and which learns from past queries reduces query time and improves accuracy significantly.



DISCOVERY

Wearables Track Genesis and Spread of Disease

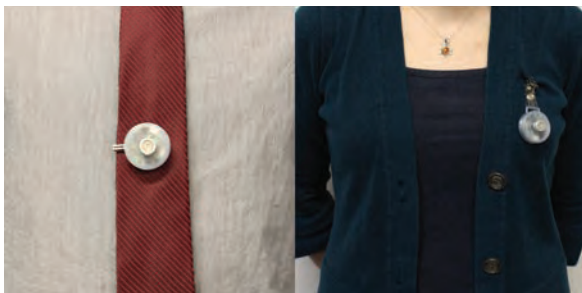
Public health officials are always on the lookout for infectious disease outbreaks and the source of those occurrences. A constant challenge for these researchers is to establish accurate ground truth for epidemiological monitoring and modeling.

In a project funded by the Centers for Disease Control and Prevention, Prof. Prabal Dutta investigated how small wearable devices can provide the data that will provide for more accurate and timely understanding of the spread of diseases.



Prof. Dutta led development of a small lapel pin, called Opo, that is designed to allow researchers to reconstruct the physical social network and the physical interaction space between people, including the duration of the contact and the temperature and humidity that is ambient in the environment during contact. This collection of face-to-face and other proximity data allows for reconstruction of disease outbreak scenarios.

Opo runs for 4 days on a battery the size of a Chiclet. Opo tags are around 3 cm in diameter and weigh 8 grams, making them easily wearable. Opo remains asleep until pinged and uses a novel ultra-low power ultrasonic wakeup circuit to synchronize nodes, bypassing challenges faced by traditional RF synchronization.



The CDC project used only RF frequencies for measuring distance between people and for communication. Recognizing that ultrasonic sound waves could be combined with RF to enhance measurements of distance, Prof. Dutta extended the project and teamed up with Prof. Marisa Eisenberg at the U-M School for Public Health to perform tests in student dorms. Future work envisioned for Opo includes the inclusion of a microphone and cough detection.

Big Data Digs Deep Into Diabetes

Prof. H.V. Jagadish, Bernard A. Galler Collegiate Professor of EECS, is well-known for taking on significant, long-term challenges in the area of biomedical informatics. For the last six years, he has been engaged in projects with multiple researchers at the U-M Medical School who hope to better understand the complications of diabetes. Diabetes is a long-term condition that causes high blood sugar levels. It can result in a number of complications, including vision loss, problems with kidneys, and nerve problems that begin with losing sensation in extremities, such as toes. The point of onset and the degree to which patients suffer these various complications varies a great deal.

Prof. Jagadish's role in these investigations has been to integrate and analyze patient and experimental data in order to identify the processes by which each of the three major disease complications occur. In doing so, he has worked with physicians who have expertise with the three body systems impacted by these complications and who are treating patients with diabetes.

The data that Prof. Jagadish is working with includes human patient medical record data and research data from experiments on mice. It includes data collected from different biological levels, such as gene transcript information, metabolic information, and phenotype information.

Like cancer, diabetes is a disease whose processes are complicated and will not be quickly understood. According to Prof. Jagadish, there are indications that the disease processes for the three complications could be different. At the same time, depending upon the stage of progression, links between the three can be found. Work is ongoing.



DISCOVERY

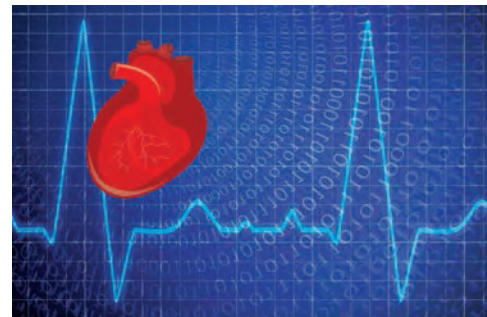
Predicting Atrial Fibrillation Following Cardiac Surgeries

Postoperative atrial fibrillation (PAF) occurs in 10 to 65% of the patients undergoing cardiac surgery. PAF is associated with increased mortality and morbidity, as well as longer and more expensive hospital stays. Being able to predict PAF allows for prophylactic use of therapies such as beta-adrenergic blockers and amiodarone, as well as other options such as rhythm control and anti-coagulation, but the benefits of therapy must be balanced against side effects and costs.

Being able to accurately stratify patients for PAF is essential to matching them with appropriate prophylaxis. A number of preoperative, intraoperative, and postoperative factors have been proposed to identify patients most likely to experience PAF. While each has shown some promise, few have been routinely incorporated into clinical practice because of inconsistent findings across studies, uncertain analytic performance, and lack of data regarding specific treatment implications.

The prediction of PAF following cardiac surgery is the goal of a project being led by Prof. Zeeshan Syed. In collaboration with Prof. Satinder Singh Baveja in EECS, Dr. Mohammed Saeed at U-M Cardiovascular Center, and EECS graduate students Nathan Harada and Chih-Chun Chia, this project explores a multi-factorial approach that can integrate parameters such as patient age, echocardiographic findings, and laboratory data to stratify for PAF preoperatively.

When evaluated in data across multiple institutions, the approach developed was able to demonstrate clinical utility in identifying patients likely to experience PAF – holding the potential for a tool that can be reliably used at the patient bedside to determine therapies before or immediately post-cardiac surgery. The team will present some of its most recent findings for this project at the *American Heart Association Scientific Sessions* in Fall 2015.

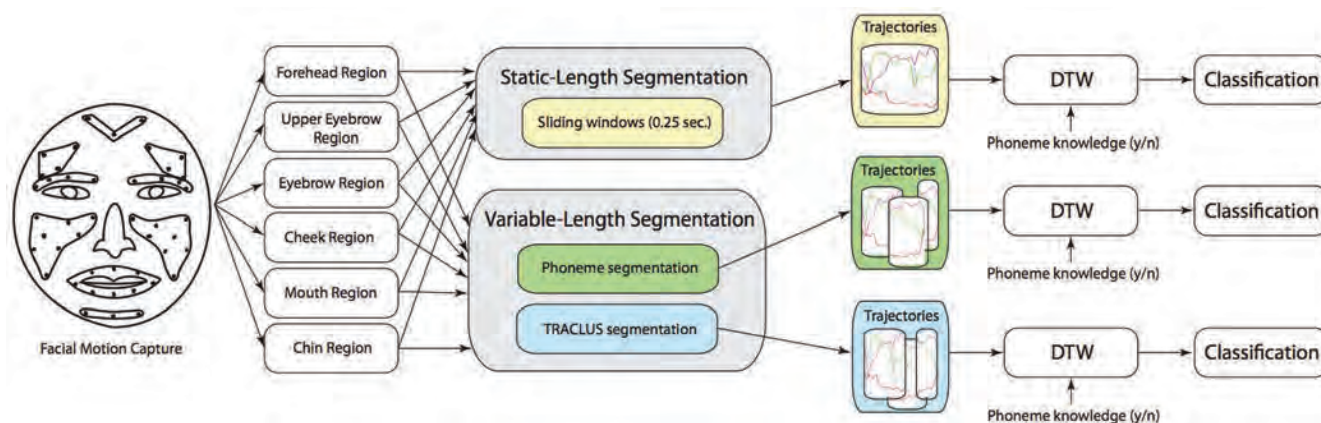


Say Cheese and Smile: Factoring in Facial Signals to Determine Emotions

Michigan researchers including Prof. Emily Mower Provost and graduate student Yelin Kim are developing a computerized facial emotion recognition system that could form the basis for social and affective human-machine interaction systems; wellness and health-related systems that help individuals to better monitor their emotional landscape; and surveillance systems that could automatically detect and alarm potentially dangerous human behaviors.

The expression of emotion is complex and can be difficult to decipher with a computer system. Emotion can be expressed through changes in facial movement, vocal expressions, and body gestures. However, some of these same changes occur simply through the process of articulation. For example, is someone with a smile on their face happy, or are they simply saying “cheese”?

The researchers’ work was designed to take facial recognition into account, in addition to speech, when designing systems to determine emotion. They designed an unsupervised learning system which first segments the facial movement cues during affective communication using fixed-length and variable-length methods. The emotion content is then estimated either given or absent knowledge of the phonetic content of speech. This modeling strategy enabled the researchers to directly model the dynamics of emotional speech. Yelin Kim received a Best Student Paper Award for her research at the *ACM International Conference on Multimedia* in 2014.



Overview of the researchers’ system, which first segments the facial movement cues during affective communication using (1) fixed-length and (2) variable-length methods. The emotion content is then estimated either given or absent knowledge of the phonetic content of speech.

PATIENT MANAGEMENT

Identifying Physiological and Linguistic Clues for Deception

Prof. Rada Mihalcea is co-PI for a two-year grant from the National Science Foundation that is exploring a new generation of computational tools for joint modeling of physiological and linguistic signals of human behavior with a focus on deception detection. The project is an interdisciplinary collaboration between Prof. Mihalcea and Prof. Mihai Burzo (PI) of Mechanical Engineering at U-M Flint.

Work on deception has received significant attention from several fields of study, ranging from physiology to psychology, sociology, linguistics, and computer vision. While a number of studies have been carried out in the past for the automatic detection of deception, most of this previous work has primarily targeted one modality at a time. There is very little work that has considered the simultaneous exploitation of multiple modalities for the purpose of deception detection.

This work will be the first to create joint physiological and linguistic models for the recognition of deception. The researchers are pursuing three lines of inquiry: First, a novel physio-linguistic dataset of deceit is built, covering several different domains. Second, rule-based classifiers for deception detection are explored, using physiological features (e.g., heart rate, respiration rate, galvanic skin response, skin temperature), as well as linguistic features. Third, data-driven learning approaches for multimodal deception detection are developed, taking advantage of the recent progress in early, late, and temporal fusion models.



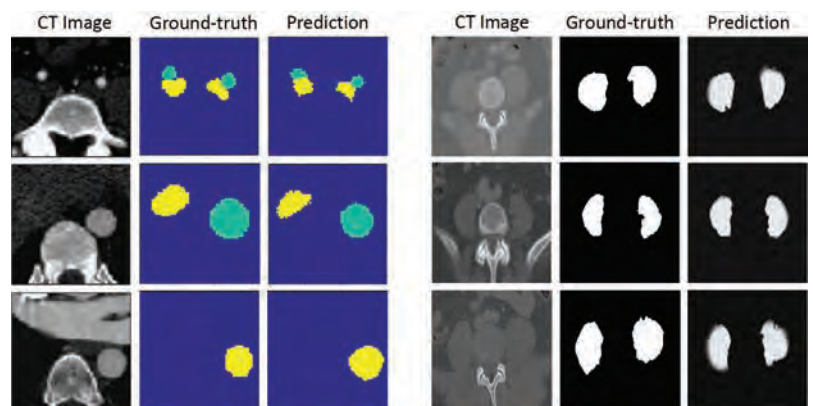
Machine Learning Identifies Preoperative Risk Factors

It is now recognized by medical researchers that abdominal core muscle size is an independent and potentially important preoperative risk factor for patients who are to undergo abdominal surgery. For instance, in liver transplant patients, the mortality rate of patients was on the order of 4 times higher in patients in the lowest tertile of psoas muscle size. This was first noted by Prof. Stewart Wang at the U-M Medical School, who has spearheaded the field of analytic morphomics, which assesses preoperative computerized tomography (CT) scans to better understanding patient risk and consequently improve surgical outcomes.

EECS Prof. Honglak Lee and graduate student Xinchun Yan are now collaborating with Prof. Wang in an ongoing project to leverage analytic morphomics further through the use of big data processing techniques.

In the first part of their work, Prof. Lee's research team increased the throughput and automation of the previous analytic morphomics system at the U-M Medical School by using deep convolutional neural networks. For example, the accompanying images show the performance of their deep learning based system in segmenting (1) aorta and vena cava through full body CT scans and (2) psoas muscles, which will be useful in a wide range of surgical/medical procedures.

In the second part of their work, Prof. Lee's team aims to create an automated process for considering not just a few key indicators, but tens of thousands of structures from multiple CT scans for each patient using image recognition and processing technology in conjunction with machine learning algorithms. Combined with additional patient data and historical patient and outcome data, Prof. Lee hopes to provide a fine-grained approach that will pinpoint risks based on a growing body of knowledge for all types of abdominal surgery procedures.



A chart showing CT scans, manually segmented ground truths, and computationally predicted segmentation.

PATIENT MANAGEMENT

Helping Tens of Thousands of Coronary Artery Disease Patients Each Year

Ventricular arrhythmias cause almost 15% of all the deaths in the industrialized world (330,000 deaths in the U.S. each year). Many of these occur in patients who have had heart attacks. These lives can often be saved with therapies such as implantable cardioverter defibrillators (ICDs). However, existing guidelines fail to prescribe ICDs to the majority who die – while it is believed that as many as 80 to 90% of the patients receiving ICDs presently fail to derive benefit from them.

In a multi-year project, Prof. Zeeshan Syed and his graduate students Chih-Chun Chia and Alexander Van Esbroeck have worked alongside academic collaborators at U-M (Prof. Satinder Singh Baveja in EECS and Dr. Mohammed Saeed at the Cardiovascular Center), MIT (Prof. John Guttag, Prof. Collin Stultz), and Harvard Medical School (Prof. Benjamin Scirica) to explore different opportunities to more accurately prognosticate coronary artery disease patients and to match them to therapies.



Prof. Zeeshan Syed



Prof. Satinder Singh Baveja

In a first body of work, the team looked at computational biomarkers derived from ECG data to stratify patients to adverse cardiac events. These markers quantify different aspects of evolving cardiac health and complement information in other clinical parameters (e.g., echocardiography) by more directly measuring aspects of health that relate to an increased incidence of arrhythmias following heart attacks. Studies have shown that the biomarkers resulting from this work successfully predict tens of thousands more arrhythmic deaths each year (which could be reduced through therapies such as ICDs) relative to gold-standard stratification approaches.

In a second body of work, Prof. Syed and his team have studied ways in which these markers and existing clinical variables can be used to more holistically assess cardiac health. In contrast to clinical decision-making based on thresholds defined on individual parameters, this approach of integrating markers provides substantial opportunity in improving the precision and recall of guidelines for care. They will present findings for this project at the *American Heart Association Scientific Sessions* in Fall 2015.

Using Patient Data to Guard Against Clostridium Difficile

Clostridium difficile, also called *C. difficile* or *C. diff*, is a bacterium that can cause symptoms ranging from diarrhea to life-threatening inflammation of the colon. *C. diff* is difficult to eradicate and is often transmitted to patients in hospital environments. Each year, more than a half million people get sick from *C. diff*.

A project led by Prof. Jenna Wiens has sought to develop and validate a data-driven hospital-specific risk stratification procedure for estimating the probability that a hospital inpatient will test positive for *Clostridium difficile* infection (CDI) using patient electronic medical record (EMR) data and machine learning techniques. EMR data allows for straightforward integration into the health information system and the automatic calculation of patient risk.

The data came from the electronic databases of a large urban hospital in the U.S. The study included 69,568 admissions.

In contrast to previous risk-stratification models for CDI, Prof. Wiens' project did not limit itself to the set of known risk factors, but considered over 10,000 variables automatically extracted from the EMR data. Using machine learning techniques, she developed the model on admissions from a single year and validated it on a holdout set of admissions from the following year. The holdout set consists of cases that are withheld from the process used to construct the predictive model. She then compared her proposed model to one based on a small set of known risk variables.

The model that made use of the additional EMR data provided fewer false positives and significantly outperformed the model that considered only the small set of known clinical risk factors on all factors considered.

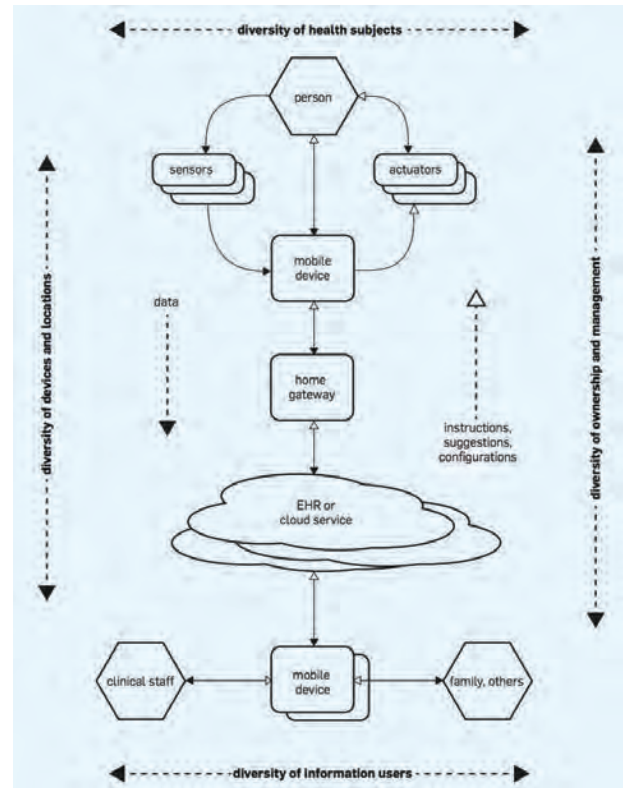
The study concluded that the addition of information not usually considered can lead to a significant improvement in discrimination performance compared to a model based on a small set of known risk variables.

While building and using such data-driven models may seem more complex than using a simple rule, the growing ubiquity of electronic health systems provides the necessary infrastructure to automate data-driven risk methods, making them easy to construct and employ. Prof. Wiens is hopeful that this type of big data approach to medicine will be adopted to improve patient outcomes across a range applications.

Developing a Security Framework for Mobile and Cloud Frontiers in Healthcare

In an article in the August 2015 issue of *Communications of the ACM*, Prof. Kevin Fu and his coauthors describe a framework for properly securing patient medical data as it is stored in and retrieved from the cloud. They diagram a system of trust relationships for healthcare IT and then describe the critical challenges to be addressed by the system. This includes usable authentication tools other than passwords, and new rules for how to limit or grant access to medical data including how to separate data collection, analysis, and presentation to limit data that travels outside a patient's trust circle. It also includes a focus on how medical devices must be secured to withstand not only the threats of today, but for the lifespan of the device. Finally, the authors point to the need for accountability through automated analysis of audit logs.

The researchers hope to build consensus for a security framework that will enable healthcare IT to achieve a level of security that is essential for widespread and reliable adoption of data-driven medicine.



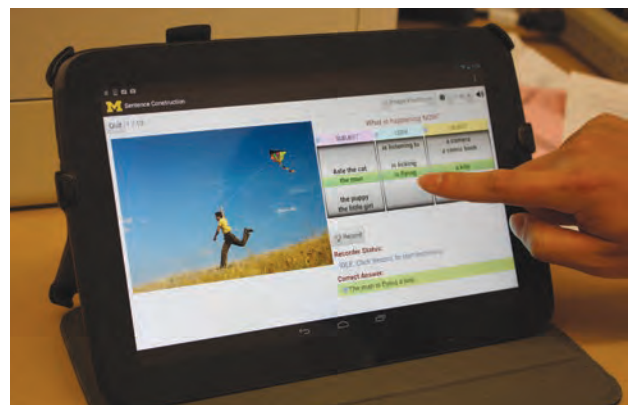
The complex trust relationships involved in healthcare information technologies.

Helping to Bring Back Lost Language

Aphasia is an impairment of language which affects the production or comprehension of speech and the ability to read or write, and is typically brought on by stroke, brain injury, or a brain tumor. Depending upon the severity of the case, therapists are often able to work with patients to restore some or all of this lost capability.

In a project in collaboration with the U-M Center for Language and Literacy, Prof. Emily Mower Provost is seeking to reinforce and extend the results of an intensive in-patient treatment program for people with brain injury or stroke resulting in language loss through the use of technology that allows patients the means to practice more and therapists with objective cues that they can use to assess progress.

Her research team has developed an app that runs on an Android tablet and which allows patients to practice sentence construction tasks based on pictures and then record their speech. The project includes the development of speech recognition technology that measures the characteristics of pronunciation, allowing clinicians to assess the quality of speech over time. In addition to measuring speech quality, a future goal for the project is to recognize the content of the recorded patient speech in order to provide additional therapeutic data.



THERAPY

Listening to Bipolar Disorder: Smartphone App Detects Mood Swings Via Voice Analysis

Many people, including those in developing and rural regions, do not have access to psychiatric care or monitoring. This can result in situations that could otherwise be managed escalating into crises.

A smartphone app that monitors subtle qualities of a person's voice during everyday phone conversations shows promise for detecting early signs of mood changes in people with bipolar disorder, according to a research team that includes Profs. Emily Mower Provost and Satinder Singh Baveja in collaboration with Prof. Melvin McInnis at the U-M Depression Center.

The app runs in the background on an ordinary smartphone, and automatically monitors the patients' voice patterns during any calls made as well as during weekly conversations with a member of the patient's care team. A computer program analyzes many characteristics of the sounds – and silences – of each conversation. The researchers hope the app will eventually give people with bipolar disorder and their health care teams an early warning of the changing moods that give the condition its name. The technology could also help people with other conditions.

"We collect speech data from the smart phone and process the data in a privacy preserving manner to learn the acoustic patterns associated with harmful mood variations," said Prof. Mower Provost. More patients, all taking part in the study funded by the National Institute of Mental Health and facilitated by the Prechter Bipolar Research Fund at the U-M Depression Center, have already started to use the app on study-provided smartphones.

As work on the project progresses, the research team will continue to test and improve the technology, with an aim of developing software that will learn to detect the changes that precede the transitions to mild depressions and hypomania (mild mania), as well as to full-blown depressed and manic states. They are also developing strategies for notifying the app user and care providers about mood changes so that appropriate intervention can take place.

The app currently runs on Android operating system phones, and complies with laws about recording conversations because only one side of the conversation actually gets recorded and the recorded data is analyzed in small chunks. *Full story: eecs.umich.edu/n/mood*



Prof. Mower Provost



Prof. Baveja

Supporting Smoking Cessation

Studies have shown that the most effective approaches to smoking cessation include incentives, which could consist of texted messages of encouragement, points in a system, or a monetary offer. But in addition to incentives, it is helpful to have a system in place to verify compliance.

Prof. Prabal Dutta worked with collaborators at the U-M Department of Psychiatry and at the University of Florida to create a smartphone-based breath carbon monoxide meter to detect cigarette smoking.



The smartphone-based CO detector, with views from the front, side, and of the internal circuit board.

The researchers developed a compact and portable breath CO detector that attaches to and communicates with a smartphone through an existing audio port using Prof. Dutta's HiJack technology. More recent versions can connect wirelessly to smartphones using Bluetooth Low Energy (BLE), enabling new sensors that are hardly larger than a stick of chewing gum. They also developed an app that can be used to calibrate the CO sensor, to display breath CO measures, and to send CO data to a remote server.

In a final step to ensure a participant's actual compliance, the researchers made use of the phone's built-in camera to take pictures of the participant during use to authenticate the user's identity and CO levels. The researchers have open-sourced the technology developed as a part of the project so that it can be used as a validation tool in smoking cessation studies.

THERAPY

New Center Develops Technologies to Help Youths With Disabilities



A \$4.5 million federal grant will allow U-M researchers to study how technology – including apps for smartphones and tablets, cloud devices, an educational web/social media site, and a U-M-developed video game – may help young adults with spinal cord dysfunction and neurodevelopmental disabilities to improve their health and become more independent as they mature. The Collaboratory for Technology, Health, and Independence is co-directed by Prof. Edmund Durfee and includes participation by Profs. Satinder Singh Baveja and Mark Ackerman, as well as researchers and clinicians from the U-M Health System, College of Pharmacy, School of Public Health, College of Engineering, and the School of Information.

For youth with spinal cord dysfunction and neurodevelopmental disabilities, making the transition from parental management of health to self-management and independence can be challenging. The young people often lack knowledge and skills to anticipate and avoid secondary health complications, and they may have impairments in cognition that may also make it difficult to complete the tasks required of them.

Researchers at the center will explore how technology can be used to develop and implement strategies and interventions to address both of these kinds of challenges by supporting and reinforcing healthful behaviors, helping disabled youth to become more autonomous, confident, and successful in life. All projects led by the new center have a goal of transferring the technology to the marketplace to benefit the target community. *Full story: eecs.umich.edu/n/rerc*

A Focus On Assistive Technologies

Dr. David Chesney's software engineering classes are often sought out by students who want to work at the intersection of technology and childhood disability. Dr. Chesney has forged bonds with the U-M Mott Children's Hospital, other U-M units, and with technology firms that have allowed his students to conceive and engineer real assistive technology products for use by real patients with disabilities. In doing so, both the students and Dr. Chesney have advanced an understanding of how data and technology can be harnessed for positive outcomes.



A child presses on a fabric structure to paint the flowers in front of him.

In the past, Dr. Chesney's students have created computer games with motion control interfaces designed for use by autistic children and have turned an iPad into a messaging input device for children with motor control disabilities. These projects were tested and used by children at Mott Hospital. More recently, Dr. Chesney's students created a series of projects designed to help one patient, a 13-year-old girl with cerebral palsy to communicate with others.

In the 2014–2015 academic year, Dr. Chesney formed a collaboration with Prof. Sean Ahlquist in the School of Art and Urban Architecture and with Prof. Sile O'Modhrain in the School of Music, in which students from the schools collaborated to create interactive

fabric structures that would allow a young autistic patient to develop tactile awareness by "painting" inside projected images using pressure on a stretchable fabric. Microsoft Kinect sensors were used to calculate pressure by measuring the distance the fabric was pressed. Depending upon the pressure exerted, different color shades were applied. The system can be tuned to an individual child's needs. *Video: eecs.umich.edu/n/art*



EECS Welcomes New Engineering Robotics Center

A newly-approved \$54M robotics center is planned for North Campus, and EECS faculty are excited at the promise the new space offers for increased collaboration and synergy of effort. The Center will offer state-of-the-art facilities in a 3-story, 100,000 square foot building.

The facility will be constructed in an open plan to maximize flexibility and a free flow of ideas. In addition to lab space, the building will house offices, classrooms, space for small conferences, and a robotics museum to showcase the university's past work. One Michigan robot, MABEL, is currently on loan to the Chicago Field Museum. MABEL is the robot-child of Jessie Grizzle, Elmer G. Gilbert Distinguished University Professor and Jerry W. and Carol L. Levin Professor of Engineering.

"This building will put Michigan on the robotics map," said Prof. Grizzle, who also has been instrumental in developing the Robotics PhD program and in planning for the Robotics Institute. "We already have leading research activities in robotics at Michigan, but they are spread out so that many people do not see it. The new building and the work taking place in it will establish Michigan as a leading presence in the field of robotics."

EECS has a rich history of contributions to robotics. The department is able to offer a number of fresh perspectives on robotic movement, design, computer vision, and control of vast autonomous systems.

Full story + video: eecs.umich.edu/n/robo

Robotics and Autonomous Systems

MARLO Walks – All by Herself

With prosthetic feet and hips that can swing sideways for stability, ECE's newest two-legged robot has taken its first steps outside. Named MARLO, it is Prof. Jessie Grizzle's third-generation bipedal robot. While its predecessors were connected to lateral support booms and confined to the lab, MARLO recently ventured outside to take 15 steps, free from tethers and walking on its own.

Researchers believe that fast, two-legged machines with human-like running could eventually travel over rough ground and inside the remains of places built for people, such as burning or collapsed houses. In the short term, the work could lead to advanced prosthetic legs with powered, coordinated knees and ankles.

MARLO and its counterparts represent the second bipedal robot model in the world—and the first at a university—with a gait that isn't flat-footed. This fluid action is vital for real-world stability.

"If we want robots that can walk outside, over roots, stones, uneven sidewalks or steps, they need a walking gait that allows the foot to have only partial contact with the ground," said Prof. Grizzle.

Full story + video: eecs.umich.edu/n/marlo

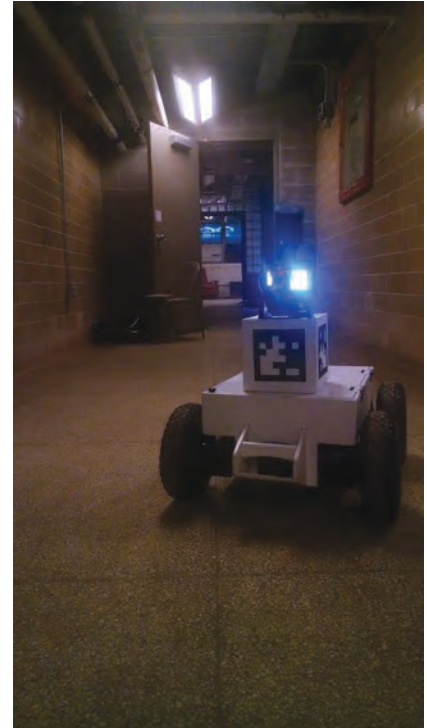


Robots Learning to Think About Others

Under a project funded by DARPA, Prof. Edwin Olson is leading research that aims to formulate, develop, and evaluate a novel multi-agent coordination framework in which robots explicitly model the intent of their human and robot teammates, with the goal of simplifying human oversight of teams of cooperating robots and speeding responsiveness in applications such as urban reconnaissance, search and rescue, security/patrol, and surveillance.

Students and researchers involved with the project recently returned from testing a team of robots at the Muscatatuck Urban Training Center, a 1,000 acre urban training facility located near Butlerville, Indiana. While there, the robots were deployed in a variety of challenging indoor and outdoor environments, including a simulated shanty town, fields with mud and high grass, and dark interior spaces. The test results will inform their work as they continue to develop both the robots' sensors and their cooperative intelligence.

The project is intended to reformulate inter-agent communication beyond current state-of-the-art systems that do not make optimal use of radio bandwidth due to redundant/unnecessary transmissions. Each robot maintains a model of its teammates that allows it to predict the actions of another robot under multiple scenarios, including scenarios in which a specific item of data has been transmitted via radio. The resulting prediction of behavior allows a robot to objectively rate the value of that information and prioritize its transmissions based on their importance.



MAEBots Make Multi-Autonomous Research Projects Easier

Researchers in Prof. Edwin Olson's APRIL lab have introduced the MAEBots (Miniature APRIL Educational roBots): a small, smart, and low-cost platform for multi autonomous robotics research or classroom use that has been open sourced for researchers everywhere. MAEBots include rich sensor capabilities designed to provide students and researchers with a robust platform on which to explore the concepts of robot control, localization, kinematics and machine vision. Everything needed to build a MAEBot is either a 3D printed part, a circuit board, or a commercially available part.

Video: eecs.umich.edu/n/maebots



Swarms of Robots and Cyber-Physical Systems

In the near future, swarms of interconnected autonomous devices will be ubiquitous, thanks to the combination of sensors, wireless communication, and devices at least partially controlled by computers. Called cyber-physical systems (CPS), these devices have applications ranging from environmental monitoring, to healthcare, agriculture, factory automation, and transportation.

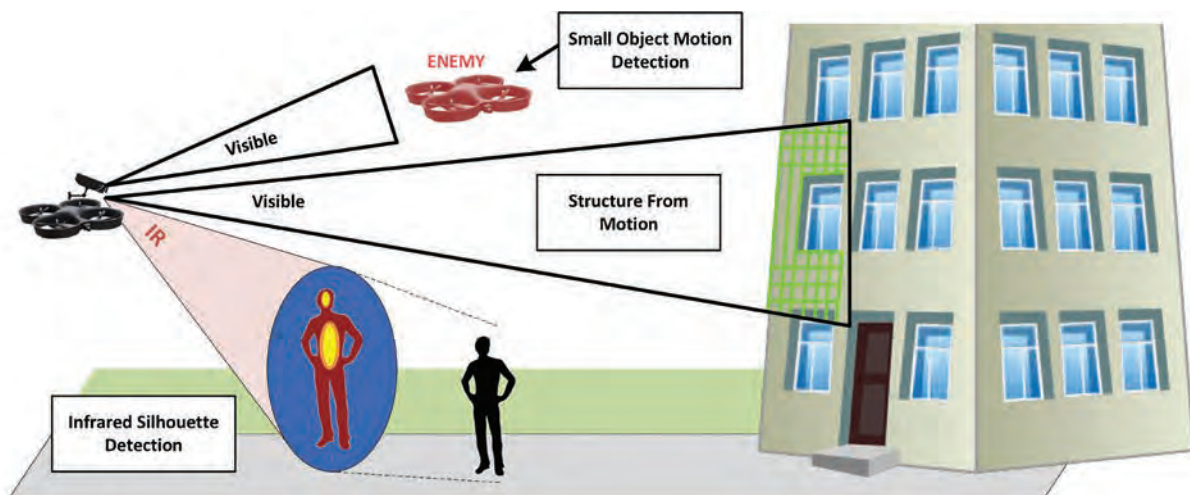
“Robots are canonical examples of cyber-physical systems,” says Prof. Necmiye Ozay, who specializes in CPS. “The goal in robotics is to move a physical system to achieve certain tasks while interacting with the physical environment by using lots of computational (cyber) elements, for instance, control, perception and decision-making algorithms.”

Several faculty in the EECS Department, including Necmiye Ozay, Stéphane Lafortune, Demosthenis Teneketzis, Jessy Grizzle, and Kang Shin are working to ensure the proper functioning of these cyber-physical systems.

Insectoid Drones

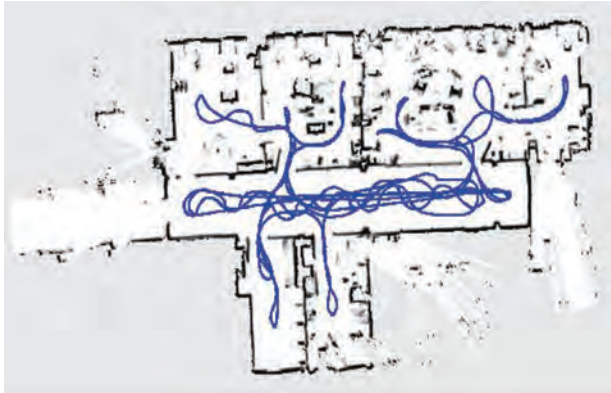
Michigan is designing the microelectronics that are the eyes, ears, and brains of insect-like drones being developed under the Micro Autonomous Systems and Technology (MAST) collaborative. The research at Michigan is part of the Center for Objective Microelectronics & Biomimetic Advanced Technology (COM-BAT), directed by Kamal Sarabandi, Rufus S. Teesdale Professor of Engineering. The goal of MAST is to produce lots of different microbots that can detect details about different environments, even when typical navigation systems, such as GPS, are compromised.

These aerial robots could enter buildings undetected, provide 3D mapping of an area, and remotely identify threats and other tasks vital to national security. Michigan is building a variety of sensors to support these goals. One sensor may transform the way inertial and many other types of sensors are designed, fabricated, and produced, using their newly developed HAIR technology (High-performance, Actuation and Integrated sensing Research). They are also developing: image sensors for navigation and autonomous flight; solutions to enable sensing of the environment day or night for surveillance, collision avoidance, and map building; an ultrasmall, high-resolution imaging system that allows for a wide field of view even in low light situations; the ability to send out teams of cooperative robots; and even the ability to see through walls.

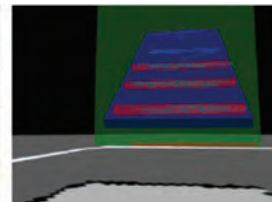
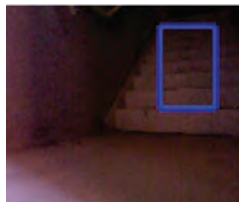
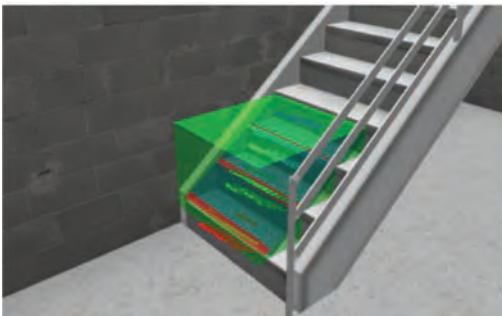
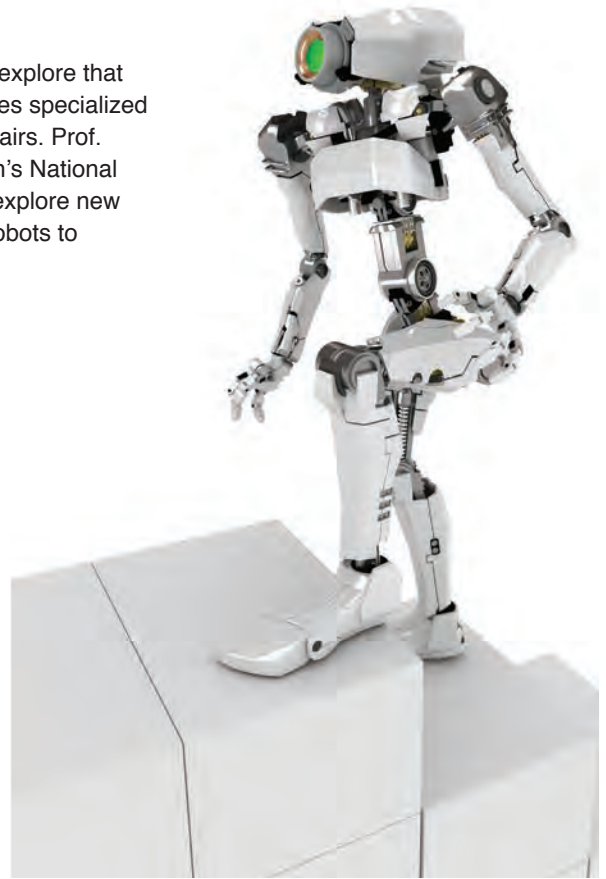


Robots Exploring With Computer Vision

Robots that encounter new environments have a limited ability to navigate and explore that environment. For example, there may be terrain, such as a stairway, that requires specialized capabilities from the robots and a computer vision system that can recognize stairs. Prof. Jason Corso is working on a project funded by the National Science Foundation's National Robotics Initiative to add a new level of semantic awareness to robots as they explore new environments; the goal of the project is to enable a linguistic capability for the robots to understand new environments in terms of natural language.



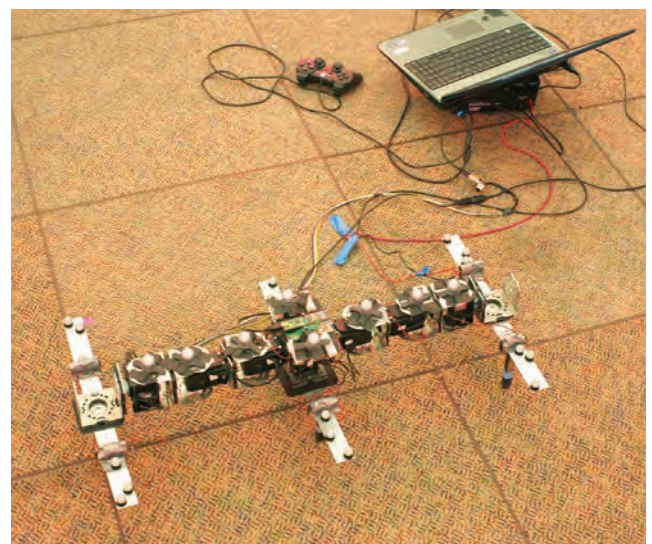
Robot path through floorplan.



Biologically Inspired Robotics

Prof. Shai Revzen is taking a close look at how non-humans get around in order to translate those methods into highly efficient motion for robotic devices in his Biologically Inspired Robotics and Dynamical Systems (BIRDS) Lab. Through his investigation of running animals, he discovered that it is possible to develop a control model for multi-legged robotic locomotion that uses almost no sensing devices, yet still results in stable mobility.

In other robotics work, he is designing robots that are able to assemble and adapt "on the fly." Prof. Revzen believes that the next frontier in robotics is to design robots that can adapt to unforeseen situations. His team has developed a unit that can assemble robots of varying shapes and functions with foam. The resulting creations can move around, uncannily resembling their bioinspirations. Prof. Revzen says his robots come prepared to face the unknown, to "solve the problems that we find, after we know what they are."



Transportation and Navigation

A Fleet of Cooperating Cars is Coming

Prof. Edwin Olson is heading a new project called SmartCarts, which will help researchers to begin understanding the challenges of a “transportation on demand” system built around autonomous vehicles. Rather than focusing on the details of fully autonomous cars (other projects are doing that), this project is designed to jump ahead and focus on the things that would accompany a smart transportation network once the autonomous vehicle itself is essentially ready, such as passenger-robot interaction, understanding user preferences and requirements, routing and load balancing.

To accomplish this, Prof. Olson is working with Local Motors, a custom vehicle firm based in Arizona, to manufacture specialized low-speed electric vehicles (LSEVs) which can be rapidly fitted with technology to support sensing and autonomy; essentially a quickly-built network of intelligent vehicles that can share data and act cooperatively on a test track. The vehicles designed by Local Motors will be 3D printable, so if the researchers need to make changes, it’s just a matter of hitting “print” again.

The technology that will drive the cars has roots in robots that Olson and his students used to win the *Multi Autonomous Ground-Robotic International Challenge (MAGIC)* in 2010. The LSEVs will be used at the MCity test facility near North Campus.
Full story: umich.edu/n/smartcart

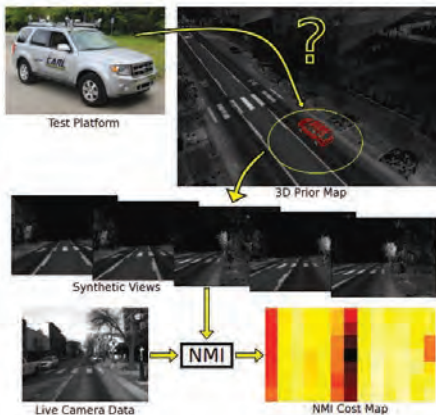


Justin Tesmer, Research Project Engineer in the Department, in the first cart to arrive at the lab. Note the absence of a steering wheel.

Researchers Create Lower-Cost Navigation System for Self-Driving Cars

EECS graduate student researcher Ryan Wolcott and his advisor Prof. Ryan Eustice have developed a new software system that uses video game technology to provide an alternative to the high cost of laser scanners that are typically used in self-driving cars to determine their location.

The system uses a single video camera to deliver the same level of accuracy as laser scanners, but only costs a few dollars. It builds upon the navigation systems used in other self-driving cars that are currently in development, which use three-dimensional laser scanning technology to create a real-time map of their environment and then compare that real-time map to a pre-drawn map stored in the system. By making thousands of comparisons per second, they’re able to determine the vehicle’s location within a few centimeters.



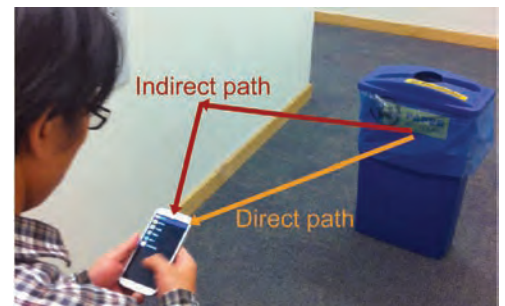
The researchers’ new system employs a new algorithm that allows for matching a forward-looking dash-cam image to a pre-built 3D map of the environment, similar to a video game.

The researchers successfully tested the system in Ann Arbor, and the navigation system was able to provide accurate location information. Wolcott and Eustice believe it’s an important step toward building lower-cost navigation systems. Eventually, this research may also help driverless vehicle technology move past map-based navigation and pave the way to systems that see the road more like humans do.

Full story: eecs.umich.edu/n/cars

Reducing Accidents During Distracted Walking

Pedestrians are increasingly risking injury by using their smartphones while walking. To deal with the collisions, injuries, and inconvenience caused by “distracted walking,” some cities have gone so far as to establish smartphone lanes. But researchers led by Prof. Kang G. Shin, Kevin and Nancy O’Connor Professor of Computer Science, have another solution: BumpAlert, an Android application that is the first to actively detect objects in front of users and alert them in real-time using phone vibrations. BumpAlert uses a phone’s existing sensors and requires no additional hardware. It uses the phone’s speaker and microphone to create an acoustic detector, similar to sonar; the phone’s accelerometer to estimate motion and speed; and the phone’s rear camera to identify dangerous objects. A fusion algorithm combines the data and provides alerts via vibrations. The researchers’ study shows that BumpAlert’s accuracy is higher than 95%, and in a survey of users, over 70% found it useful.



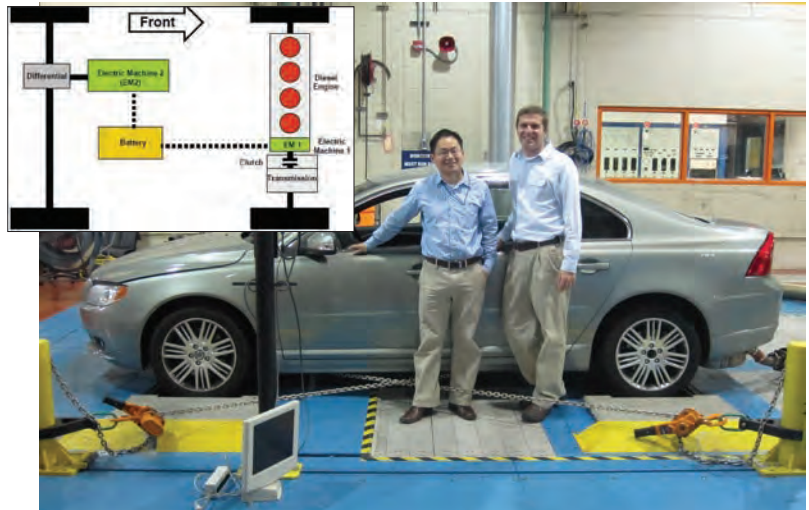
HEV Fuel Economy Meets Drivability

Controlling the flow of energy in a hybrid electric vehicle (HEV), called energy management, is critical to achieving the superior fuel economy expected by HEV owners. At the same time, owners want their vehicles to accelerate and brake smoothly and quickly (responsively), features known as “drivability.”

Prof. Jessie Grizzle and a team of researchers investigated the tradeoffs between fuel economy and drivability in HEVs. The team employed a process called shortest path stochastic dynamic programming (SP-SDP) to optimize both energy management and drivability in a Volvo S-80 test vehicle.

Using their own SP-SDP-based controllers, they achieved an 11% improvement in fuel efficiency over an industrial baseline controller, without sacrificing drivability. The algorithms developed by the researchers provide a systematic approach to the fuel economy vs. drivability dichotomy, removing much of the trial-and-error approach of previous solutions. This research won the Outstanding Paper Award at the 2014 IEEE Transactions on Control Systems Technology (TCST).

Full story: eecs.umich.edu/n/hev



Xiaoyong Wang (left) and Daniel Opila stand in front of a prototype hybrid electric vehicle (a modified Volvo S-80), on which they implemented their advanced power management control system. The diagram shows the layout of the primary components in the HEV. The car is able to split power between the front and rear axles, and between the diesel engine and electric motors.

New U-M and KACST Research Partnership Will Focus on the Auto Industry

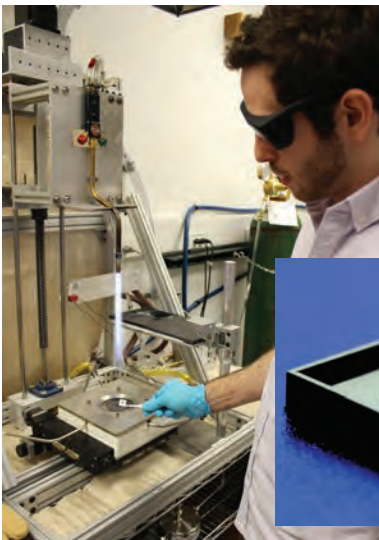
A new collaborative research center, called the Center of Excellence for Microwave Sensor Technology, has been established between faculty in the Radiation Laboratory and Saudi Arabia's King Abdulaziz City for Science and Technology (KACST). The Center, directed by Prof. Kamal Sarabandi and initially including Prof. Michael Flynn, Prof. Anthony Grbic, Dr. Adib Nashashibi, and Prof. Fawwaz Ulaby, will be a major site for research in microwave sensor technology, with the first projects focusing on autonomous vehicles and novel approaches to electric vehicle charging.

KACST will collaborate with Michigan faculty and students on their projects, giving them a chance to better understand the ins and outs of advanced research and its execution. In addition, KACST researchers will take courses at Michigan as non-degree seeking students, and short courses will be offered at KACST. Michigan's researchers will have more freedom to pursue ambitious projects that offer real market potential.

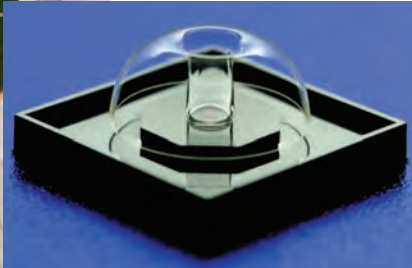
First priority in terms of research will be applying microwave technology to autonomous vehicles. The automotive industry is in a stage of rapid innovation, and being so close to several major companies gives the Center's projects great potential for real impact. The projects explored in the new center would encompass many facets of smart driving technology, as well as novel improvements to charging electric vehicles. “We are looking into sub-millimeter-wave collision warning and imaging radar, radar based surface traction sensors, wireless network for intra-vehicle sensor connectivity and inter-vehicle communication,” said Prof. Sarabandi. They will also investigate the possibility for electric vehicle charging while they are driving on highways, using microwave power transfer.

Full story: eecs.umich.edu/n/kacst





Tal Nagourney fabricating a wineglass gyroscope.

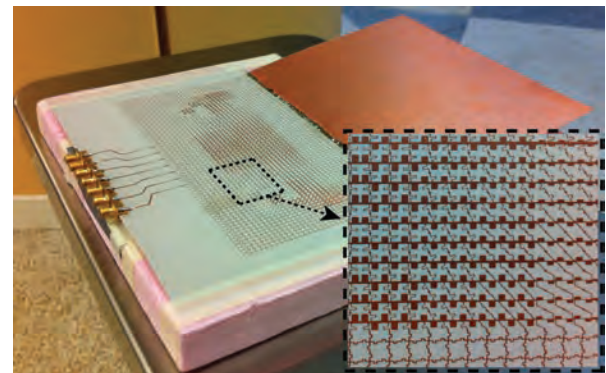


Navigation Without GPS

New micro-scale resonating gyroscopes being developed by Prof. Khalil Najafi's group could pave the way to navigation without GPS. These devices could be deployed just about everywhere, including on vehicles, satellites, unmanned aerial vehicles, and even on people to help them navigate when GPS is not available.

Doctoral student Tal Nagourney has been researching fabrication techniques for a micro rate-integrating gyroscope using a vacuum mold and blowtorch. The device is called a wineglass gyroscope, and operates by resonating like a flicked wine glass. The longer Tal can get the device to resonate, the better the gyroscope will maintain an accurate read out, which is critical for this project. The award-winning devices currently built by Prof. Khalil Najafi's research group have the best performance of any other known device.

Full story + video: eecs.umich.edu/n/gps15



Smart Antennas

Antennas are integral to virtually all electronic devices to transmit and receive radio signals. They come in many types, shapes, and sizes to best address their use. Designing functional antennas that are very small is one of the key challenges in incorporating antennas into miniaturized electronics. Making them out of metamaterials, which are man-made materials that exhibit properties not found in nature, has been found to increase performance - especially in small antennas.

Prof. Anthony Grbic and his group have developed an antenna beam former with specially-tailored electromagnetic properties using metamaterials. Beam formers are devices used to control the direction of a received or transmitted wireless signal. They can be used to track objects in radar systems, as well as improve communication quality and reduce interference in communication systems.

The antenna system promises a large bandwidth of operation and a wide angle of coverage. It can also be fabricated using standard printed circuit board processing, making it low cost and lightweight. Such antenna systems are suitable for vehicles and other platforms.

Invisible Sensing of Vehicle Steering

Detecting how a vehicle is steered and alerting the driver in real time when appropriate is an important safety feature for cars; in 2012, over 30% of driving fatalities were related to steering maneuvers. Existing solutions are implemented only in newer, high-end vehicles or on smartphones as mobile apps that use the phone's cameras, and existing smartphone apps have limitations in processing video data accurately.

Researchers led by Prof. Kang G. Shin, Kevin and Nancy O'Connor Professor of Computer Science, have introduced V-Sense, a vehicle steering detection middleware solution that uses existing non-vision sensors in commodity smartphones. V-Sense specifically detects careless steering and also provides fine-grained lane guidance, determining which lane a driver is in and determining whether or not it is the correct one. V-sense is programmed to know the difference between lane changes, curvy roads, sharp turns, curved turns, and other maneuvers. It uses accelerometer, GPS, and gyroscope data to determine headings and position. They found the accuracy of V-Sense to be well over 90%, even when the phone is in the driver's pocket.



Space Travel

MITEE Small Satellites in Space

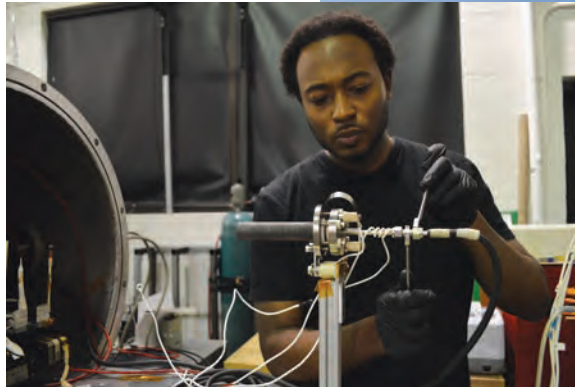
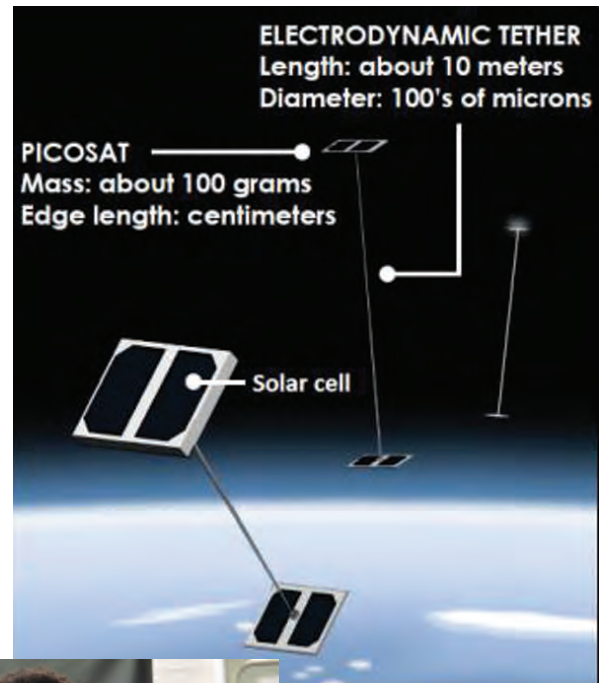
In 2014, NASA selected more than dozen small research satellites that each could fit in the palm of your hand to fly in space on future rocket launches. These cube-shaped nanosatellites, called CubeSats, can fit in the palms of your hands and weigh less than three pounds. A team of Michigan students, including recent graduate Iverson Bell, are members of the Miniature Tether Electrodynamic Experiment (MiTEE).

MiTEE will use CubeSat capabilities to deploy a picosatellite body of approximately 8 cm × 8 cm × 2 cm from a CubeSat to demonstrate and assess an ultra-small satellite electrodynamic tether in the space environment. The miniature tethers, which are a few meters long, have the potential to provide propellantless propulsion, passive two-axis attitude stabilization and enhanced communication utility to the next generation of small satellites.

As a member of Prof. Brian Gilchrist's research group, Dr. Bell is investigating the potential of electrodynamic tether propulsion technology to enhance the capabilities of an emerging class of "smartphone-sized" spacecraft known as picosatellites and femtosatellites.

This electrodynamic tether is long, thin, conducting, has semi-rigid wires, and ranges from 1-30 meters in length. When they conduct current, the tethers interact with the planetary magnetic field to produce thrust without the need for traditional consumable "fuel" or propellant. All they need is electrical power, which can be generated using solar panels.

Dr. Bell's research demonstrated that electrodynamic tether technology is capable of providing propulsion for very small spacecraft and may be able to provide attitude stability and function as an enhanced antenna aperture or serve as part of an ionospheric plasma probe.



Dr. Iverson Bell in the lab.



Two AprilTags, circled in red, can be seen behind a researcher during a test inside NASA's Weightless Wonder C9 jet.

AprilTags Play Role in Enabling NASA/ Microsoft Sidekick Project

AprilTags are a type of 2D bar codes, similar to QR codes, but optimized for reliable operation at long ranges and large viewing angles. They were developed in Prof. Edwin Olson's APRIL Lab for use in augmented reality, robotics, and camera calibration. The AprilTag detection software computes the precise 3D position, orientation, and identity of tags relative to the camera, making them ideal mapping and modeling.

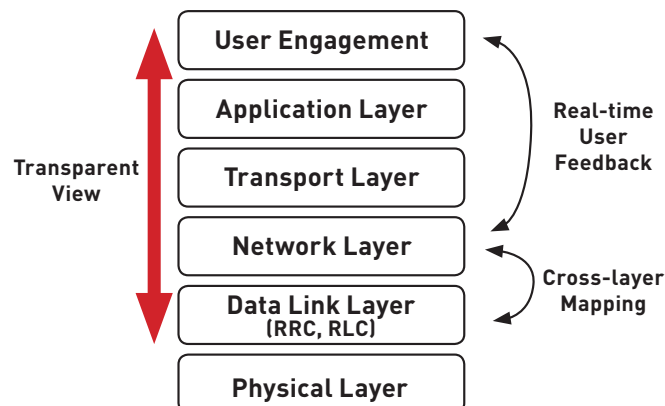
AprilTags are now headed for space as a part of Sidekick, a project led by NASA and Microsoft to develop control headsets for use by researchers aboard the International Space Station. The AprilTags will provide orientation to headset users in weightless environments. The AprilTags software is freely available under a BSD license.

Helping App Developers to Build Better Apps

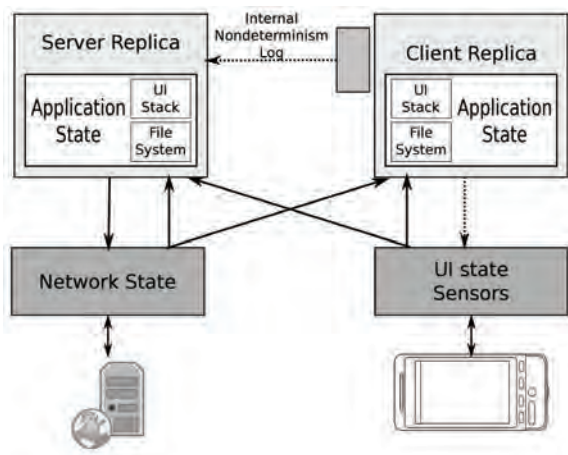
The performance characteristics and energy efficiency properties of today's mobile apps depend on a variety of factors such as network conditions, device resources, and server response times. However, understanding the interactions of software with the unique architectures of mobile devices and those devices' interactions with the networks that they operate on can be difficult for mobile app developers. To address this, Prof. Morley Mao has created a diagnosis tool to aid in the development of responsive and energy-efficient mobile apps that work well in diverse network conditions.

She states, "It is particularly challenging to discover the critical path of a user-triggered network operation for a mobile app due to the opaqueness of the cross-layer interaction across the layers in the network OSI stack, e.g., between the RLC and the TCP layers."

She is working on a tool called XLayer, which will enable cross-layer visibility to identify performance bottlenecks and to expose the impact of network properties on app-level quality of experience. XLayer will help improve an app's design, network stack, or other OS components. This work is funded by Google.



The proposed architecture to enable cross-layer visibility for mobile apps.



Tango's architecture when the client is the leader.

Tango Accelerates Mobile Applications

Tango is the name for a new method for using a remote server to accelerate the performance of mobile applications. Created by EECS graduate student researchers Mark Gordon and David Ke with Profs. Peter M. Chen, Jason Flinn, Scott Mahlke, and Z. Morley Mao, Tango replicates the mobile application on a server and executes it on both the client and the server.

Since either the client or the server execution may be faster during different phases of the application, it allows either replica to lead the execution. This method attempts to reduce user-perceived application latency by predicting which replica will be faster and allowing it to lead execution and display output, leveraging the better network and computation resources of the server when the application can benefit from it. Tango uses techniques inspired by deterministic replay to keep the two replicas in sync, and it uses flip-flop replication to allow leadership to float between replicas. In the researchers' results, two computation-heavy applications obtain up to 2–3x speedup, and five network applications obtain from 0–2.6x speedup. Currently, Tango works for several unmodified Android applications. The researchers received a Best Paper Award at the *13th International Conference on Mobile Systems, Applications, and Services (MobiSys 2015)* for the project.



Prof. Peter M. Chen



Prof. Jason Flinn



Mark Gordon



David Ke Hong



Prof. Scott Mahlke



Prof. Morley Mao

Mobilyzer Helps to Debug Cellular Networks Using Mobile Devices

To diagnose and debug network problems in a cellular network, especially at the edge of the network, network measurements from mobile devices are needed. However, network and battery resources to conduct measurements from mobile devices are scarce and traditional network measurement approaches that use continuous, periodic, or random measurements are either infeasible or ineffective under such circumstances.

Researchers working with Prof. Z. Morley Mao, including graduate students Shichang Xu and Ashkan Nikraves, have introduced Mobilyzer, an evaluation platform that triggers network measurements based on relevant device context such as signal strength and historical performance data. By carefully selecting when to conduct a measurement and using prediction to improve the likelihood that triggered measurements will succeed, Mobilyzer can allow for more reliable measurement of important network phenomena with less overhead. The researchers won the a Best Poster Award at *MobiSys 2015* for their work on the project.

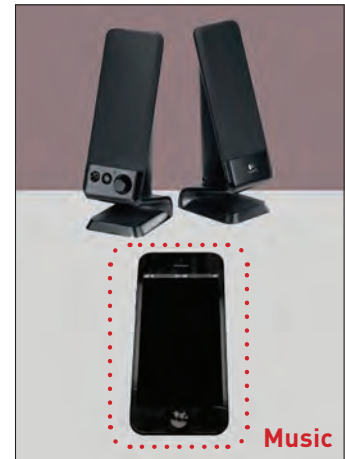
Global Scheduler



Based on historical movement patterns, use devices X, Y, and Z to measure throughput at location L.

EchoTag Provides Context-Aware Computing for Mobile Phones

Researchers led by Prof. Kang G. Shin, Kevin and Nancy O'Connor Professor of Computer Science have created a system that allows mobile phones to identify and remember specific indoor locations using existing sensors, allowing a user to associate predetermined applications with each location. For example, placing your phone by your bed could activate a silent mode to avoid interrupting your sleep, while placing your phone near your medicine cabinet could activate medication reminders and placing your phone near your stereo could activate music streaming while suppressing other alerts. Their solution, called EchoTag, uses the phone's speaker and microphone to actively generate acoustic signals and sense the reflections of those signals to create and record an environmental map. EchoTag allows users to tag and remember locations with finer than 1cm resolution. Its initial testing shows a more than 90% accuracy.



Outatime Improves Mobile Cloud Gaming

Gaming on mobile devices is very popular, but a key challenge for developers is being able to attain real-time interactivity in the face of wide-area latency. Prof. Jason Flinn, graduate student Kyungmin Lee, and other researchers have created Outatime, a speculative execution system for mobile cloud gaming that is able to mask up to 120ms of network latency.

Outatime renders speculative frames of future possible outcomes, delivering them to the client one entire RTT (round trip time) ahead of time and recovers quickly from mis-speculations when they occur. Clients perceive little latency. To achieve this, Outatime combines: 1) future state prediction; 2) state approximation with image-based rendering and event time-shifting; 3) fast state checkpoint and rollback; and 4) state compression for bandwidth savings.

The researchers evaluated the Outatime speculation system using two high-quality, commercially-released games: a twitch-based first person shooter, *Doom 3*, and an action role playing game, *Fable 3*. Through user studies and performance benchmarks, they found that players strongly prefer Outatime to traditional thin-client gaming where the network RTT is fully visible, and that Outatime successfully mimics playing across a low-latency network. The researchers received a Best Paper Award at the *13th International Conference on Mobile Systems, Applications, and Services (MobiSys 2015)* for the project.



An image from *Fable 3*, by Lionhead Studios. Researchers tested Outatime using *Fable 3*.



Let's Encrypt: New Website Authority Brings Free, Easy Encryption to All

Website security is a constant concern and the aging HTTP protocol, which is the default protocol in use by most sites worldwide, is inherently insecure and provides no protection to sites or visitors from threats that range from surveillance through phishing and identity theft. HTTPS – a secure cryptographic version of HTTP – exists and when deployed correctly addresses many of these issues. But HTTPS has historically been cumbersome and costly for website operators to implement and maintain, limiting its potential impact.

Researchers including Prof. J. Alex Halderman and graduate student James Kasten have joined with The Electronic Frontier Foundation (EFF), Mozilla, and other industry and non-profit partners to offer “Let’s Encrypt,” a free, automated, and easy process for converting web servers from HTTP to HTTPS that is implemented with a single command.

“What makes Let’s Encrypt different is that it is free and automatic,” says Prof. Halderman. “We provide certificates to anyone with a domain name at zero cost.”

Full story + video: eecs.umich.edu/n/encrypt



ZMap is Instrumental in Quantifying Internet Threats

ZMap, the open-source Internet scanning tool developed by Prof. J. Alex Halderman and graduate students Zakir Durumeric and Eric Wustrow in 2013, has proven invaluable as a means of rapidly quantifying the scope of security flaws and exploits as they are discovered on the Internet.

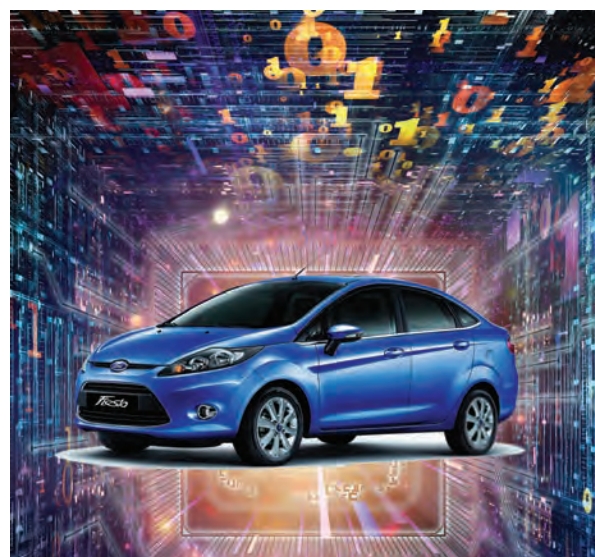
In April 2014, the Heartbleed bug gained notoriety as one of the most significant security bugs found since the advent of the commercial Internet. The day after Heartbleed was made public, Durumeric was able to identify compromised servers worldwide. His work enabled notification of network operators and served as a guide to web users regarding risks of compromised servers.

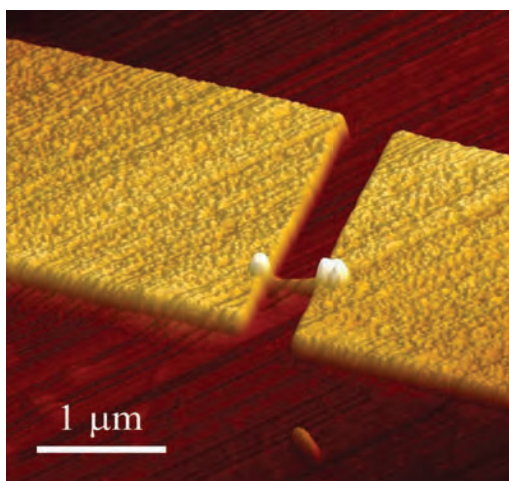
In March 2015, the FREAK RSA security flaw was identified. Using ZMap, the Michigan researchers were again first to map the extent of the vulnerability and identified over 14 million affected servers in a list referenced as authoritative by the *New York Times*. In May of the same year, the Logjam flaw — an encryption flaw similar to FREAK — was made public. Once again, ZMap was employed as an essential tool in understanding and responding to the threat.

Full story: eecs.umich.edu/n/zmap

Developing a Security Framework for Previously Closed Automotive Systems

Modern vehicles are equipped with a number of electronic control units that are responsible for virtually all aspects of vehicle performance and safety. The control units communicate across in-vehicle networks, which have historically been developed as closed systems and with cost, not security, in mind. Now that vehicles are becoming connected — for entertainment, navigation, remote service monitoring, etc. — these networks are open to cyber attack. Researchers working with Prof. Kang Shin have been working with a leading automaker to develop an encryption scheme, which they call IA-CAN, that will encode/decode valid instructions in real-time (so as not to affect vehicle performance) while providing protection against code injection, modification, and other attacks. Prof. Shin is investigating the potential for IA-CAN to be adopted by OEM suppliers to spur adoption.





An atomic force microscope image of a nanowire single photon emitter.

Advancing Secure Communications

In a development that could make the advanced form of secure communications known as quantum cryptography more practical, Prof. Pallab Bhattacharya has demonstrated a simpler, more efficient single-photon emitter that can be made using traditional semiconductor processing techniques.

Single-photon emitters release one particle of light, or photon, at a time, as opposed to devices like lasers that release a stream of them. Single-photon emitters are essential for quantum cryptography, which keeps secrets safe by taking advantage of the so-called observer effect: The very act of an eavesdropper listening in jumbles the message. This is because in the quantum realm, observing a system always changes it.

For quantum cryptography to work, it's necessary to encode the message—which could be a bank password or a piece of military intelligence, for example—just one photon at a time. That way, the sender and the recipient will know whether anyone has tampered with the message.

Prof. Bhattacharya's emitter is a single nanowire made of gallium nitride with a very small region of indium gallium nitride that behaves as a quantum dot. A quantum dot is a nanostructure that can generate a bit of information. The emitter is fueled by electricity, rather than light, and each photon it emits possesses the same degree of linear polarization, so that all could be used in an encoded message.

Full story: eecs.umich.edu/n/sec

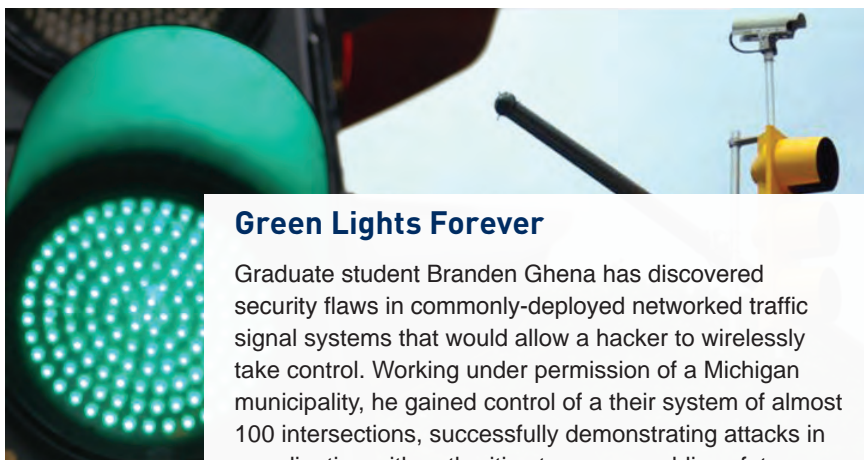


Radar Systems for Security and Law Enforcement

A primary motivation behind the development of sub-millimeter wave radar systems is security, especially the stand-off imaging of persons and hidden objects such as illicit drugs and explosives. Imaging in this frequency band is attractive because the corresponding wavelength is short enough to provide very high resolution with moderate aperture size, yet long enough to penetrate materials such as clothing and packaging materials. Having already proven the concept in indoor environments, Prof. Kamal Sarabandi and his group are investigating the unique advantages of sub-MMW radar technology, as well as the performance limitations of such systems, in typical outdoor environments with varying weather.



Characterization of the radar cross section of a grass rough surface.



Green Lights Forever

Graduate student Branden Ghena has discovered security flaws in commonly-deployed networked traffic signal systems that would allow a hacker to wirelessly take control. Working under permission of a Michigan municipality, he gained control of a their system of almost 100 intersections, successfully demonstrating attacks in coordination with authorities to ensure public safety.

Full story: eecs.umich.edu/n/green

E-Voting is Still Not Secure: Flaws Found in Estonia, New South Wales

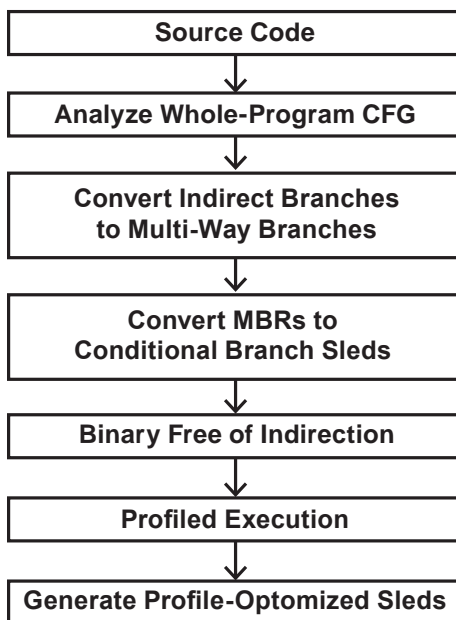
Prof. J. Alex Halderman and his collaborators have continued to demonstrate significant security risks in on-line voting systems, having performed new studies prior to elections in New South Wales, Australia in March 2015 and during the May 2014 election in Estonia that revealed the possibilities for stolen or changed votes. In both cases, the researchers demonstrated that attackers could easily compromise the integrity of the country's Internet voting system and influence an election's outcome, quite possibly without a trace.

Why is e-voting so hard to secure when we are able to trust ebanking and other electronic records systems? Evoting systems have many attack vectors and, because voting is secret, provides no reliable means of verification. For now, the general consensus amongst security researchers in this area is to continue to recommend paper ballots as the most secure and reliable form of voting.

Full story: eecs.umich.edu/n/ivote



Prof. Halderman, second from right, and other researchers report their findings to Estonian authorities.



Researchers Control Those Control-Flow Attacks

Code injection is one of the most common techniques used to initiate computer attacks. It is used by an attacker to introduce code into a computer program to change the course of execution, or control flow. The results of a change in control flow can be disastrous, and can lead to the attacker taking control of a system without the owner's knowledge.

Researchers including graduate student William Arthur, Prof. Todd Austin, and research scientist Reetuparna Das have developed a technique that is designed to eliminate the possibilities for control flow attacks. While previous approaches to control-flow security consisted of layering additional complexity on top of user data in an effort to shield any vulnerabilities from attack, the Michigan researchers took the opposite approach, using a subtractive approach by removing the actual vulnerability. They chose to simply not trust any user data, and instead removed all avenues for such data to be injected into the program counter.

Their technique, called Control Data Isolation, provides protection by going to the root of the problem and removing all of the operations that inject runtime data into program control. When a program is installed, it is compiled in the researchers' Pitbull compiler in a process that essentially locks out the possibility for code injection, and that recompiled code is run on the system. The Pitbull compiler is now available as open source software.

Phishing Attacks

Phishing is a type of cyber crime where the perpetrator seeks sensitive information located on your computer by disguising themselves as something safe. For example, these attacks may involve replacing the contents of safe web pages with harmful data. The attacker can often attack different members of a network from one domain while constantly changing its IP address to avoid detection, which is called fast-flux.

Prof. Mingyan Liu and her team are using big data analysis to tackle phishing scams. They set out to identify patterns in this phenomenon using a huge set of real data from past phishing campaigns. Identifying a pattern would enable identification of such an attack in real time, instead of relying on after-the-fact data to learn about the nature of an infection.

They were able to visualize the spread, or propagation, of a phishing attack with 2D models. Their research group is one of the first to approach the problem of phishing from both a Big Data and a cyber security perspective. "This is a very hot area," said doctoral researcher Yang Liu. "The government, Google, and Facebook are all investing in this kind of research." This research received a Best Applications Paper Award at the *ACM/IEEE International Conference on Data Science and Advanced Analytics (DSAA2014)*.



Shared Memory in Mobile Operating Systems Provides Ingress Point for Hackers

A weakness believed to exist in Android, Windows, and iOS operating systems could be used to obtain personal information from unsuspecting users, according to a team of security researchers including Prof. Z. Morley Mao, graduate student Qi Alfred Chen, and their collaborators at the University of California, Riverside.

The vulnerability occurs in the use of shared memory by the operating system that could allow a malicious app to monitor the state of user interactions with an app in use in order to steal sensitive data, such as login credentials, photos, and other personal data. The team demonstrated an exploit based on the vulnerability on a smartphone running the Android operating system.

Specifically, the researchers demonstrated that the confidentiality of the shared memory framework used for graphical user interface (GUI) display could be breached by a background app without requiring any permission. This allows the background app to seamlessly “watch” user actions and substitute malicious user interface screens in place of intended screens, with those duplicate screens siphoning off and stealing personal information.

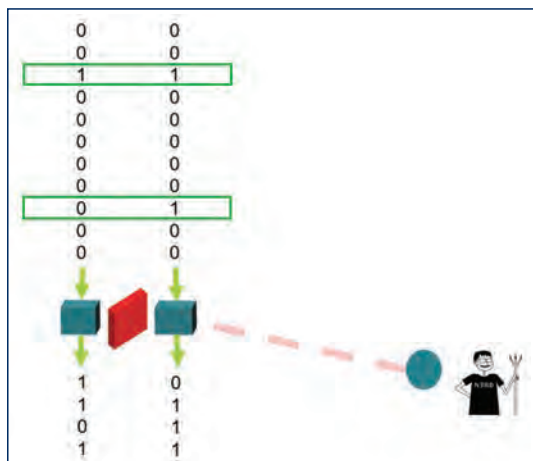


The attack starts when a user downloads a seemingly benign app, such as a wallpaper control app. That app runs malicious code in the background, allowing attackers to access shared memory without needing any special privileges. This method was successful between 82 percent and 92 percent of the time on six of the seven popular apps tested by the researchers.

Full story + video: eecs.umich.edu/n/mobile

Generating Securely Random Numbers

Quantum measurements are inherently unpredictable, and this fact can be leveraged to provide a unique and powerful way of generating random numbers. Moreover, measurements on quantum entangled states introduce a new possibility: random number generation that is *provably* random, even if one is using hardware that is imperfect or maliciously designed.



A protocol for untrusted-device randomness expansion (Coudron-Vidick-Yuen, 2013).

In 2014, Prof. Yaoyun Shi and Dr. Carl Miller gave the first mathematical proof of error-tolerant untrusted-device quantum random number generation. Their work was presented at a plenary talk at the annual Quantum Information Processing conference in 2014, along with a related work (Physical Randomness Extractors) co-authored by Xiaodi Wu (PhD CSE, 2013).

Unlike pseudorandom number generators, which are based on assumptions about computational hardness, the security of untrusted-device random number generation is only based on faith in the correctness of quantum physics. The ability to generate provably random numbers even in the presence of an adversary opens up new avenues in information security. This topic is part of a larger subject which Prof. Shi calls “trustworthy quantum information,” a subject which was studied at the new *Trustworthy Quantum Information Workshop*, held at Michigan June 28 – July 2, 2015.



Prof. Kevin Fu Testifies on IRS Data Breach for Senate Committee

On June 2, 2015, Prof. Kevin Fu was one of the five witnesses to testify to the U.S. Senate Committee on Homeland Security & Governmental Affairs at a hearing on “The IRS Data Break: Steps to Protect Americans’ Personal Information.”

Prof. Fu spoke about knowledge-based authentication and recommended to the committee that they encourage research collaboration between cybersecurity experts and social and behavioral scientists to carry out human subject experiments that measure the risks and benefits of knowledge-based authentication.

Artificial Intelligence



Employing Machine Learning to Allocate Resources

Prof. Jake Abernethy is exploring a range of deep mathematical connections emerging across two research domains: Machine Learning, which focuses on developing algorithmic tools to synthesize data into predictions, and Microeconomic Theory and Finance, which seeks to understand markets, the allocation of resources, and prices.

The project will begin with the development of mathematical tools that enable a semantic correspondence between learning-theoretic objects and economic abstractions. For example, the project hopes to show that many algorithms can be viewed as implementing a market economy, where learning parameters are associated with prices, parameter updates are viewed as transactions, and under certain conditions learned hypotheses can be extracted as market-clearing price equilibria. Prof. Abernethy will explore several applications of this line of research, including new models for distributed computing and the development of techniques for crowdsourcing and labor decentralization.

Prof. Abernethy will begin a new initiative related to this project: the Michigan Prediction Team, a data-science focused program for formulating and solving prediction and learning challenges that arise from all around the University of Michigan community. This work is funded by an NSF CAREER Award.

Welfare Effect of Market Making on Market Performance

Graduate student researcher Elaine Wah and Prof. Michael Wellman have investigated the effects of market making on market performance. A market maker facilitates trade in a two-sided auction market by simultaneously maintaining offers to buy and sell.

The researchers employed empirical simulation-based methods to evaluate heuristic strategies for market makers as well as background investors in a variety of complex trading environments.

Their findings showed that the presence of the market maker strongly tends to increase not only total surplus across a variety of environments, but also background-trader surplus in thin markets with impatient investors, with urgency captured by a limited trading horizon. Comparison across environments revealed factors that influenced the existence and magnitude of benefits provided by the market maker function. Wah won the Pragnesh Jay Modi Best Student Paper Award at the *International Conference on Autonomous Agents & Multiagent Systems 2015* for her paper on the work.



Elaine Wah



Prof. Michael Wellman



Prof. Baveja



Nan Jiang



Alex Kulesza



Prof. Richard Lewis

Shorter, Estimated Horizons Can be Better

Markov decision processes (MDPs) provide a mathematical framework for modeling decision making in situations where outcomes are partly random and partly under the control of a decision maker. MDPs are useful for studying a wide range of optimization problems solved via dynamic programming and reinforcement learning. For MDPs with long horizons, it is common in practice to use reduced horizons during planning to speed computation.

The research team of graduate student Nan Jiang, postdoctoral researcher Alex Kulesza, EECS Prof. Satinder Singh Baveja, and Psychology and Linguistics Prof. Richard L. Lewis has developed a precise explanation for why using a shorter planning horizon with a model estimated from data for Markov decision processes with long horizons can actually be better than a policy learned with the true horizon.

The researchers' explanation for this phenomenon is based on principles of learning theory. They show formally that the planning horizon is a complexity control parameter for the class of policies to be learned. Each complexity measure gives rise to a bound on the planning loss predicting that a planning horizon shorter than the true horizon can reduce overfitting and improve test performance. The researchers won a Best Paper Award for the project at the *International Conference on Autonomous Agents & Multiagent Systems 2015*.

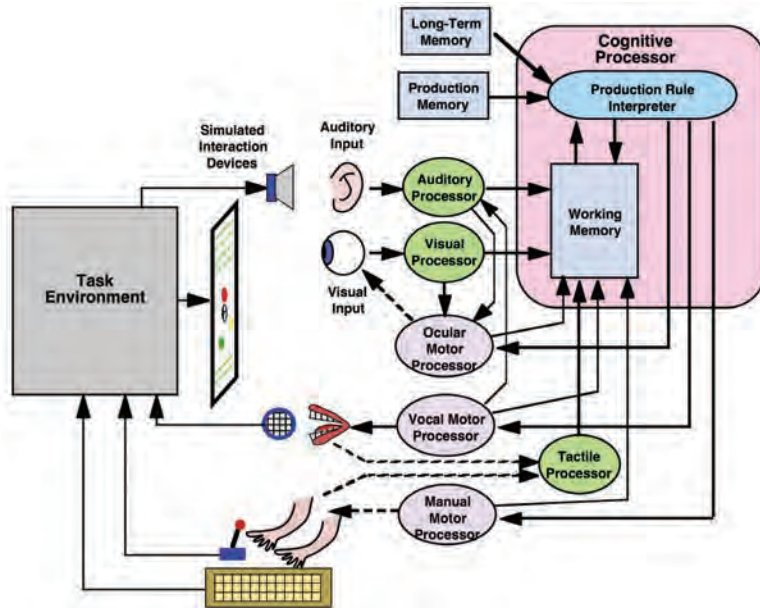
Human Computer Interaction

Making Sure You Hear it All

Auditory display is the use of sound to communicate information from a computer to the user, and a common problem in the design of auditory displays is how to manage multiple sources so that the user can maximize the information gained from each acoustic source.

Profs. David Kieras and Gregory Wakefield have explored the use of a cognitive architecture, called EPIC (Executive/Process-Interactive Control), to model human performance in a two-talker listening task. EPIC is one among several architectures whose goal is to provide a comprehensive account of human abilities and limitations in perception, cognition, and action.

The researchers' work has resulted in the proposal of a strategy for a two talker listening task and modified production rules to provide a corpus-driven model that accounts for human performance in the listening task. The results of their research can inform the work of auditory interface designers who create systems for vision-impaired people or systems where auditory processing is critical. Their work was chosen for a Best Paper Award at the *International Conference on Auditory Display* in 2014. Full story: eecs.umich.edu/n/epic



The overall structure of the EPIC architecture. A simulated task environment is on the left; the simulated human, made up of a set of components, is on the right.

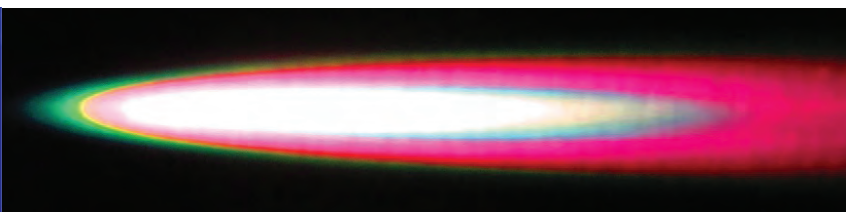
Easy Computing Interfaces are a Science

Visual search pervades everyday computer usage, such as the simple task of finding an icon on a smartphone. Icons that are always in the same location on the home screen and used often will be found quickly, but icons that are used occasionally or that change their position often as new applications are added will require visual search. Designing systems that support faster visual search will improve usability and increase satisfaction for smartphone users.



Prof. David Kieras and his former student Anthony Hornof (PhD CSE 1999) have completed a cognitive modeling project which could contribute to this goal. Their project goes beyond previous cognitive modeling of icon search by incorporating a more advanced simulation of visual perception and ocular motor processing. They used human volunteers to perform a carefully constructed set of tasks, such as searching for an object of a certain shape, color, size, and recorded the speed with which the object was found and the speed with which the next object was found. At the same time, eye movements were recorded with a corneal-reflection film camera system and were scored by hand. They used the data to create increasingly realistic and accurate predictions for visual human-computer interaction tasks.

The features captured by the research were then used to formulate a predictive model for use by interface designers, allowing a designer to test proposed aspects of design, such as icon and environment design, empirically. This research won a Best Paper Award at the *ACM CHI Conference on Human Factors in Computing Systems* in 2014. Full story: eecs.umich.edu/n/visual



DYNAMO: MURI Center for Dynamic Magneto-Optics

Michigan is home to a new major research program that aims to provide a better understanding of phenomena driven by the magnetic field component of light. A key long-term goal of this five-year, \$7.5M Multi-University Research Initiative (MURI), called the Center for Dynamic Magneto-Optics (DYNAMO), is to investigate the prospects for direct conversion of light to electricity without the thermodynamic losses typical of photovoltaic (solar cell) technology. The Center will establish the framework required to develop a new and revolutionary class of materials capable of sustained operation of magneto-electric conversion.



Prof. Stephen Rand, principal investigator of the project, stated that, “the fundamental objective of this basic research initiative is to uncover, explain, and exploit dynamic magneto-optical processes and materials for new technological capabilities. A particularly important process is the magneto-electric conversion (MEC) process, that in principle accomplishes the highly-efficient transformation of light energy into electricity without generating much heat in transparent insulating materials.”

In foundational research that led to the current project, Prof. Rand came to the rather startling discovery in 2007 that, under the right conditions, a low-intensity light field can generate magnetic effects that are one million times stronger than previously expected. Under these circumstances, the magnetic effects develop strength equivalent to a strong electric effect.

“This could lead to a new kind of solar cell without semiconductors and without absorption to produce charge separation,” Rand said. “What we are potentially talking about here is using light to charge capacitors – which are energy storing devices – simply by passing the light through a material to create a charge separation that can then work in the outside world.”

“MEC should enable direct conversion of any kind of intense light into electricity, whether the input is in the form of sunlight, laser beams, or other forms of directed energy, because coherence of the input light is not required,” said Rand.

The University of Michigan is the lead institution in this effort, and is partnering with Northwestern University, Columbia University, and the University of Central Florida, as well as international collaborators. The Center’s kickoff meeting was held May 23, 2014 at the University of Michigan. *Full story: eecs.umich.edu/n/dynamo*

Power From Sustainable Sources to Your Home



Prof. Johanna Mathieu is working on the problem of how best to integrate wind and solar power into the nation’s established electrical grid system. Wind and solar power are great sources of sustainable energy, yet by their very nature are highly variable. The public’s use of energy is variable, yet there is little tolerance for a power supply that is not completely reliable throughout even extreme peaks in energy usage.

“For this project,” explains Prof. Mathieu, “we will explore how electric loads, which are inherently uncertain, can be used to provide back-up capacity to electric power systems, helping balance electricity supply and demand. This is especially important in power systems with a lot of wind and solar power.” The results of this research will guide load control program design as well as power system market design.

Johanna is also working with the U-M Energy Institute and NSF to investigate the environmental impacts of distributed energy storage in electric power systems.

More broadly, the research may one day impact the nation’s energy policy as it attempts to balance the cost of energy with the environmental impact of generating that energy.



Prof. Mathieu took her class, “Grid Integration of Alternative Energy Sources,” on a field trip to a local wind farm.

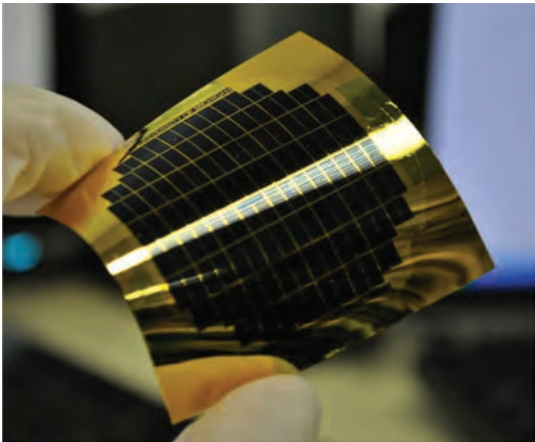
Next Generation Photovoltaics

Stephen Forrest, Paul G. Goebel Professor of Engineering, was selected as part of the U.S. Dept. of Energy SunShot's "Next Generation Photovoltaics 3" program. This was the only project awarded for organic photovoltaic research and development. Prof. Stephen Forrest and his group have achieved significant results in the area of organic photovoltaics, which have the potential to redefine the cost structure of the solar industry and introduce solar power to untapped applications. Advances made in the lab will be transferred to the group's commercialization partner, NanoFlex Power Inc.



Making Solar Cells Flexible

Prof. Stephen Forrest's group, led by doctoral student Kyusang Lee, has developed an innovative new fabrication technique using an inorganic III/V material, GaAs, to build lightweight, flexible devices not possible with conventional silicon.



What makes Kyusang's process truly unique is that it recycles the wafer multiple times without affecting the performance of the device. This is a major breakthrough since the price tag for a typical GaAs wafer is \$20k/m², which severely limits its applications for large area devices such as displays and solar cells.

Kyusang uses a technique called non-destructive epitaxial lift-off to separate the device from the wafer by etching a sacrificial layer. The resulting device can then be formed into any shape and mounted on a thin plastic substrate.

A particularly promising application for these recyclable wafers is in solar cells. Thin-film f III/V devices make photon recycling possible by using integrated mirrors to reflect photons back into the device. The resulting solar cells are highly efficient.

Beautiful Energy

Colorful, see-through solar cells invented by Prof. Jay Guo's group could one day be used to make stained-glass windows, decorations and even shades that turn the sun's energy into electricity. The cells, believed to be the first semi-transparent, colored photovoltaics, have the potential to vastly broaden their use.

"I think this offers a very different way of utilizing solar technology rather than concentrating it in a small area," said Prof. Guo. "Today, solar panels are black and the only place you can put them on a building is the rooftop. And the rooftop of a typical high-rise is so tiny. We think we can make solar panels more beautiful—any color a designer wants. And we can vastly deploy these panels, even indoors."

The cells are comprised of both organic and inorganic components, and are 10 times thinner than traditional amorphous silicon solar cells. The ultrathin, hybrid design helps the cells hold their color and leads to a nearly 100 percent quantum efficiency (which is different from overall efficiency).

The decorative solar cells are not as efficient as a traditional cell, and the team is working to improve efficiency through the use of new materials. But, the trade-off between beauty and utility will always exist.

Full story + video: eecs.umich.edu/n/cells



More Efficient Electronics With Blue OLEDs

In a step that could lead to longer battery life in smartphones and lower power consumption for large-screen televisions, Prof. Stephen Forrest and his team have extended the lifetime of blue organic light emitting diodes by a factor of 10.

Blue OLEDs are one of a trio of colors used in OLED displays such as smartphone screens and high-end TVs. But not all OLEDs are created equal. Phosphorescent OLEDs, also known as PHOLEDs, produce light through a mechanism that is four times more efficient than fluorescent OLEDs. Green and red PHOLEDs are already used in these new TVs—as well as in Samsung and LG smartphones—but the blues are fluorescent.



Prof. Forrest and his colleagues demonstrated the first PHOLED in 1998 and the first blue PHOLED in 2001. But the short life of a blue PHOLED limits its usefulness for displays and other electronics. With their new results, the efficiencies of blue OLEDs in electronic devices could jump from about 5 percent to 20 percent or better in the near future.

One of the reasons for exploring OLED technology is to create television screens that are extremely thin and even curved, with little blurring of moving objects and a wider range of viewing angles.

Officials at Universal Display, an industrial collaborator with Prof. Forrest, are excited about the possibilities inherent in this latest breakthrough, and believe it will lead to full phosphorescent RGB in commercial electronics.

Full story: eecs.umich.edu/n/blue

A Better Light Bulb With PHOLEDs

The most common kind of light bulb in the United States—the incandescent—is only about 5 percent efficient. The phosphorescent organic light-emitting diode (PHOLED), on the other hand, makes light out of 100 percent of the electricity that goes into it.

They're good for smartphone screens and mood lighting, but they drop off in both efficiency and lifetime when they have to shine brightly.

However, Prof. Stephen Forrest and his group have found an elegant way to get around this problem—by arranging the PHOLEDs into a pyramid.

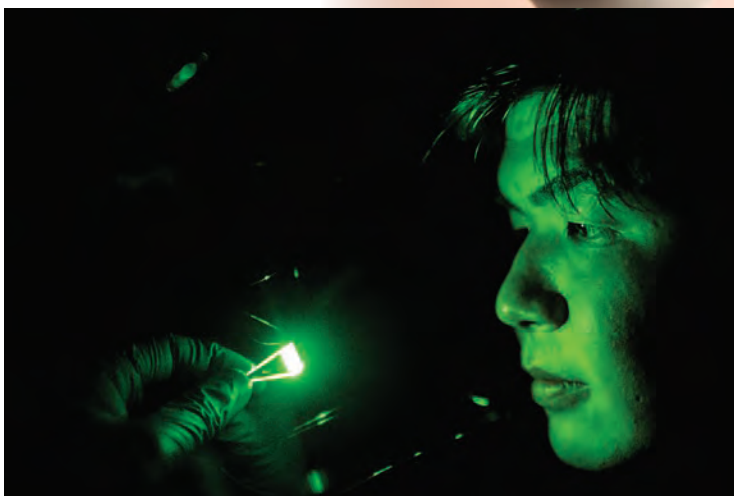
“Achieving extra brightness from the conventional, flat design is inefficient and shortens the device lifetime,” said doctoral student Jaesang Lee.

“However if we integrate our PHOLEDs into a pyramidal shape, we are able to achieve the equivalent, concentrated brightness at a much lower electrical current.”

Lee's pyramidal structure resulted in illumination three times brighter than a flat configuration at the same current, and further enhancements are expected to further improve the brightness.

“My hope is that PHOLEDs will deeply penetrate all aspects of the lighting market because they're very efficient, very attractive and as people accept them, it will take a load off the electricity grid,” said Prof. Forrest.

Full story + video: eecs.umich.edu/n/pholed



Scientific Discovery: A New Quantum Mechanical State, With Important Implications for Electronic Devices

Like a spring connecting two swings, it has been discovered that light can act as photon glue that binds together the quantum mechanical properties of two vastly different materials, resulting in a third, unique quantum state.

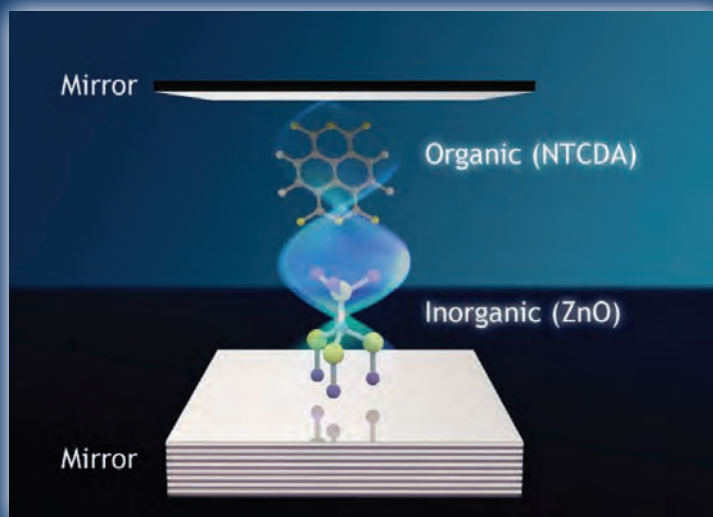
The effect could harness the most useful characteristics from each material for hybrid solar cells and high efficiency lighting, among other applications, including optical switching, quantum communication and computing.

Prof. Stephen Forrest and colleagues at Queens College in New York used light to create links between organic and inorganic semiconductors in an optical cavity—a mirror-lined nanoscale filament about 1/1,000th the width of a hair.

In the optical cavity, the photon essentially “glues” together all these quantum mechanical states, forming a unique and potentially useful new state called a polariton that can efficiently transfer energy from one material to another.

“In that new state lies their magic,” said Prof. Forrest. “Uses in solar energy conversion, light emission and optical switching are just a few examples of applications that can benefit.

Full story: eecs.umich.edu/n/glue



Extracting Utility-Scale Energy From Municipal Waste

Prof. Edwin Olson is collaborating with faculty in the Department of Civil and Environmental Engineering under an NSF Cyber-Innovation for Sustainability Science and Engineering (CyberSEES) grant to engineer a transformative means of extracting utility-scale energy from waste using next-generation facilities to be termed Sustainable Energy Reactor Facilities (SERFs).

The majority of municipal solid waste generated is still disposed of in landfills despite national and international efforts aimed to increase recycling. In modern landfills, this waste is treated as a material to be isolated and contained, and current waste management strategies result in the generation of biogases, primarily methane and carbon dioxide, that are mostly flared, vented, or leaked to the atmosphere where they remain as greenhouse gases. As a result, landfills represent the second largest anthropogenic source of methane in the U.S.

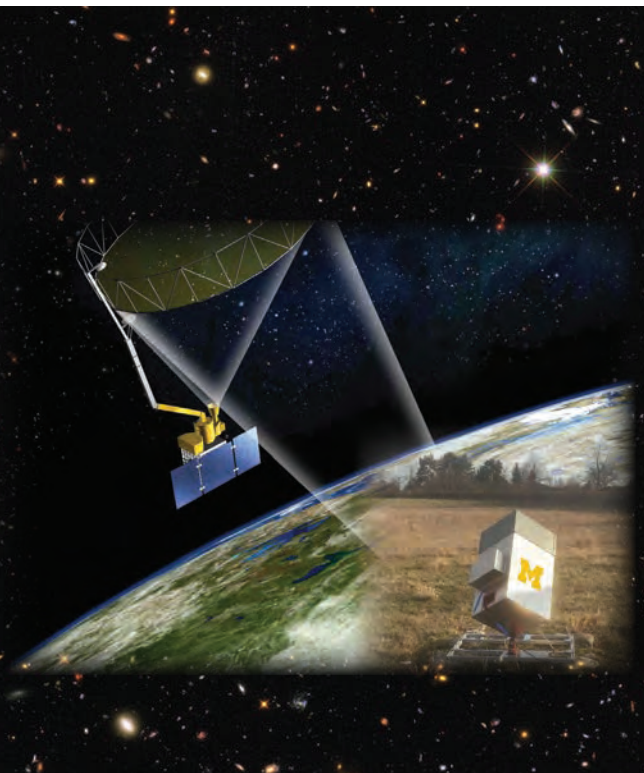
SERFs will be designed with two objectives: maximize energy recovery and minimize environmental impact. SERFs are only possible through environmental sensing and modeling of physical-chemical-biological processes occurring within a landfill. Through the adoption of high-performance computing for multi-domain process modeling, low-cost autonomous sensor networks, and unmanned autonomous vehicles (UAVs), the energy generation capacity of a SERF can be maximized resulting in lower cost energy production with a dramatic reduction in greenhouse gasses and carbon footprint compared to traditional dry-tomb landfills.



One of Prof. Olson's autonomous robots collects data from a landfill site.



Top: Dr. Adib Nashashibi, Prof. Kamal Sarabandi, Mani Kashanianfard, and Dr. Leland Pierce in the field testing their device, which just captured data from SMAP as it flew overhead.



Helping NASA Map the World's Soil Moisture

A research team led by Prof. Kamal Sarabandi has constructed the most powerful radar calibration device in the world to interface with NASA's newest orbiting satellite, called Soil Moisture Active Passive (SMAP). This calibration device will provide a reference point on the mission's finished maps. It becomes a known value that will be used to scale the rest of the data on the map, ensuring accurate results.

SMAP, launched January 31, 2015, is a 5-year mission that will measure the amount of water present in the top 2 inches of soil around nearly the entire Earth (only excluding the Poles). The data collected by SMAP is expected to improve our ability to forecast the weather, monitor droughts, predict floods, enhance crop productivity, and understand the Earth's water, energy, and carbon cycles. SMAP is the first satellite ever built to specifically target soil moisture.

Prof. Sarabandi, the Rufus S. Teesdale Professor of Engineering, said U-M invented radar calibrators to interact with satellites 15 years ago, and they were sufficient for the satellites in space at that time. SMAP, however, sends out a signal that covers a greatly expanded area. For example, most existing satellites cover a swath of about 50km. SMAP covers 1,000km. This means that a single pixel of the SMAP radar's image will cover an area of 1km x 1km, as opposed to 30m x 30m.

This required a dramatic improvement in the radar calibration device to ensure an accurate interpretation of all the data being collected. Michigan's device provides a signal to interface with SMAP that is 1,000x stronger than anything in existence today. In addition to its power, the device is unique for its ability to operate completely autonomously. Solar panels charge its battery; a specialized computer algorithm allows it to wake up every few days to catch, process, and return the signal; and data is transmitted in real time wirelessly to NASA scientists and other researchers around the world.

Full story: eecs.umich.edu/n/smap



Applying Cyber Information to Air Quality Management

Prof. Robert Dick is studying the impact of weather and human activity on production of, and exposure to, ozone and other air pollutants through the grant, "Connecting Next-generation Air Pollution Exposure Measurements to Environmentally Sustainable Communities."

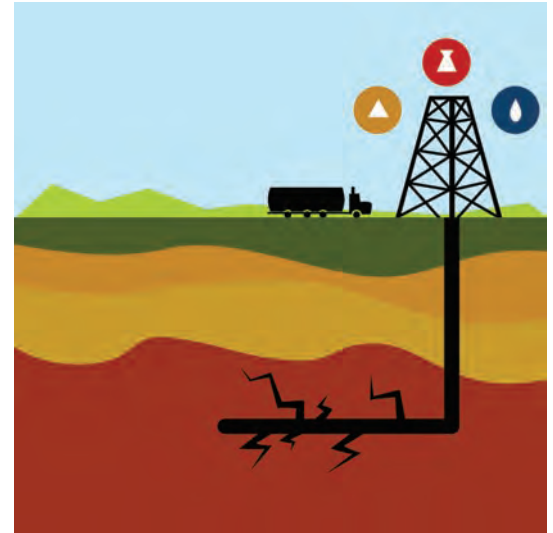
His work is focused on gathering information about air quality in the micro-environments around people, and will be used in the development of scalable pollution exposure models. These models will help us better understand the relationships between human activity, weather, and air pollutants.

Making Fracking Safer

Oil and natural gas still contribute to more than 55% of the power sources available worldwide. Hydraulic fracturing, or fracking, has been widely adopted by the petroleum industry to access the oil and gas currently trapped in layers of rock. As the use of fracking has grown, concerns about its environmental and public health impacts have also increased. One of the most significant concerns is the potential for hazardous fluids injected into rock formations to result in water and soil contamination.

The goal of research led by Prof. Kamal Sarabandi is to generate an accurate map of the fracturing area to prevent environmental damage, while optimizing the production efficiency of oil and natural gas. Current electromagnetic techniques are able to detect fractures only ~25m from the source, using high-power transmitters and very sensitive receivers. Using the method developed by Prof. Sarabandi and his student, Jiangfeng Wu, they are able to detect fractures ~2.5km from the source, using a medium frequency band imaging system to estimate the sub-surface fractures.

Knowing how far the fractures extend will help keep the chemicals used in the process away from water and soil that could be contaminated in the process, and at the same time will create a mapping system the companies can use to inform their fracking activity.



Soil Moisture and the Weather

Soil moisture data is required for many scientific applications, including land surface models, water and energy balance models, weather prediction models, general circulation models, and ecosystem process simulation models. It also aids in precision farming and agricultural drought monitoring. Michigan engineers are tackling the problem of monitoring soil moisture over time using a wireless network of underground sensors. The ultimate goal is to be able to monitor the soil moisture over time with as few measurements as possible and with a high degree of accuracy, using a technique called compressive sensing.

Prof. Mingyan Liu and Xiaopei Wu successfully employed compressive sensing to take soil moisture readings that minimized the total amount of time the node remained active in actuating the moisture probes and in data transmission, and that also achieved a very low estimation error at no more than 10% of the standard sampling rate. They applied their results to the SoilSCAPE (Soil moisture Sensing Controller And oPtimal Estimator) project, where soil moisture sensor probes have been placed at varying depths in the ground every few square feet and measurements are wirelessly transmitted to a base station for processing.

Prof. Liu estimated that the lifetime of a wireless node in SoilSCAPE using their newly-developed system would increase from approx. 6 months to 5 years by taking samples at 100-min. intervals rather than 10-min. intervals. Key to the success of the system is a 10-fold reduction in the amount of transmitted data, and the employment of long periods of sleep mode for the sensor nodes.

Collaborators on the SoilSCAPE project include Prof. Demos Teneketzis and researchers from the University of Southern California and MIT. The research received a Best Paper Award at the 11th ACM/IEEE Conference on Information Processing in Sensor Networks.

Video: eecs.umich.edu/n/soil

Prof. Mingyan Liu at one of the locations where soil moisture sensors have been placed in the ground.



Breakthroughs in Light



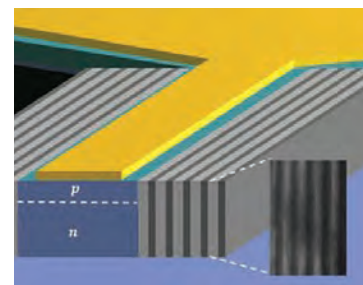
World's First Electrically-fueled Polariton Laser

Prof. Pallab Bhattacharya and his group have accomplished a scientific breakthrough in the world of lasers and light. They have made what's believed to be the first polariton laser that is fueled by electrical current as opposed to light, and that operates at room temperature, rather than way below zero. This development represents as significant a milestone as the invention of the most common type of laser – the semiconductor diode – in the early 1960s. Room-temperature operation is an important further development of the first electrically injected polariton laser created by Prof. Bhattacharya in 2012, a feat that researchers around the world had been trying to demonstrate since it was first proposed in 1996.

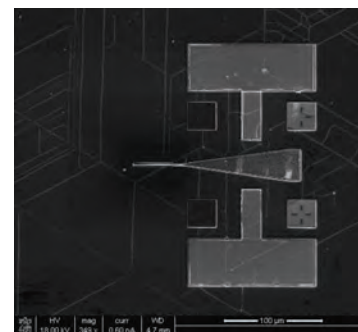
A polariton is part light and part matter. Polariton lasers harness these particles to emit light, and are predicted to be more energy efficient than traditional lasers. The new prototype requires 250 times less electricity to operate than its conventional counterpart made of the same material.

"For the past 50 years, we have relied on lasers to make coherent light and now we have something else based on a totally new principle," said Prof. Bhattacharya. In contrast with a traditional laser, polariton lasers don't stimulate radiation emission. Instead, they stimulate scattering of polaritons. This work could advance efforts to put lasers on computer circuits to replace wire connections, leading to smaller and more powerful electronics. It may also have applications in medical devices and treatments and more.

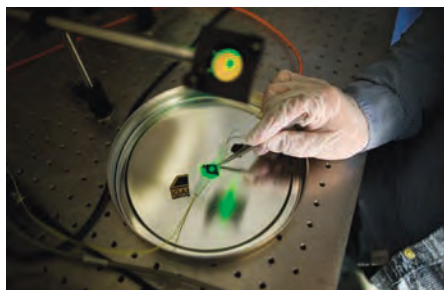
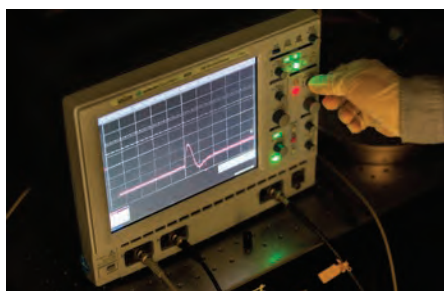
Full story: eecs.umich.edu/n/pol



Schematic representation of the GaN microcavity diode.



Scanning electron microscopy image of the fabricated device.



Lenses used to convert terahertz waves into sound.

T-ray Converts Light to Sound for Weapons Detection, Medical Imaging

A device that essentially listens for light waves could help open up the last frontier of the electromagnetic spectrum—the terahertz range. So-called T-rays are light waves that are too long for human eyes to see. Because terahertz frequencies fall between the capabilities of the specialized tools presently used to detect light, engineers have yet to efficiently harness and make use of them.

The terahertz band is scientifically rich, but today's detectors are either bulky, need to be kept extremely cold to work, or can't operate in real time. This greatly limits their usefulness for applications like weapons and chemical detection and medical imaging and diagnosis.

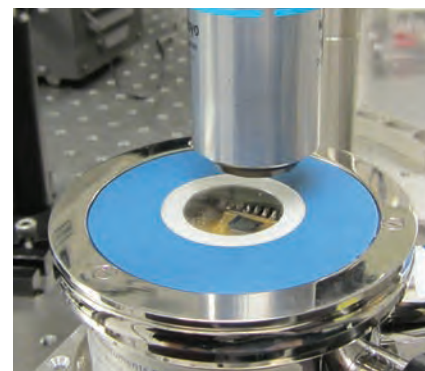
Profs. Jay Guo and Ted Norris created a device that turns T-rays into ultrasound, which can then be detected by a highly sensitive acoustic sensor. To do this, they invented a special transducer that turns terahertz light into ultrasound waves and then transmits them. The use of T-rays could help airport security guards find chemical and other weapons; let doctors image body tissues with less damage to healthy areas, and give astronomers new tools to study planets in other solar systems.

Full story: eecs.umich.edu/n/tray

1st Room-temperature IR Light Detector Could Enable Night-Vision Contact Lenses

The first room-temperature light detector that can sense the full infrared (IR) spectrum has the potential to put heat vision technology into a contact lens. IR vision allows us to see in the dark, monitor blood flow, identify chemicals in the environment, and even peer under layers of paint.

Developed by Profs. Zhaohui Zhong and Ted Norris, the device doesn't need the bulky cooling equipment of comparable infrared detectors currently on the market. "Our work pioneers a new way to detect light," said Prof. Zhong. "We envision that people will be able to adopt this same mechanism in other material and device platforms."



Graphene heterostructure photodetector being tested.

Rather than trying to directly measure the electrons that are freed when light hits graphene, the researchers looked instead at how the light-induced electrical charges in graphene affect a nearby current. The new approach allowed the sensitivity of a room-temperature graphene device to compete with that of cooled mid-infrared detectors for the first time.

The device can be integrated with contact lenses or other wearable electronics, and provides another way of interacting with the environment. It is already smaller than a pinky nail and is easily scaled down even further.

Shrinking the Size of Optical Systems Exponentially

Researchers have developed a way to exponentially shrink the size of a system typically needed to control the polarization of light, while maintaining the high level of performance needed for numerous optical applications such as color displays, microscopy and photography.

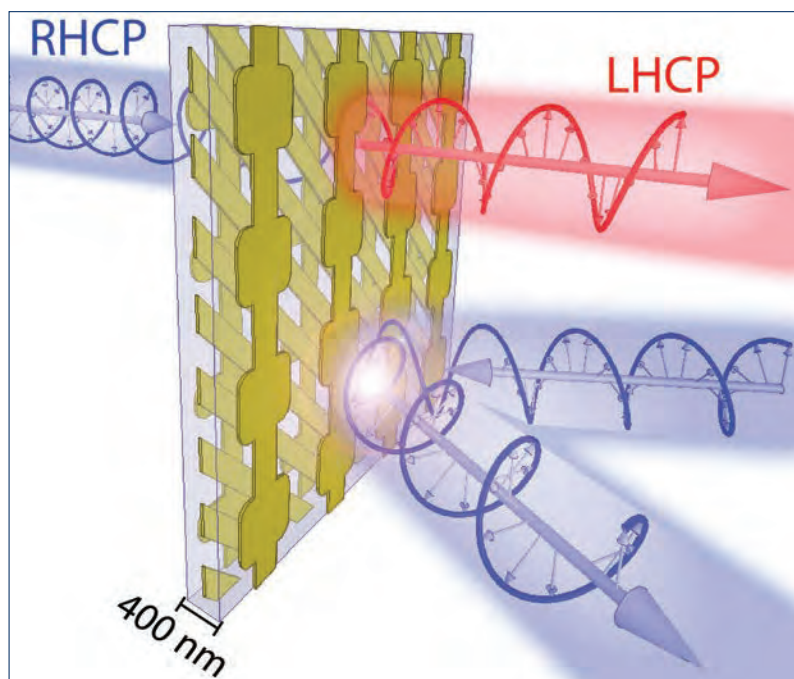
Prof. Anthony Grbic, Prof. Jay Guo and doctoral student Carl Pfeiffer used ultra-thin metamaterials called metasurfaces as a substitute for a typical bulky optical setup made up of millimeter-sized lenses, crystals, and polarizers.

The researchers designed and fabricated a metasurface that is composed of three patterned gold sheets separated by dielectric substrates; the layers are spaced at a subwavelength scale.

In the future, larger areas can be fabricated using methods such as nano-imprinting, which has been developed for years in Prof. Guo's lab. The researchers believe that metasurfaces could one day be used to completely control the phase and amplitude, as well as the polarization of light, which will further extend their usefulness.

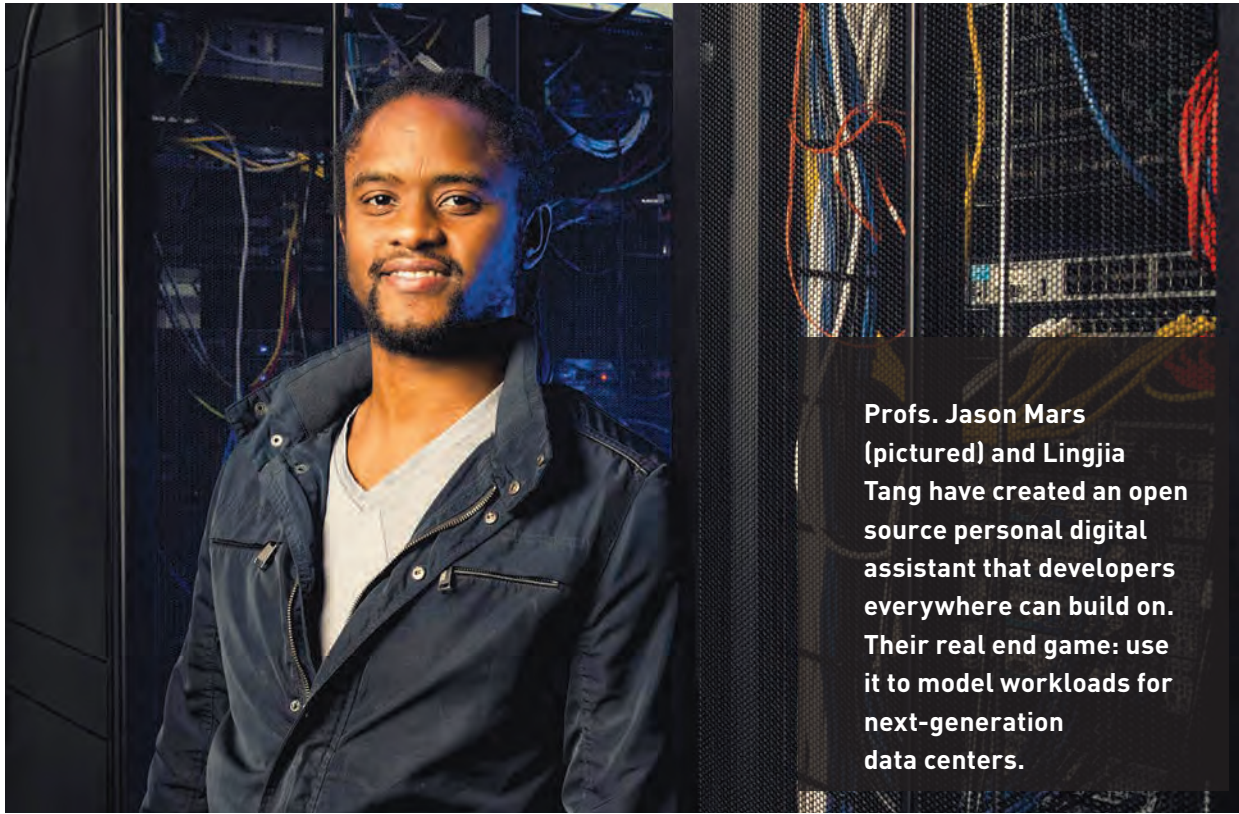
"One day," said Carl Pfeiffer, "we believe that we will be able to replace the optical components that are currently used in analytic chemistry, biology, and crystallography to identify the spatial structures of molecules, with our ultrathin metasurfaces. These metasurfaces could also be used in applications such as infrared identifiers, which utilize the unique polarization signature emitted by an infrared ID tag in a similar way that newer credit card readers use near field communication to read a credit card without swiping it."

Full story: eecs.umich.edu/n/opt



Right-handed circularly polarized (RHCP) light enters the metasurface, but exits as left-handed circularly polarized (LHCP) light.

Breaking Down Big Data



Profs. Jason Mars (pictured) and Lingjia Tang have created an open source personal digital assistant that developers everywhere can build on. Their real end game: use it to model workloads for next-generation data centers.

Meet Sirius: An Open-Source Digital Assistant

Researchers including Profs. Jason Mars and Lingjia Tang and EECS graduate student Johann Hauswald have designed Sirius, an open-source intelligent personal assistant system with core functionalities that include speech recognition, image matching, natural language processing, and a Q&A system.

Sirius uses many of the same algorithms that Apple Siri, Microsoft Cortana, and Google Now do, but it is free and can be customized. The researchers believe that their platform represents a new opportunity for developers who would like to create their own intelligent devices.

“We’re very excited to see what the world comes together to build and learn with Sirius as a starting point,” says Mars.

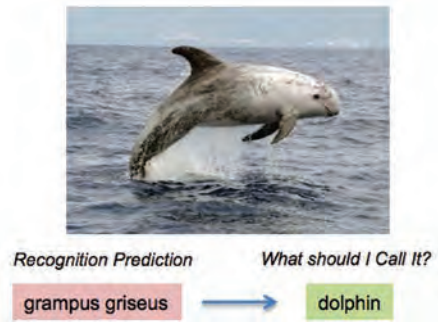
Sirius was built to allow the researchers to model how the data centers that process media- and data-rich queries should evolve to keep up with escalating pressure from wearable gadgets and their computation-heavy queries. Most of the work to process these requests happens in the cloud; for example, smartphone-based assistants can accept commands or questions and translate them to text but it’s cloud-based software that figures out what the text means, searches for answers, picks the best one and sends it back to the mobile device.

Wearables will rely heavily on voice and image input, and by 2018, sales in the category are expected to reach 485 million devices each year.

“Some people ask whether speech or visual-driven computer interaction is just hype or the next big thing, and I truly believe it’s the natural trend,” says Tang. “I think in the future we will communicate with computers more like how we communicate with humans.”

Full story + video: eecs.umich.edu/n/sirius





Defining Entry-Level Categories at a Large Scale

Psychologists first defined and studied entry-level categories in the 1980s, which are the labels people use to name an object. Prof. Jia Deng and his collaborators at University of North Carolina and Stony Brook University conducted research on entry-level categories for big data and developed the first models for predicting entry-level categories for images.

Their models combined visual recognition predictions with proxies for word “naturalness” mined from the enormous amounts of text on the web. They demonstrated the usefulness of their models for predicting nouns (entry-level words) associated with images by people. The researchers also developed mappings between concepts predicted by existing visual recognition systems and entry-level concepts that could be useful for improving human-focused applications such as natural language image description or retrieval. Their work received the Marr Prize at the *International Conference on Computer Vision*.

Changing the Way We Use Social Network Data

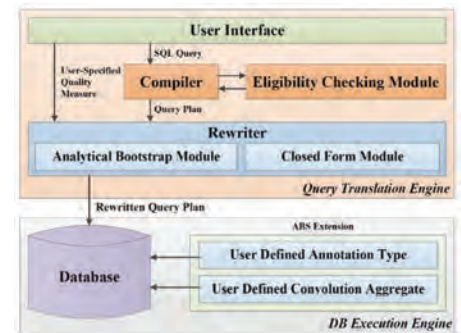
A better understanding of social networks will help understand what technologies and practices people and firms will adopt, how information is transmitted and aggregated, and how network structure relates to an agents’ ability to search within a network. Prof. Grant Schoenebeck will seek to develop a better understanding of social networks through a rigorous theoretical understanding of complex and strategic network processes, network structure, and algorithms for network properties with his NSF CAREER grant.



His project is developing and applying traditional tools, insights, and approaches from theoretical computer science including functional analysis, graph theory, combinatorics, linear algebra, probabilistic analysis, linear and semidefinite program hierarchies, complexity theory, and game theory to the study of network processes and structure. The increasing presence of computer-accessible data has rekindled an interest in this field because of the new ability to gather data to test theories on a large scale.

ABS: A Fast Error Estimation System

Prof. Barzan Mozafari and four collaborators from UCLA have created the Analytical Bootstrap System (ABS), a fast error estimation system for a technique called Approximate Query Processing (AQP), which is used with data sampling to support timely and cost-effective analytics of big data. The ABS system is designed to bridge the gap between the two existing approaches by dovetailing their merits while avoiding their limitations, inheriting general and automatic operation that allows for application to more general queries, but without the need for computationally-demanding simulations that would impact efficiency. These merits of ABS enable complex exploratory data analysis on large volumes of data. Their work won a Best Demo Award at the *2014 ACM SIGMOD/PODS Conference*.



ABS Architecture.



With the wealth of information available to today’s researchers in all fields, it is increasingly important to know when there is enough of the right kind of data to provide reasonable assumptions. Prof. Al Hero and his group are focusing on establishing theoretical fundamental limits that can aid practitioners and data analysts in acquiring the appropriate amount of data for reliable extraction of information. His group has experience working with astronomical data, network data, biomedical diagnostics, and predictive health.

Prof. Hero is also developing computational models useful for analyzing high dimensional data – such as information coming in from large networks of data collection sites, including the Internet. His group has applied these methods to a variety of projects, including gene analysis, video imaging, radar imaging, and social networks.

What's Missing in That Data?

Big Data means missing data. Prof. Laura Balzano is creating improved algorithms to make better sense of the huge amount of data available, data that has varying levels of certitude attached to it. This is a fairly new problem in the field of signal processing, where engineers have traditionally been able to achieve a high level of certainty when applying statistical methods to data sets – because those data sets have been relatively small.



“Unless we handle the fact that there’s missing data in these data sets, we won’t be able to do the really strong statistical analysis that we’re used to doing on small data sets,” said Prof. Balzano.

She is finding ways to model phenomena even when data are missing due to faulty measurement devices or privacy concerns. She sees immediate payoffs for environmental science, managing the power grid, and speeding up large computations – and long term impact in government, health, science, and industry.

Video: eecs.umich.edu/n/bdata

Connecting the Dots Between Big Databases

Prof. H.V. Jagadish is working on a project to use big data to achieve social good. He is developing a data manipulation prototype that uses data available via the Data.gov clearinghouse and merges sets of incompatible geographic data to make them comparable. This enables the data to be used to form new and meaningful connections for questions such as “Does better primary school education lower crime rates?” Such a question would compare crime data (organized by police precinct) and educational achievement data (organized by school district). The fact that these data sets don’t currently match geographically makes it hard to compare them using traditional means.



Prof. Jagadish plans to make his prototype tool publicly available when it is complete. This work was funded by a grant from the Bill and Melinda Gates Foundation as a part of the Foundation’s Grand Challenge Explorations. The project is one of the first Grand Challenges based on the manipulation of data.

Better Classifications for Objects in Images

Prof. Jia Deng and collaborators at Google have conducted research in large-scale object classification which addressed a computer’s ability to accurately classify objects in images, which is a fundamental challenge in computer vision research and an important building block for many other tasks such as localization, detection, and scene parsing.



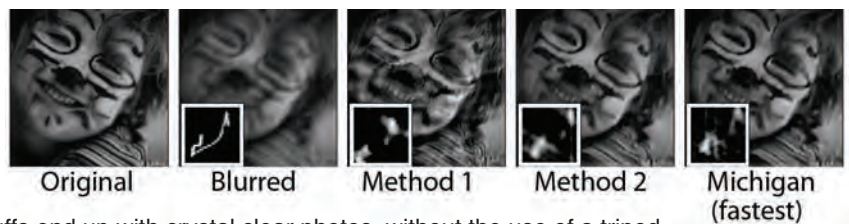
Traditional method (L) and the researchers’ method (R). HEX graphs capture relations between labels applied to the same object.

Because other classification methods do not adequately capture the complexity of semantic labels in the real world, the researchers set out to develop an approach to object classification that exploits the rich structure of real world labels and that allows flexible encoding of relations based on prior knowledge, thus overcoming the limitations of systems which tend to be either overly restrictive or overly relaxed.

They introduced Hierarchy and Exclusion (HEX) graphs, a new formalism that captures semantic relations between any two labels applied to the same object. They then provided rigorous theoretical analysis that illustrates properties of HEX graphs, such as consistency, equivalence, and computational implications of the graph structure. Next, they proposed a probabilistic classification model based on HEX graphs and show that it enjoys a number of desirable properties. Finally, the researchers evaluated their method using a large-scale benchmark and to show empirical results, which demonstrated that their model could significantly improve object classification by exploiting the label relations.

Sharper Photos

Photographers have come up with methods for reducing “camera shake” when taking photos that include raising your left shoulder, holding in your elbows, lying down, or even holding your camera like a machine gun. Engineers have also been working on the problem, and are finding new ways to help camera buffs end up with crystal clear photos, without the use of a tripod.



Prof. Ali Hero, in collaboration with Prof. Anna Gilbert and Dr. Paul Shearer, have developed a blind deconvolution method using incremental sparse edge approximation to recover images blurred by camera shake. The solution estimates the blur kernel first from only the strongest edges in the image, then gradually refines this estimate by allowing for weaker and weaker edges. Their method compares favorably with the best of current techniques to deblur photos, while being significantly faster and easier to generalize. The research received a Best Paper Award at the 2013 IEEE International Conference on Image Processing (ICIP).

Full story: eecs.umich.edu/n/photo

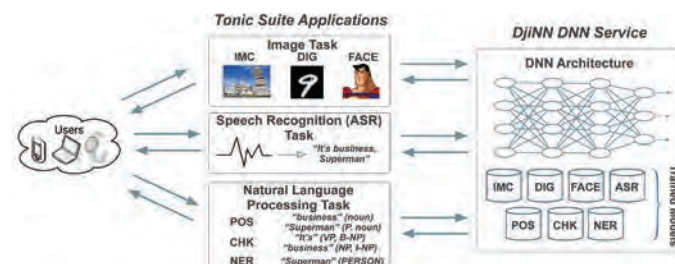


Software Helps Detect False Claims on Twitter

Because rumors and their negative effects can spread rapidly on social media, graduate student researcher Zhe Zhao is developing software with his advisor, Prof. Qiaozhu Mei, to help society identify false claims on Twitter.

The goal of the software is to detect emerging rumors as quickly as possible, and this was demonstrated when the researchers analyzed tweets about the Boston Marathon bombings. The software successfully detected 110 rumors from the stream of tweets about the bombings, with an average accuracy of more than 50 percent. This percentage is higher than the 10 percent accuracy of rumor-detecting through hashtag tracking and trending topics. Also, the software can detect rumors 3.6 hours earlier than methods that use trending topic detection, and 2.8 hours earlier than methods using hashtags as signals.

Deep Neural Network System Makes Deep Learning Accessible



Deep learning is a branch of machine learning that mimics how the human brain works and is used by major companies such as Apple, Google, Microsoft, and Facebook for tasks including image processing, speech recognition, and natural language processing. Researchers led by Profs. Lingjia Tang and Jason Mars have developed DjiNN, an open infrastructure for DNN as a service in warehouse scale computing (WSC) environments, and Tonic Suite, a set of seven applications that span image, speech, and language processing.

Through the use of DjiNN and Tonic, the researchers have enabled a system to accept user input from a variety of devices and process them in a common framework. Studying the properties of workloads under DjiNN and Tonic has enabled the researchers to recommend design points for future WSCs, which includes heavy use of graphics processing units for acceleration. By co-designing software and server hardware, the researchers hope to maximize total number of users a server can support and a data center can support, and to reduce the latency of user queries. DjiNN and the Tonic Suite are available via open source. *Full story + video: eecs.umich.edu/n/djinn*

Protean Code Enables Continuous Recompilation for Data Centers

A team of researchers has developed a new technique, called Protean Code, which is aimed at efficiently and continuously transforming the way in which the application programs running in data centers are recompiled in order to adapt to changing computer environments.

Given the continuing growth in demand for web services and the need to mitigate the cost and impact of building ever-larger and more resource-intensive data centers, maximizing the efficiency and utilization of Warehouse Scale Computers (WSCs) has become an important challenge.

Protean Code is an enabling technology for dynamically recompiling native applications and rebalancing the use of WSC resources as demands dictate. Although previous approaches have existed to perform dynamic compilation, none have been deployable in production because they have come with high overhead cost, demanding that applications be stopped and started in order to recompile. Protean Code makes use of a novel mechanism that enables precise control of the computer resources used to dynamically recompile code and stitches that new code into use in an asynchronous manner. This mechanism provides dynamic recompilation while incurring less than a 1% overhead cost for doing so.

The researchers, including graduate students Michael Laurenzano and Yunqi Zhang and Profs. Lingjia Tang and Jason Mars, have published their results in the paper entitled, "Protean Code: Achieving Near-free Online Code Transformations for Warehouse Scale Computers," which was presented at 47th Annual IEEE/ACM International Symposium on Microarchitecture (MICRO).

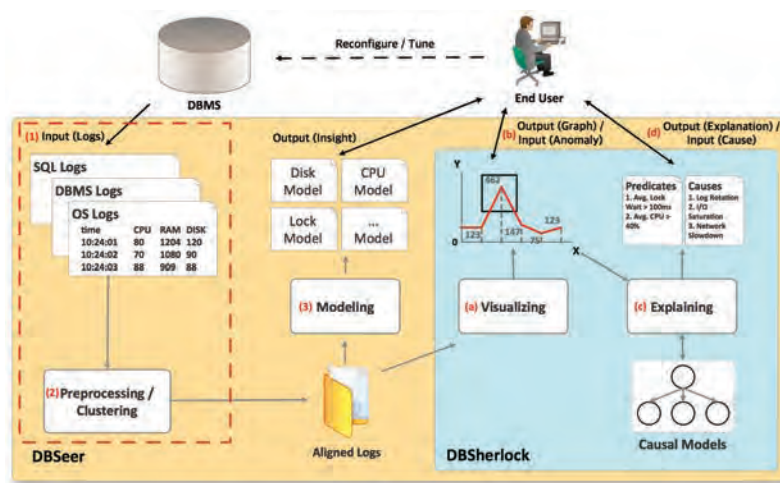
Full story + video: eecs.umich.edu/n/protean



DBSeer Makes Database Administration Easier

Databases are mission-critical assets that companies and governments rely upon, and database administrators need to sustain high levels of performance at all times. The complexity of modern databases has increasingly made this a challenge. DBSeer is a workload intelligence framework that exploits advanced machine learning and causality techniques to aid the database administrators.

Developed under the direction of Prof. Barzan Mozafari, DBSeer uses machine learning and statistical regression techniques to identify the bottleneck resources and predict performance for a given set of resources. These features help DBAs decide how to best allocate their budget to various types of resources. DBSeer also comes with a performance explanation module, called DBSherlock. DBSherlock utilizes the statistics collected from the database and the operating system. By combining techniques from outlier detection and causality analysis, DBSherlock assists administrators in diagnosing performance problems more easily, more accurately, and in a principled manner. Prof. Mozafari is currently investigating the commercial potential for DBSeer.



Decontaminating Data Models

Prof. Clay Scott and colleague Gilles Blanchard (U. of Potsdam) are developing a framework to deal with data that comes from multiple and varied data sets. In this theoretical work, Prof. Scott is addressing the problem known as “supervised pattern classification.” In this problem, labeled examples of different classes of objects are observed, and the goal is to design an algorithm that is able generalize them in order to correctly classify future observations. Prof. Scott is addressing the question of what happens when the labels provided to a classification algorithm are noisy. Such “weakly supervised” learning problems are increasingly common in the big data era.



Prof. Scott was able to provide general conditions on the amount of label noise that can be overcome by a classification algorithm. The work has implications for a number of topics including: crowd sourcing (which relies on non-expert annotators to provide labels); topic modeling (the problem of extracting coherent topics from large collections of unlabeled documents); and nuclear particle classification (where ground truth labels are inaccessible because contaminating particles are always present in background radiation).

This research won a Notable Paper Award at the 2014 *Int. Conference on Artificial Intelligence and Statistics (AISTATS)*.

Understanding Relationships Within Images

Prof. Jia Deng aims to advance image understanding in terms of recognizing the relationships present between multiple entities in images. This would include actions, such as “a person eating cake” and spatial relationships, such as “a keyboard on top of desk.”

His aim is to develop an image understanding system that parses and decodes complex or arbitrary queries, such as “is there a person standing on a red chair and fixing the light?” It would also enable the generation of rich image descriptions.

Is this a man playing guitar outdoors and wearing a hat?





An inaugural symposium to mark the launch of MIDAS will be held October 6, 2015. Registration is available at um-ds-kickoff.eventbrite.com.

Michigan Institute for Data Science: Bringing the MIDAS Touch to Big Data

Michigan is home to a new institute that aims to facilitate finding the gold nuggets in the massive data sets now available to researchers in virtually all fields. Called the Michigan Institute for Data Science (MIDAS), it is the new focal point for the multidisciplinary discipline of data science at Michigan, and part of Michigan's \$100M Data Science Initiative.



Alfred O. Hero, Jr.,
R. Jamison and Betty
Williams Professor of
Engineering, co-director
of MIDAS.

"The affiliations of the more than 120 faculty involved so far gives an insight into the breadth of activity that falls under Data Science," said Al Hero, R. Jamison and Betty Williams Professor of Engineering, and newly-named co-director of MIDAS. These faculty hail from at least 11 different Schools, Colleges, and Institutes across the University, and include at least 20 from the EECS Department. The key mission of MIDAS is to facilitate shared knowledge and synergy among those already working in the area of Data Science, with the goal of advancing technologies and scientific methods that can be used in a wide variety of applications.

At Michigan, faculty have access to massive data sets related to their own research in areas as diverse as: public health and personalized medicine; transportation with connected vehicles; brain sciences; environmental and earth sciences; astronomy; materials science; genomics and proteomics; computational social science; business analytics; learning analytics; computational finance; information forensics; and national defense. At the same time, researchers are dealing with critical associated issues such as high-performance computation and cyber security.

"There's an immense amount of data generated from sensing devices and other sources," said Prof. Hero, "yet very little scientific methodology available to merge this data into usable information. It's very exciting for me to help move the extraordinary and diverse activities happening in the field of data science at Michigan into a more coordinated focus. I want to enhance the data science community in terms of collaboration (which has always been of tremendous value in my own research), access to resources, and the identification of new directions for funding with the goal of improving the overall scientific enterprise."

Primary MIDAS Activity:

Education and Training

- New undergraduate program and graduate-level certificate in data science
- Continuing education for alumni
- Industry-sponsored projects

Research and Collaboration

\$10M in funding available in the areas of:

- Learning Analytics
- Transportation
- Computational Social Science
- Health Sciences

Infrastructure

- High-performance computing
- Storage

Consultancy

YouTube Smarts

Prof. Jason Corso is developing a consistent and reliable method for producing a visual and textual summary of any video that describes a process – from simple sandwich how-to's to more elaborate technical processes.

This research could make it easier to search for certain types of videos on the web, especially on a site such as YouTube. In addition, it could enable artificial intelligence agents, such as service robots, to learn typical human processes as naturally as humans do by leveraging terabytes of this rich instructional video content.

Professor Corso's research group runs a website called <http://video2text.net> where these capabilities are demonstrated.



Test Video



Concept Detection

Tech Transfer/Commercialization

With a focus on startup companies spun-off from technology developed by faculty and students in the EECS Department.

Ambiq Micro Announces the Apollo MCU

Ambiq Micro, a leader in ultra-low power integrated circuits for power-sensitive applications, closed a \$15 million Series C funding round in November of 2014 to accelerate the development and marketing of its SPOT™ (Subthreshold Power Optimized Technology) platform. By January 2015, it had launched its ultra-low power Apollo microcontroller, which promises unrivaled power savings combined with high-performance processing for wearable electronics, IoT devices, wireless sensors, and other power-sensitive applications.

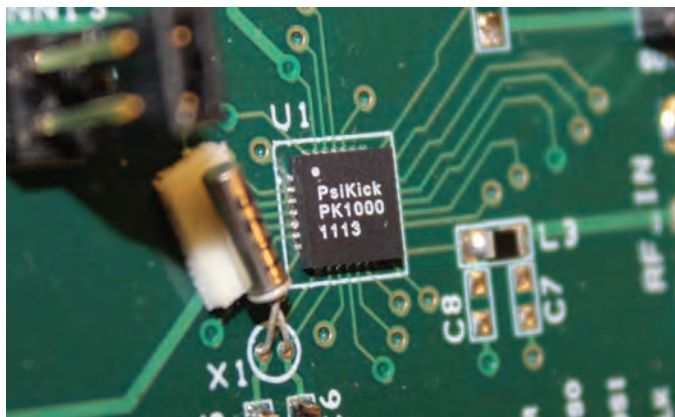
The Austin, TX-based startup was co-founded by Scott Hanson (BSE MSE PhD '04 '06 '09) and Profs. David Blaauw and Dennis Sylvester. The fabless semiconductor company specializes in mixed-signal solutions for a new generation of wireless electronics. The SPOT™ Platform uses very low voltage transistors to achieve total system power consumption on the order of nanowatts.



PsiKick – A Batteryless Sensor Chip for the Internet of Things

PsiKick, an ultra-low-power wireless sensor company co-founded by Prof. David Wentzloff and Prof. Benton Calhoun (U. Virginia) in 2012, has completed first-round funding. The financing will be used to accelerate PsiKick's growth and product development to meet the increasing demand for energy-efficient systems.

PsiKick aims to make the Internet of Things a reality with its complete systems-on-chip that operate on such low levels of energy that they are able to acquire the energy they need to operate through autonomous energy-scavenging techniques. The company aims to be a supplier of the chips that will be the brains of all sorts of wireless sensing devices; they have already developed an EKG monitor.



Arborlight Gets \$1.7M in VC Funding to Commercialize New Lighting Technology

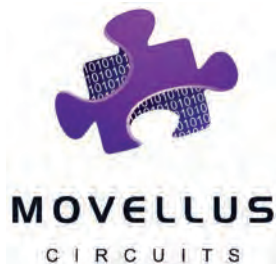
Ann-Arbor based Arborlight seeks to replicate daylight with its smart lighting system, and a \$1.7 million investment of venture capital may make it possible. The company incorporates LED components, optics, analytics, and embedded systems into a new lighting experience the market has never seen.

Co-founded by Prof. P.C. Ku and Prof. Max Shtein (Materials Science and Engineering), the company's Lightwell product looks and behaves just like a skylight. It tunes to geography and time, tracking the position of the sun throughout the day, mimicking the color, intensity, and direction of daylight as normally experienced through windows and skylights. The fixtures can be controlled by a mobile or web app, allowing users to change the location and adjust the color, brightness, and time of day for different lighting.



Movellus Circuits Shrinks Clock Generators

Muhammad Faisal (PhD EE '14), along with co-founders Jeffrey Fredenburg (PhD EE '15) and Prof. David Wentzloff, are tackling the Internet of Things with their startup company, Movellus Circuits. Movellus provides a patent-pending clock generator technology that significantly outperforms existing solutions. They have already acquired a number of high profile customers and have attracted significant investments from Michigan and California investors.



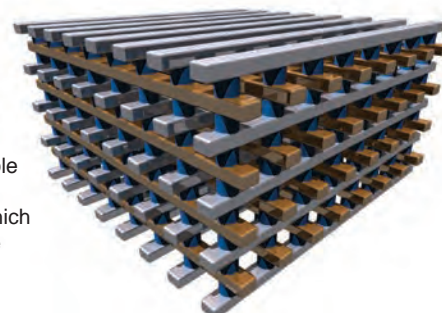
Founded in 2014, Movellus won the 2014 Michigan Business Challenge and the 2015 Great Lakes Entrepreneurs Quest business plan competition. Dr. Faisal serves as the CEO and Dr. Fredenburg leads product development as VP of engineering. Dr. Fredenburg worked with Prof. Michael Flynn, another member of the Michigan Integrated Circuits Laboratory (MICL), before joining the company. Located in downtown Ann Arbor, the Movellus team is rapidly expanding.



Crossbar Takes on DRAM and Flash Memory with Super-Fast, Super-Long-Lasting RRAM Tech

A new paradigm in memory is on its way to the market. U-M startup Crossbar, founded by Prof. Wei Lu, has developed a nonvolatile memory that is smaller, faster, and more power-efficient than NAND flash and RAM.

So-called RRAM (resistive random-access memory) will deliver 20 times faster write performance, 20 times less power consumption and 10 times more durability than NAND flash. The memory chips will be stacked, and a 1TB module will be roughly half the size of a NAND flash module with similar storage. It will also be cheaper than NAND flash, partly because RRAM is less expensive to manufacture.



Crossbar RRAM Technology CMOS Compatible for Easy Integration

Crossbar's simple and very scalable memory cell structure enables an entirely new class of 3D RRAM which can be easily incorporated into the back endline of any standard IOS manufacturing fab.

Stryd is Launching Wearable Technology for Runners

Stryd, co-founded in 2014 by Prof. Robert Dick, is the first wearable power meter for runners. According to the company, while runners have metrics to guide them – from pace, to heart rate, to perceived exertion – the variability and complexity of those metrics leads to inconsistent results. Runners get injured at a higher rate than individuals of any other sport; they need to know power to avoid injuries.

Stryd lets runners accurately measure workout intensity across any terrain. To use Stryd, runners clip it to their running shorts and go. It automatically syncs with both sports watches and mobile phones. The company far exceeded their Kickstarter goal of \$50K by raising more than \$250K earlier this year. They hope to bring their product to market in 2016.





CubeWorks

CubeWorks: Millimeter-Scale Computing. Real-life Smart Dust

CubeWorks was founded in 2013 to make next-generation millimeter-scale computing available today. The company's origins come from the Michigan Micro Mote (M³) initiative, a project from the University of Michigan seeking to push the frontiers of computing.

The Cubisens™ platform by CubeWorks enables the first truly autonomous wireless sensing platform measuring less than a millimeter. Cubisens systems are able to sense and process their environment, wirelessly transmit the results or store them for later usage. The versatility of the Cubisens platform allows multiple units to be combined together to tackle larger monitoring and sensing applications.

CubeWorks' first-generation systems are equipped with imaging, motion detection, temperature sensing, and pressure sensing. The company aims to expand the breadth of applications and position its Cubisens technology as pivotal to the Internet of Things.

CubeWorks was founded by Prof. David Blaauw, Prof. Prabal Dutta, ZhiYoong Foo, Gyouho Kim, Dr. Yoonmyung Lee (MSE PhD EE '08 '12), Prof. Dennis Sylvester, and Prof. David Wentzloff. Running the company are: ZhiYoong Foo (BSE MSE PhD EE '06 '13 '13) as CEO; Gyouho Kim (BSE MSE EE '09 '11) as CTO, Yejoong Kim as VP R&D, and Pat Pannuto (BSE EE '12 and current CSE graduate student) as Principal Systems Architect.



Keravnos Energy, LLC

Keravnos Energy wants to make quick-charging electric vehicle (EV) stations economical. The founders of this startup company, Rupert Tull de Salis (MSE EE:S '14) and Dimitris Assanis (PhD ME '15), received the Erb Award for Environmental and Social Sustainability at the 2014 Michigan Business Competition.

Fast-charging stations are eight times faster than typical EV stations, but they are too expensive for most companies to adopt. This is because commercial customers are charged a steep tariff that is based on their peak demand. The spike from a single fast-charge will instantly skyrocket an operator's monthly fees. Keravnos Energy has developed a technology and an innovative business model to solve this problem. Called the Keravnos Energy Management System, the company believes this system can reduce the electricity bill of the building that is offering the EV charging station, while simultaneously being able to deliver fast charging for electric vehicles.

VIRTA LABS™

Virta Labs Introduces PowerGuard™

Virta Laboratories, Inc., a start-up co-founded in part by Prof. Kevin Fu and former CSE postdoctoral researcher Dr. Denis Foo Kune in 2013, detects malware and anomalies in IoT and medical devices.

Virta Labs recently introduced their flagship product, called PowerGuard™. While it looks like an everyday power outlet, its embedded intelligence detects whether a device plugged into the outlet is infected with malware by analyzing subtle power consumption patterns. PowerGuard requires no software installation, a crucial point for operators of high-assurance devices that are themselves rarely kept up to date with security patches. Dug Song, CS alumnus and CEO of security firm Duo Security states, "Virta's platform can detect malware more effectively than the NSA can read your email. The best part is, it's literally plug and play with no messy software installation. It's easier than installing a Nest thermostat to gain the upper hand on malware."



In 2014, Virta Labs was named Best of Boot Camp at the conclusion of Ann Arbor SPARK's Entrepreneurial Boot Camp, and the company has become a hot employer for Michigan graduates with expertise in machine learning, cybersecurity, and electrical engineering.

As hospitals begin beta tests, medical device manufacturers are cheering for Virta. Bill Aerts, Director of Product Security for Medtronic, Inc. explained that, "Kevin is widely credited as establishing the field of medical device security. His highly respected research lab has produced some of the world's leading experts in medical device security. And now he's driving the creation of new security tools for the industry."

Most Innovative Companies in SE Michigan

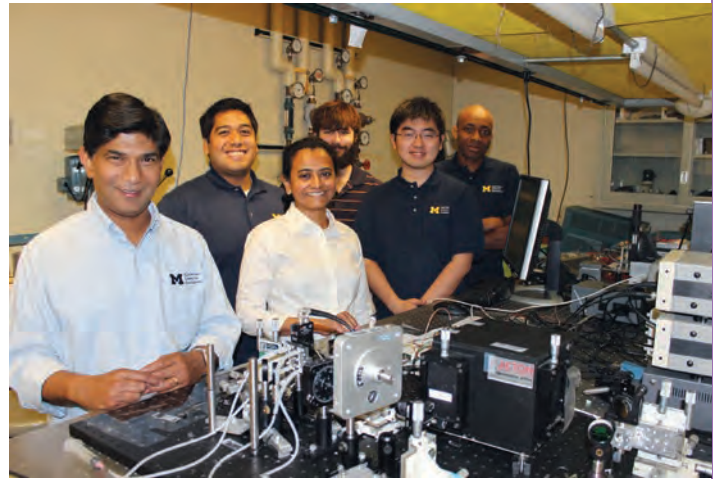
Four EECS faculty and alumni companies specializing in the life sciences and computer security made the list of the top 25 most innovative companies in SE Michigan for 2014, according to Crain's. Topping the list is Omni MedSci, Inc., a medical device company founded by Prof. Mohammed Islam. At #3 is NeuroNexus Technologies, Inc., specializing in neural probes, co-founded by Prof. Emeritus David Anderson, alumnus and Prof. Daryl Kipke (Biomedical Engineering), and Jamie Hetke. At #11 is Integrated Sensing Systems, Inc., a company working on microelectronic implants for monitoring heart functions, co-founded by alumnus and CEO Dr. Nader Najafi, Prof. Khalil Najafi, and Prof. Kensall D. Wise. And at #14 is Duo Security, a computer security company founded by alumni Jon Oberheide and Dug Song.

This annual ranking of companies in SE Michigan is based on the quality of patents received during the past year. Omni MedSci, with three patents, was ranked #1 due to the high quality of those patents. Writing a patent that will endure challenges both legal and technical is an art, according to Prof. Islam. A registered patent agent with the U.S. Patent and Trademarks Office, Prof. Islam has participated in about 150 U.S. patents, and teaches a course on patent fundamentals for engineers. He is frequently joined in the classroom by ECE alumnus Thomas Lewry, a patent attorney at Brooks Kushman. This was possibly the first course of its kind specifically tailored to engineers.

Full story: eecs.umich.edu/n/inn



Prof. Mohammed Islam with just a few of his approx. 150 patents.



Prof. Mohammed Islam, founder of Omni MedSci, Inc., with members of his research group at the University of Michigan: Ramon Martinez, Chitrarekha Chaudhari, Michael Buiteweg, Kaiwen Guo, Hafiz Sherif, Jr.

Omni MedSci, Inc.



Energy Harvesting Backpacks

Prof. Heath Hofmann is helping develop energy harvesting backpacks in collaboration with the company LightningPacks. These backpacks generate electricity while the wearer is walking. More than 100 backpacks are currently being delivered to the military, and a mid-size backpack is under development.

[illegible]

An Eye for Detail Brings Unique Rewards

Prof. Igor Markov has received two Knuth reward checks in exchange for suggesting improvements to publications authored by Prof. Donald Knuth of Stanford. According to MIT Technology Review, “Knuth’s reward checks are among computerdom’s most prized trophies.”

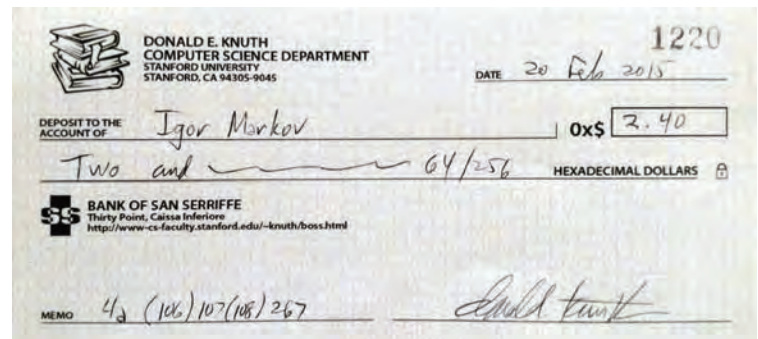
In the preface of each of his books and on his website, Knuth offers a reward of one hexadecimal dollar (\$2.56 USD) to the first person to find each error in his published books, whether it be technical, typographical, or historical. Knuth writes checks to recipients from his own “Bank of San Serriffe.”

Prof. Markov made suggestions to Prof. Knuth that were related to mathematical clarity and writing style, and pointed out errors that included incorrect literature references and wording.

He has received one check for finding two bugs and making two suggestions (two hexadecimal dollars for each bug and 20 hex cents for each suggestion) and a second for making a suggestion (20 hex cents, or 32 cents USD). This totals to \$2.60 hex dollars, or \$6.08 USD. He has no plans to cash the checks, saying “the checks themselves are the prize.”



Knuth and Markov (right) meet in Palo Alto to discuss research that Markov did with Prof. Kareem Sakallah and their students ten years ago, and which is covered in the just-released draft of the fourth volume of Knuth’s iconic “Art of Computer Programming.”



One of Prof. Markov’s Knuth checks.

Despite Winter Weather, Students Turn Out for Science on Screen



Braving cold and blowing snow, students and faculty from the CSE Division turned out in force for a special Science on Screen event at downtown Ann Arbor’s Michigan Theater on the evening of January 8, 2015. The event featured a screening of the movie, *The Imitation Game*, followed by Prof. Kevin Compton’s lecture on WWII cryptography and the life of Alan Turing.

Full story: eecs.umich.edu/n/science



Workshop Brings Together Industry and Researchers on Medical Device Security Challenges

On May 4 and 5, 2015, over 60 professionals from medical device manufacturers and level-I trauma centers joined security researchers at the *Third Annual Archimedes Workshop*. The workshop is organized by Prof. Kevin Fu through his Archimedes Research Center for Medical Device Security.

From Ultrafast to Extreme Light: A Symposium in Honor of Gérard Mourou

An international symposium, "From Ultrafast to Extreme Light," was held in recognition of the 70th birthday of Gérard A. Mourou, A. D. Moore Distinguished University Professor Emeritus, on June 21, 2014. Attended by over 200 participants, the symposium celebrated Prof. Mourou's many contributions to optics and featured distinguished speakers who came to know him over the course of his expansive career.

The seventeen featured speakers included: Sir David Payne (Director, Optoelectronics Research Centre University); Ursula Keller (Head of Research in ultrafast laser physics, ETH Zurich), Tibor Juhasz (co-founder of IntraLase); Paul Corkum (Research Chair in Attosecond Photonics for the National Research Council- Canada); Chris Barty (CTO, National Ignition Facility and Photon Science Directorate at Lawrence Livermore National Laboratory); and Theodore Norris, Gérard A. Mourou Professor of Electrical Engineering and Computer Science and Director, Center for Photonic and Multiscale Nanomaterials (C-PHOM).

Prof. Mourou's invention of Chirped Pulse Amplification (CPA) has enabled the development of the world's most intense laser pulses, with applications ranging from fundamental particle physics to health care. He put U-M on the map in ultrafast optics with his establishment of the Center for Ultrafast Optical Science (CUOS). This center now houses the HERCULES laser, which set a world record for intensity in 2011, and other advanced optical research. After retiring from U-M, Prof. Mourou was named Director of the new International Center for Zettawatt-Exawatt Science and Technology (IZEST) at Haut Collège at the École Polytechnique in France. He proposed and oversaw the creation of a major European project called the Extreme Light Infrastructure (ELI), dedicated to the production of the most powerful laser pulses ever produced.

Full story + video: eecs.umich.edu/n/mou



Gérard Mourou



Attendees at the Symposium held in honor of Prof. Mourou.



Students celebrated the 2015 Lunar New Year in the EECS atrium on February 18 with Chinese dance, music, cuisine, and calligraphy. A large crowd turned out for the show, including many Chinese graduate students. "Students told me that this recognition of their country's most widely celebrated calendar holiday made them feel more at home," said Rachel Antoun, ECE graduate coordinator and instigator of the event. All were fascinated by the bubble tea – with hundreds served in the first 30 minutes!

Full story + video: eecs.umich.edu/n/lunar



Jason Davis Distinguished Diversity Leader

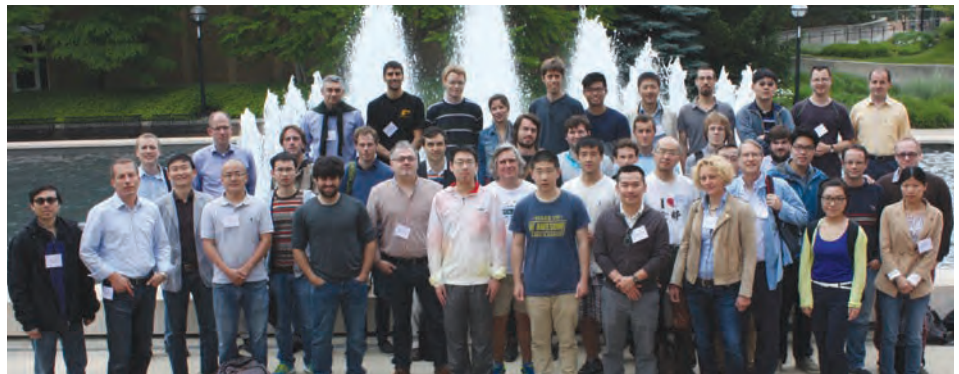
Jason Davis, Alumni Relations Director for Electrical and Computer Engineering, is a recipient of the 2013 University of Michigan Distinguished Diversity Leaders Award. This award recognizes individuals and teams that have demonstrated extraordinary commitment and dedication to diversity and inclusion at the University of Michigan. He currently serves on the Diversity team on U-M's Voices of the Staff.



Researchers Gather at Michigan for Midwest Theory Day

Computer scientists and mathematicians from across the greater midwest region gathered at the Beyster Building at Michigan on December 6, 2014 for the *66th Midwest Theory Day*. This event is a semiannual tradition among CS theorists in the Midwest, aiming to be an opportunity for the community to meet each other, share research findings, and initiate collaborations.

The invited speaker was David Steurer, Assistant Professor at Cornell University, whose talk was entitled "Lower Bounds on the Size of Semidefinite Programming Relaxations." The *66th Midwest Theory Day* was organized by Prof. Anna C. Gilbert, Prof. Martin J. Strauss, and Dr. Ilya Volkovich.



Researchers Attend the First-Ever Trustworthy Quantum Information Workshop

Researchers from around the world attended the first-ever *Trustworthy Quantum Information Workshop*, which took place June 28 – July 2, 2015 on North Campus at Michigan. The workshop's aim was to bridge the gap between theory and practice by engaging theorists and experimentalists in the direct discussions. Workshop topics included delegated quantum computation, device-independent and semi-device-independent quantum cryptography, nonlocality, contextuality, and self-testing, and quantum-secure classical randomness extractors.

Distinguished Lectures in Computer Science and Engineering



ROSALIND PICARD

Founder and Director of the Affective Computing Research Group
Massachusetts Institute of Technology
Emotion Technology, Wearables, and Surprises
March 23, 2015



SUSAN LANDAU

Senior Staff Privacy Analyst
Google
Does Wiretapping Make US More Secure?: What a Computer Scientist Has to Add to the National Conversation
February 14, 2014



DIANE TANG

Google Fellow
Google
A/B Testing at Google: Scaling to 1000s of Simultaneous Tests
February 24, 2015



SANJEEV ARORA

Charles C. Fitzmorris Professor of Computer Science
Princeton University
Provable Bounds for Machine Learning: Getting Around Intractability
December 2, 2013



JOSE GOMEZ-MARQUEZ

Little Devices Lab Director
Massachusetts Institute of Technology
The Science and Policies of DIY Medical Technologies: Health Makers from Matagalpa to Montana
December 9, 2014



EDWARD W. FELTEN

Professor of Computer Science and Public Affairs
Princeton University
Debugging DC: Why Government Is That Way, and How to Start Fixing It
November 19, 2013



PETER LEE

Corporate Vice President
Microsoft Research
From Snowstorms to Star Trek: A Career in Advanced Technology
October 31, 2014

Michigan Institute for Computational Discovery and Engineering Lecture



CINDY COHN

Legal Director
Electronic Frontier Foundation
Crypto Wars Part Deux: How the NSA is Making Us All Less Safe
April 3, 2014



CHARLES E. LEISERSON

Edwin Sibley Webster Professor of EECS
Massachusetts Institute of Technology
What the \$#@! Is Parallelism? (And Why Should Anyone Care?)
March 23, 2015



The CSE Distinguished Lecture Series brings top thinkers in the field of computer science to Michigan. These speakers meet with faculty and students and present their ideas and research to the community. Many CSE Distinguished Lectures are available to view on the EECS website.
Videos: eecs.umich.edu/n/dls

Distinguished Lectures in Electrical and Computer Engineering



STEPHEN FORREST

Peter A. Franken Distinguished University Professor, Paul G. Goebel Professor, gave a special lecture as the 2015 U-M Distinguished University Innovator.

An Academic's Adventure in Business
May 5, 2015



JESSY GRIZZLE

Elmer G. Gilbert Distinguished University Professor; Jerry W. and Carol L. Levin Professor, gave a special lecture as a 2015 Distinguished University Professor.

Taking Bipedal Walking Robots from Science Fiction to Science Fact
February 4, 2015



BABAK PARVIZ

Vice President, Amazon
Homecoming Lecture: Computers That We Can Wear
October 31, 2014



ABDUR CHOWDHURY

Co-founder and CEO, Pushd
The Economics of a Job: Why Starting or Joining a Start-up Might Make More Sense
April 21, 2014



APRIL S. BROWN

John Cocke Professor of Electrical and Computer Engineering, Duke University
Chemical – Electronic Coupling and the InAs Two-Dimensional Electron Gas (2DEG): Highly Sensitive and Selective Sensing of Surface-Based Biomolecule Interactions
March 14, 2014



FAWWAZ ULABY

Emmett Leith Distinguished University Professor of EECS, Chen-To Tai Professor of Engineering, and Arthur F. Thurnau Professor, gave a special lecture as the 2014 U-M Henry Russel Lecturer.

Great ideas start very small; the challenge is in how to grow them.
February 4, 2014



STEVE MOLLENKOPF

President and CEO, Qualcomm
What it Takes to Lead in Technology
October 4, 2013

William Gould Dow Distinguished Lectureship

This lectureship is the highest honor bestowed on a guest speaker by the Department, and honors William Gould Dow (1895–1999), former faculty member, Department Chair, and pioneer in electrical engineering education.



DR. THOMAS RUSSELL

Director - U.S. Army Research Laboratory (ARL)
Enabling Research for the Soldier of Tomorrow

Dr. Russell is the fourth director of the ARL, a facility with approximately 2,000 military and civilian employees and an annual revenue of over \$1 billion. ARL provides the soldiers of today and tomorrow with the scientific discoveries, technological advances, and the analyses to maintain tactical superiority and enable across-the-board operations. In his talk, Dr. Russell discussed some past and current advances that have been achieved by the ARL, a vision for where future Army technology is heading, and how ARL's mission, research programs, and external collaborations address the technical challenges associated with that vision. He also encouraged increased youth involvement in STEM fields.

"STEM can be as simple as letting your five year old set up your technology, or even just using it," he said. "Start young. Reach out to influence those who otherwise might not have any access to technology."

Full story: eecs.umich.edu/n/

Many of these lectures have been videotaped and are available on the EECS website.

Curriculum and Education



The Computer That Won at Jeopardy Comes to Michigan

In Fall 2014, software engineering students at Michigan had the unique experience of using IBM's Jeopardy-winning Watson system to develop apps to help children with special needs. Michigan was one of just

seven universities chosen by IBM for this opportunity. The artificially intelligent Watson is designed to process language more like a human than a machine, and to interact with people in ways that seem more natural than other systems.

The idea for the course came out of U-M, when IBM Watson group vice president and alumnus Michael Rhodin (BSE Comp. & Comm. Science '84) was visiting campus to discuss an unrelated research project. On a whim, Eric Michielssen, U-M associate vice president for advanced research computing, floated the idea of giving students access to Watson. "It was an instant hit and we kept talking about it," Michielssen said. "It's a win-win situation. For our students, it's a fantastic opportunity to tap into their creativity and gain exposure to this innovative AI system."

Watson was used in Dr. David Chesney's EECS 481 course, Software Engineering. Dr. Chesney has a longstanding practice of putting software engineering projects into a social context. His students input relevant data regarding their projects into Watson to program and train the system. They developed not only prototype apps, but also business plans to commercialize their ideas for use. IBM provided support from experts, guest lectures and technical mentors.

Teaching Embedded Control Systems in Switzerland

Prof. Jim Freudenberg is headed to Switzerland this fall to teach his popular course, EECS 461: Embedded Control Systems, to students at ETH Zurich. This is an ongoing relationship established in 2008 between Michigan and the Swiss technology university. EECS 461 is a senior level undergraduate course that was created in direct response to the needs of the auto industry and first taught in 2000.

There is a strong need in the auto industry for students who are capable of working in the area of embedded systems engineering. But, being somewhat of a hybrid field, finding well-trained students straight out of college can be difficult. Michigan students receive the experience they need to flourish in this industry by bridging the fields of signal processing, control theory, microprocessor hardware, and programming. The course teaches students from diverse backgrounds the fundamentals of the subject as they build a force feedback system known as a haptic interface.



Students design and implement a driving simulator using a haptic wheel.

New Books



Dr. **Jeremy Gibson Bond** has authored a new book entitled *Introduction to Game Design, Prototyping, and Development*, which has been published by Pearson as a part of

their Addison-Wesley Game Design and Development Series. The book represents the first time that the disciplines of design, prototyping, and development have been brought together into a single book and is a distillation of knowledge Bond collected teaching hundreds of game designers and developers in his years at the #1 university games program in North America.



Prof. **Thomas F. Wenisch** and his collaborator Prof. Babak Falsafi of EPFL Switzerland have authored *A Primer on Hardware Prefetching*, which has been pub-

lished by Morgan & Claypool as one of their Synthesis Lectures on Computer Architecture. It offers an overview of the various classes of hardware prefetchers for instructions and data proposed in the research literature, and presents examples of techniques incorporated into modern microprocessors.



Prof. **Igor Markov's** book, *VLSI Physical Design: From Graph Partitioning to Timing Closure*, authored with his recent PhD advisee Jin Hu, Andrew B. Kahng, and Jens Lienig, has recently

been translated into Chinese. The book introduces and evaluates algorithms used during physical design to produce a geometric chip layout from an abstract circuit design, and presents the essential and fundamental algorithms used within each physical design stage.

New Courses in EECS

As department research continues to expand into new, innovative areas, the breadth of coursework expands to match it. Over the past two years, with the help of several new faculty, new EECS courses have opened up numerous fields to undergraduates and graduates alike.

Analysis of Electric Power Distribution Systems and Loads

Fundamentals of electric power distribution systems and electric loads.

Carbon Nanoelectronics and Nanophotonics

Theories and experimental works on carbon nanotube- and graphene-based electronic and photonic devices.

Collabrified Mobile Apps for K-12

EECS students create apps to support learners in K-12 using the Collabrify SDK that students at Michigan previously developed, which enables a developer to convert a single-user app into one that supports two or more simultaneous users.

Electricity Networks and Markets

Principles and practices for reliable and economical operation of power systems.

Embedded Systems: An Application-Centered Approach

Developing products in embedded systems.

Grid Integration of Alternative Energy Sources

Alternative energy sources and energy processing technologies required for power system connection.

Hands-On Robotics

Building robots using the CKBot modular robot system.

Hybrid Systems: Specification, Verification and Control

Hybrid systems and dynamical systems where continuous dynamics and discrete events interact.

Information Retrieval and Web Search

Presents traditional material, as well as recent advances in Information Retrieval (IR), the study of indexing, processing, querying, and classifying data.

Infrastructure for Vehicle Electrification

Physical and cyber infrastructures for large-scale integration of plug-in electric vehicles.

Intelligent Interactive Systems

Focuses on the development of effective speech-based user modeling for interactive systems; topics include basic speech modeling, feature handling techniques, data classification, visualization, and interactive system design.

An Introduction to Social, Economic and Technological Networks

Network connection and formation, network processes and transactions, and modern network interconnectivity.

Laser Plasma Diagnostics

Creating, characterizing, and timing high power laser pulses.

Network Information Theory

Mathematical tools to study communication problems in networks.

Performance Systems: Mobile Phones as Musical Instruments

Design of mobile phone musical instruments, composition of pieces for this new genre, and development of mobile music performance practice in a unique blend of music performance and engineering.

Plasmonics

Optical phenomena related to the electromagnetic response of conductors.

Power Semiconductor Devices

Semiconductor devices for both discrete and integrated power electronics.

Power System Dynamics and Control

Angle and voltage stability concepts and control strategies for improving dynamic power system performance.

Practical Machine Learning

Presents the basics of practical machine learning and data mining while focusing on real-world applications.

Prediction and Learning: It's Only a Game

Focuses on the problem of prediction, learning, and decision making, with an underlying theme that involves game playing, betting, and minimax analysis.

Probabilistic Analysis of Large Scale Systems

Epidemics and diffusions, queuing systems, analysis of randomized algorithms, Bayesian information cascades, network analysis, and random graphs.

Probabilistic Graphical Models for Vision and Beyond

Probabilistic graphical models in detail, including contemporary results and computer vision applications.

Random Matrix Theory, Algorithms and Signal Processing Applications

Random matrix theory and algorithms in signal processing, machine learning, statistics, and science applications.

Solar Cell Device Physics

Physical operation of diode solar cell devices and analysis of factors that determine power conversion efficiency.

Statistical Learning Theory

Performance guarantees that quantify the ability of a machine learning algorithm to generalize from training data.

VLSI Digital Signal Processing Systems

Efficient and high-performance custom or semi-custom VLSI systems for DSP applications.



ECE Grad Program

To better reflect the multidisciplinary nature of Electrical and Computer Engineering (ECE) at the University of Michigan, the two graduate programs, Electrical Engineering (EE) and Electrical Engineering:Systems (EE:S), have merged to form one graduate program: Electrical and Computer Engineering.

The new ECE program includes more areas of concentration at the Master's level, while completely removing distinct areas of concentration at the PhD level. Doctoral students have the freedom to fashion their own major area of concentration along with their advisor without having to select courses from a predetermined list of specialties.

Master's students can now choose from the following specialties:

- Applied Electromagnetics & RF Circuits
- Embedded systems
- Power & Energy
- Communications
- Integrated Circuits & VLSI
- Robotics
- Computer Vision
- MEMS & Microsystems
- Signal & Image Processing and Machine Learning
- Control Systems
- Optics & Photonics
- Solid State & Nanotechnology

Reinvented: A Project-based Intro to CS

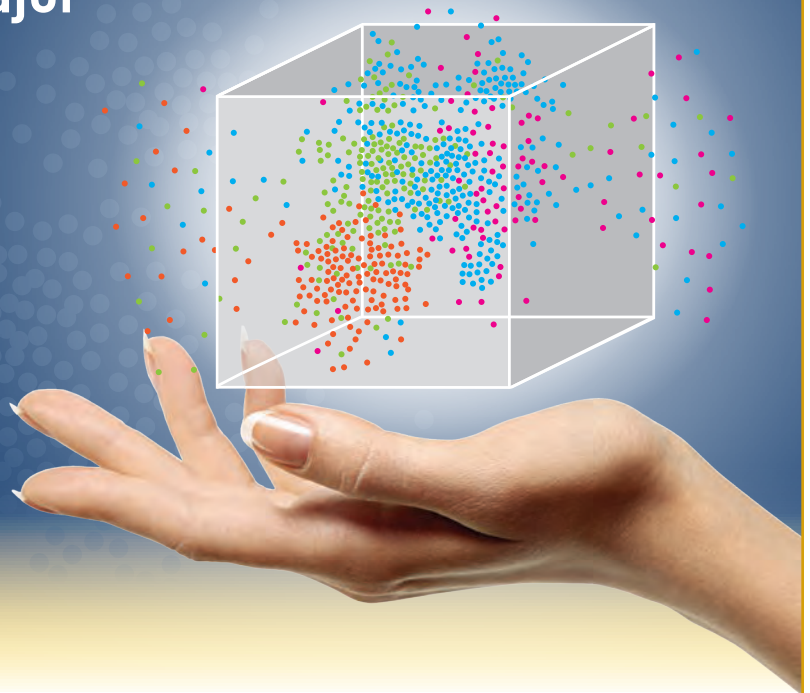
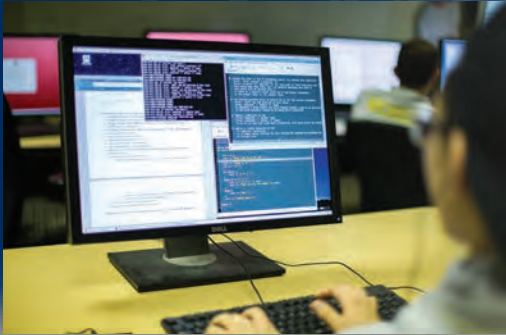
EECS 183, Elementary Programming, is an introductory course in computing that is open to students in the College of LSA. Dr. Mary Lou Dorf has redesigned the course to focus less on lecture and more on teamwork and hands-on projects. In the Fall of 2014 she replaced the final exam with an expo at which teams of students demonstrated their final projects – which was quite an accomplishment, with over 750 students in the course who created 183 projects. Response to the new format has been positive; registration for the course is climbing and it is expected that over 900 students will take the class in Fall 2015. Declares for computer science as a major through LSA have also shot up.

Full story + video: eecs.umich.edu/n/183



Students in EECS 183 demonstrate their projects in the class showcase.

New Undergraduate Major in Data Science Introduced

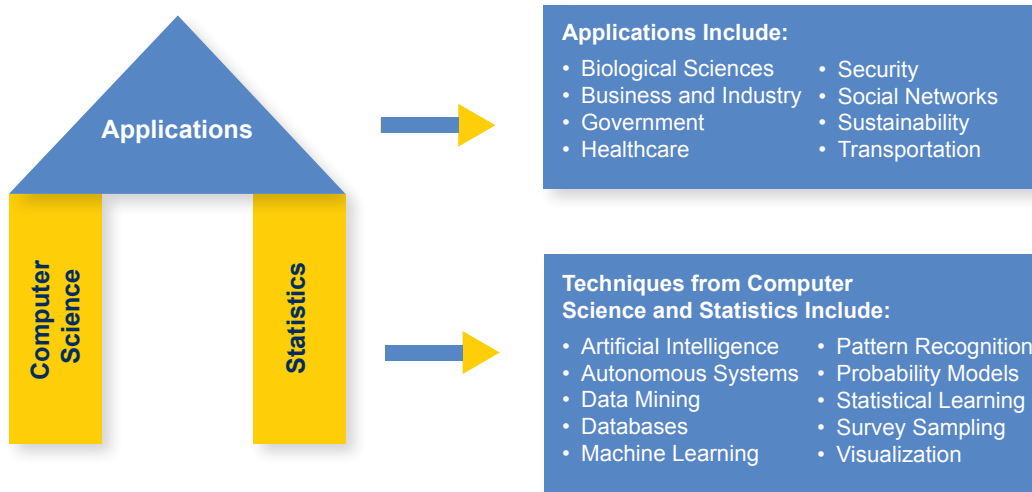


Michigan students have a new major course of study to choose from, and it is one that is highly relevant in this age of “Big Data.” Developed jointly between EECS and the Department of Statistics in the College of Literature, Science and the Arts, the new multidisciplinary Data Science major will be offered for the first time in the Fall of 2015.

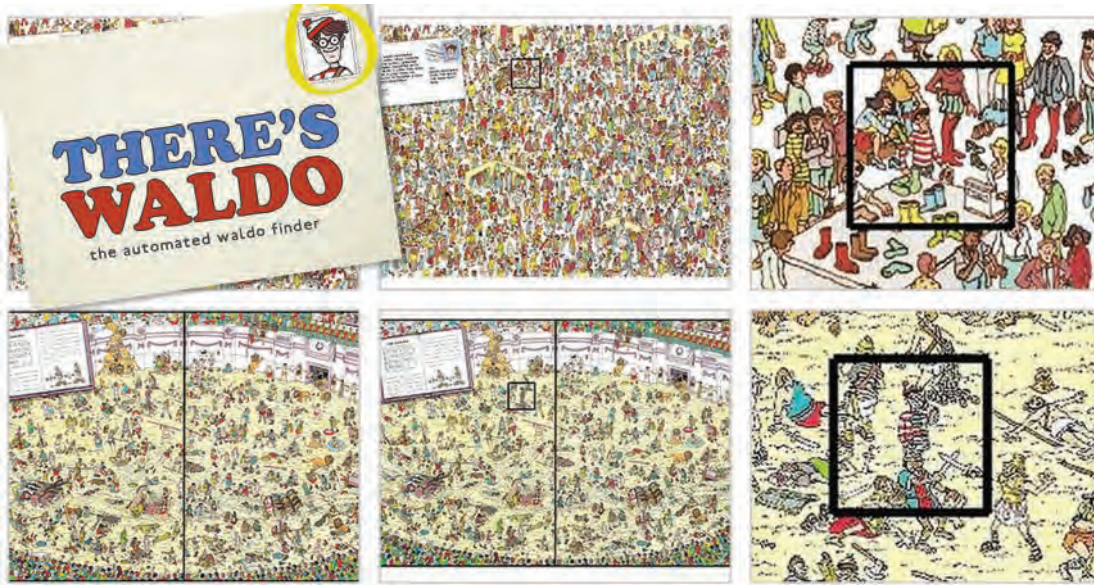
Key to the program is bringing together practices from computer science and statistics – such as machine learning, artificial intelligence, pattern recognition, statistical learning, probability models, and visualization – in order to adequately

manage, analyze, and interpret data at scale. Electives for the program expose students to a wide range of application areas, from earth and environmental systems through computer vision and the modeling of infectious diseases, allowing students to tailor or broaden their experience as desired. Capstone projects will be designed with input from industry and will afford students the opportunity to develop solutions for real problems.

Full story + video: eeecs.umich.edu/n/data



Data science leverages methods and techniques from computer science and statistics to enable new discoveries.



Students automated the classic scene-search game, *Where's Waldo*.

A Real-World Approaching to Digital Signal Processing

With funding from U-M's Third Century Initiative, Prof. Laura Balzano has incorporated a data collection and analysis project into the course, Digital Signal Processing, that gives the students firsthand experience with sensors and many signal processing techniques. Students are now able to use sensors or other data collection tools to pursue a goal of their choosing, ranging from smart handwriting replicators to recreating the reverb of famous recording environments. The project was a big success. Many students commented in evaluations that the project gave them a chance to really make a connection to how the algorithms work in real life on real data. Some students decided to pursue signal processing because of this experience.

Also, to encourage undergraduate students to take the course earlier in their academic career, the Digital Signal Processing course has been renumbered from EECS 451 to EECS 351 beginning fall semester of 2015. The course will include the same basic material, and will incorporate more image processing and machine learning techniques.

State Farm Gift Supports Student Projects Lab

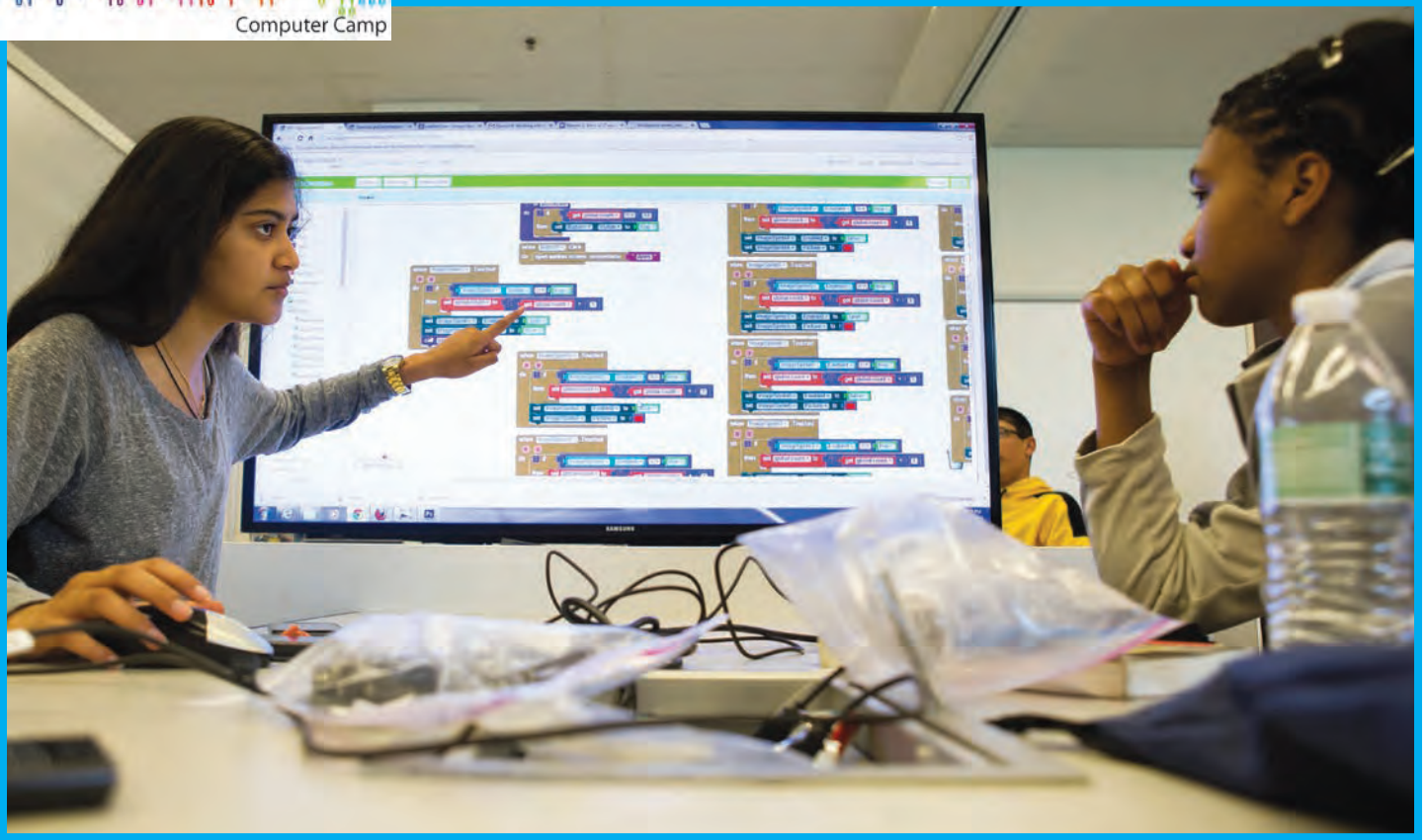
State Farm has donated \$50,000 to the College of Engineering to support and enhance the activities of the Student Projects Lab, which is located on the first floor of the Bob and Betty Beyster Building and which is home to both the Embedded Systems Hub, a shared resource for the development of projects with embedded systems, and MSuite, the student mobile applications development group.

The Embedded Systems Hub is available to all U-M students, staff, and faculty. It provides the resources needed to do basic embedded systems work and also offers a variety of training sessions related to embedded systems, including sessions on PCB design, soldering, and microcontroller basics. The Hub also hosts short-term faculty-sponsored projects related to embedded systems.

The funds from State Farm will be used to renovate the Student Projects Lab and to increase its capacity to serve students. Mark Brehob, Director of the Embedded Systems Hub, said, "We're excited about the prospect of improving substantially upon what the Student Projects Lab can offer students. This funding will help us to become more of a maker and hack space, allowing students to work with devices from processor boards to Google Glass." Plans include improved fabrication facilities and a library of hardware available for checkout to students.



Outreach



MiBytes – A Deep Dive into CS for High School Students

The CSE Division has designed and hosted MiBytes, a series of summer camps for high school students with an interest in CS. First held in 2014 and again in 2015, MiBytes most recently included a 5-day Tinkering With Mobile Apps camp and a 2-week-long Hacking in a Digital World camp, both led by Dr. Jeff Ringenberg, as well as a 5-day Game Design & Development camp led by Dr. Jeremy Gibson Bond. All three camps are hands-on and immersive, and each culminates with a showcase to demo projects.

Full story + video: eecs.umich.edu/n/mibytes



Students show their hacking project at a showcase at the end of camp.



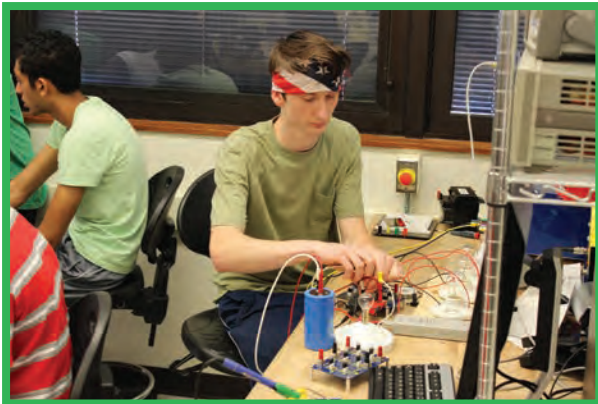
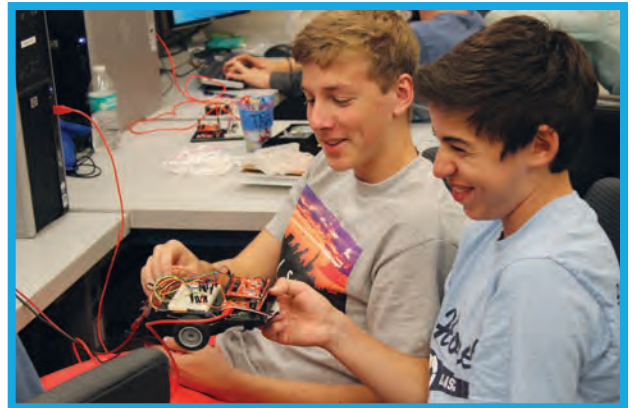
Students build game maps in Dr. Bond's game development camp.



An Electrifying Summer

ECE introduced the Electrify Tech Camps this summer, specially designed to give high school students hands-on experience with concepts and applications in electrical and computer engineering. Three 5-day camps were offered in 2015: Power Up, the Power & Energy Tech Camp; Light It Up, the Optics & Photonics Tech Camp; and Sense It, the Wireless Sensors Tech Camp. Campers worked on university lab equipment as they learned about solar panels, wind turbines, lasers, LED's, heart rate monitors, holograms, Arduino-controlled devices, and wireless networks and devices. Each camper brought home a device they built at camp.

Full story + video: eecs.umich.edu/n/camp



Over 100 High School Girls Explore Computer Science at Girls Encoded

High school girls and their parents attended Girls Encoded, an exciting all-day event designed to encourage girls to study computer science, on November 8, 2014. The event was run under the coordination of students Allison McDonald, Ariana Mirian, Lauren Molley, and Prof. Rada Mihalcea. The day included hands-on activities, guest speakers, panel discussions, and tours of labs in the Beyster Building.



MARLO Greets Her Guests

Prof. Jessie Grizzle, his students, and his robot companion MARLO host many outreach activities for visiting students. In the past year he's put on demonstrations for Society of Women Engineer's GREAT Day visit, the Summer Engineering Exploration camp, the Cub Scouts, and many other groups of various ages.



Future Scientists Tour Beyster Building

Young people often visit the department for tours, including these preschoolers from U-M's Towsley Children's House who were hosted by Profs. Valeria Betacco and Todd Austin. The children enjoyed the air-conditioned server rooms, activities with robots, and took apart computers.

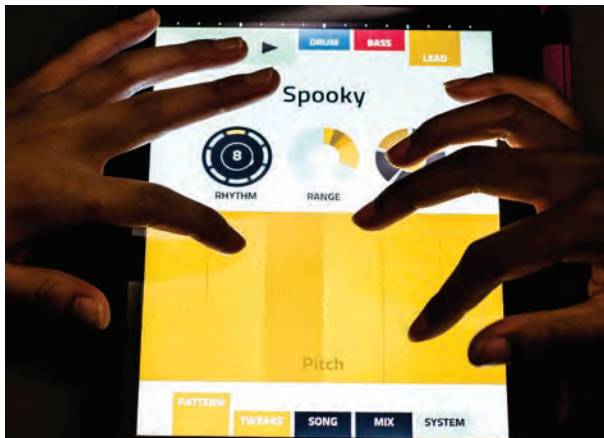
Full story: eecs.umich.edu/n/towsley



CSE Sponsors MICWIC Conference at U-M

The CSE Division sponsored the 5th Biennial Michigan Celebration of Women in Computing (MICWIC) conference in March 2015. MICWIC's goal is to increase the number of women in computer science professions by bringing together students, faculty, and professionals from across the state for discussion, to share experiences and strategies for success, and to explore issues common to women working in these fields.





It's All About the Music

In summer 2014, groups of high school students got a crash course in computing and creativity at a camp designed and led in part by Dr. David Chesney. The camp explored CS in the context of challenging, hands-on, and music-centric hardware, software, and participative applications. It was first held in 2012, and has taken place on campus and in other cities across Michigan including Detroit, Grand Rapids, and Kalamazoo.

SWE Hosts Girls' Night Out to Teach Young Girls about Engineering

The Society of Women Engineers (SWE), a CSE sponsored organization and the largest student organization in the College of Engineering, hosted Girls Night Out on November 8, 2014.

Girls' Night Out was a small engineering outreach event geared towards middle school girls. Its purpose was to give girls a better idea of the "design-test-build" thinking and problem solving of engineering, while also showcasing the different types of engineering and how engineering affects nearly every aspect of society. The event had a general theme that engineering was something attainable and it stressed the fact that engineering was not just sitting at a computer crunching numbers, but that the goal is to change the world for the better.



gEECS Hosts High School Students at {Girls Code}

On a recent April weekend, Girls in Electrical Engineering and Computer Science (gEECS) hosted twenty 9th–12th grade girls from across southeast Michigan for an Arduino Workshop on the North Campus of the University of Michigan. Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software that can be used to create interactive objects or environments.

Called {Girls Code}, the workshop taught the girls the basics of Arduino. The girls hooked up LEDs, potentiometers, and a speaker to a breadboard and an Arduino. They were able to experiment with different combinations of circuits and to make tweaks in the Arduino code. One group was able to adjust their Arduino code to make the speaker beep once every second. Upon completion of the workshop, the girls left with an increased knowledge of circuits, programming, and microcontrollers.



SWE Hosts G.R.E.A.T. Day for Girls

The Society of Women Engineers Student Section at the University of Michigan held its second annual G.R.E.A.T. Day (Girls Research Engineering And Technology) on April 12, 2014.

G.R.E.A.T. Day is designed to open up young girls' minds to the possibility of engineering as a career path. The event took place on North Campus and included a variety of activities and demonstrations in engineering disciplines that included Computer Science and Engineering, Chemical Engineering, Mechanical Engineering, and Civil Engineering, introducing the 6th through 10th grade students to a world that they may not have known. In the area of computer science, the students completed a programming project using Codecademy. They were also exposed to the concept of algorithmic thinking.

Prof. Rada Mihalcea and Tara Coffell, Assistant Director at the College of Engineering Career Center, spoke to parents about the importance of computer science and about engineering opportunities in general.

Dragomir Radev Coaches U.S. Linguistics Team to Multiple Wins at IOL

Prof. Dragomir Radev has coached U.S. high school students to successful competition at the 13th International Linguistics Olympiad (IOL), which was held at American University in Blagoevgrad, Bulgaria from July 20–24, 2015. This is the ninth year that Radev has coached the USA Red and Blue teams.

The IOL consists of individual and team contests with unique problems each year. This year's individual contest, a six hour exam with five problems, focused on Kabardian, Wambaya, Somali Masafo, Nahuatl, and Arammba, as well as on Soundex, an algorithm for phonetic classification of names. For the team contest, teams were tasked with translating excerpts from a Northern Sotho dictionary.

Team USA Red's combined scores on the individual score were the highest of any team, which brought them the annual Cup for the team with the highest average performance in the individual contest. This is the third year in a row that USA Red wins the blue cup for the highest combined score in the individual contest of any team. The two U.S. teams (Red and Blue) had an average score of 62 points, which was higher than all other teams.



The International Year of Light — Michigan Light Project

By teaching children how to build a hologram and piezo-electric animals, members of the Michigan Light Project (MLP) are introducing the future generation to technology that is key to modern society. Capitalizing on UNESCO's designation of 2015 as the International Year of Light and Light-based Technologies (IYL 2015), the MLP seeks to provide outreach and education about the world of optics in general, and the optics industry in Michigan specifically. The academics, industrialists, and artists involved are using this forum to demonstrate the amazing aspects of light and energy in society as well as to promote awareness that the State of Michigan is a worldwide hub of light-related industry, culture, and art.



ECE students and researchers were instrumental in establishing the MLP, and are having a blast introducing the science of light to K-12 children. The group organized

their first event in June at the Ann Arbor Summer Fest Kids Zone Tent, featuring fun and educational demos of optical technology, and have appeared at several other outreach events already this summer, including Detroit Metro Youth Day. Optics and photonics technologies have already enabled modern displays, internet communications, precision manufacturing, medical diagnostics, solar cells, efficient lighting, and much more. These technologies are expected to continue their influence well into the future as researchers are able to manipulate ever smaller elements.

Full story: eecs.umich.edu/n/light



**INTERNATIONAL
YEAR OF LIGHT
2015**

Special Symposium

***Celebration of Maxwell's
Equations: 150 Years***

**Friday November 20, 2015
3–7 pm EECS Building**

Sponsored by
Electrical & Computer Engineering,
OSUM (Optics Society at the University of
Michigan), IEEE Photonics

Keynote Speakers:

Dr. Jim Rautio, President, Sonnet. MTT Distinguished Microwave Lecturer (2005 – 2007) on the life of James Clerk Maxwell

Dr. Arthur Yaghjian, author of *Reflections on Maxwell's Treatise*. Fellow, Electromagnetics Academy

**Student demonstration competition to
visually show Maxwell's Equations**



Faculty News

New Faculty



MOSHARAF CHOWDHURY

Assistant Professor

*PhD, Computer Science, 2015
University of California, Berkeley*

Mosharaf Chowdhury's research interests are in the areas of networked systems and cloud computing. In his dissertation research, Mosharaf has explored and developed algorithms

and systems for application-aware scheduling, allocation, and load balancing of networked resources in the context of large-scale data-intensive computing. Mosharaf joins EECS in January 2016.



JASON CORSO

Associate Professor

*PhD, Computer Science, 2005
The Johns Hopkins University*

Jason Corso's main research thrust is high-level computer vision and its relationship to human language, robotics and data science. He focuses primarily on problems in video understanding

such as video segmentation, activity recognition, and video-to-text. Jason is the recipient of an ARO Young Investigator Award, an NSF CAREER Award, and a Google Faculty Award. He is a member of the DARPA Computer Science Study Group. Jason joins EECS from the State University of New York (SUNY), Buffalo, where he has been an Associate Professor.



REETUPARNA DAS

Assistant Professor

*PhD, Computer Science and Engineering, 2010
Pennsylvania State University*

Reetu Das is interested in computer architecture and systems. Her dissertation work on Aergia, a high-performance network-on-chip, was

selected to appear in the *IEEE Micro* "Top Picks" Issue for 2011. Her more recent research focuses on scalable and energy-proportional on-chip networks, 3D integration, and near data processing for big data applications. Currently a research scientist at EECS and Researcher-in-Residence for the Center for Future Architecture Research (C-FAR), Reetu joins EECS as an assistant professor in 2016.



RONALD DRESLINSKI

Assistant Professor

*PhD, Computer Science and Engineering, 2011
University of Michigan*

Ron Dreslinski's research interests are in novel architectures and design technologies for energy-efficient computing. His doctoral thesis has

paved the way for the adoption of near-threshold computer design by industry. In recent years, his research has contributed to the successful demonstration of experimental 3D computer chips that open up new dimensions in the exploration of energy-efficient, high-performance computer design. Previously a research scientist at EECS, Ron joined as assistant professor in Fall 2015.



CYNTHIA FINELLI

Associate Professor

PhD, Electrical Engineering:Systems, 1993

Cindy Finelli specializes in engineering education, and she currently studies student resistance to active learning, faculty adoption of evidence-based teaching practices, and institutional

change. She is currently Director of the Center for Research and Learning in Engineering at Michigan, which supports college-wide initiatives in engineering teaching and learning. Prior to joining Michigan in 2003, she served as Founding Director of the Center for Excellence in Teaching and Learning, Richard L. Terrell Professor of Excellence in Teaching, and Associate Professor of Electrical Engineering at Kettering University. She is a fellow of the American Society of Engineering Education.



ODEST CHADWICKE JENKINS

Associate Professor

*PhD, Computer Science, 2003
University of Southern California*

Chad Jenkins is an experimental roboticist focusing on human-robot interaction. His research explores methods that enable robots to learn human skills and in recent years, his

work has focused on the exploration of robot systems for assisting disabled people. His work has been supported through prestigious awards, including NSF CAREER and PECASE awards, an ONR Young Investigator Award, and a Sloan Research Fellowship. Chad joined EECS in Fall 2015 from the faculty at Brown University.

New Faculty



DANAI KOUTRA
Assistant Professor

*PhD, Computer Science, 2015
Carnegie Mellon University*

Danai Koutra's research interests are in the areas of data mining, graph summarization and visualization, and applied machine learning with an emphasis on fast algorithms

for understanding massive graphs. Her dissertation research focuses on the design of practical algorithms for understanding massive graphs by combining their global and local properties. Danai joined EECS in Fall 2015.



WALTER LASECKI
Assistant Professor

*PhD, Computer Science, 2015
University of Rochester*

Walter Lasecki's research interests are in the area of human-computer interaction. His work combines human and machine computation to create intelligent systems that can solve

problems ranging from accessibility needs for uses with disabilities to rapid analysis of large data sets. He helped introduce the idea of continuous real-time crowdsourcing, as well as the crowd agent model, which uses computer-mediated groups of people submitting input simultaneously to create a collective intelligence capable of completing tasks better than any constituent member. Walter joined EECS in Fall 2015.



HARSHA MADHYASTHA
Assistant Professor

*PhD, Computer Science and
Engineering, 2008
University of Washington*

Harsha Madhyastha's research is in the areas of distributed systems, networking, and security and privacy with a focus on simplifying the

development of and enabling the cost-effective deployment of performant, highly available, and privacy-preserving Internet-scale software services. In addition to award-winning papers and an NSF CAREER award, his research has resulted in the development of software systems that have been adopted by Facebook and Google. Harsha joined EECS in Fall 2014 from the faculty of the University of California, Riverside.



CHRISTOPHER PEIKERT
Associate Professor

*PhD, Computer Science, 2006
Massachusetts Institute
of Technology*

Chris Peikert's research is in the areas of cryptography, lattices, error-correcting codes, algorithms and complexity, and computer and network security. Among

several other recognitions of his scholarly contributions, Chris has received a Sloan Foundation Fellowship, a Bergmann Memorial Research Award, and Best Paper awards at EUROCRYPT and STOC. Chris joined EECS in Fall 2015 from the faculty of Georgia Institute of Technology.



VIJAY SUBRAMANIAN
Associate Professor

*PhD, Electrical Engineering, 1999
University of Illinois at Urbana-
Champaign*

Vijay Subramanian conducts research in the areas of social networks, network economics, random graphs, communication networks, information

theory, stochastic modeling, and applied probability.

During the years 1999-2006, he worked for Motorola in the Networks Business Sector. He was a Research Fellow at the National University of Ireland from 2006-2010, and a visiting researcher at LIDS, MIT during the summer of 2010. He joins EECS from Northwestern University, where he has been a Research Assistant Faculty.



LEUNG TSANG
Professor

*PhD, Electrical Engineering, 1976
Massachusetts Institute of Technology*

Leung Tsang conducts research in applied electromagnetics, particularly in the area of environmental remote sensing. He has served as President of IEEE Geoscience and Remote Sensing

Society, and Editor-in-Chief of the *IEEE Transactions on Geoscience and Remote Sensing*. He is the co-author of 4 books: *Theory of Microwave Remote Sensing*, and *Scattering of Electromagnetic Waves*, vols. 1, 2, and 3. Prof. Tsang received the Pecora Award and the IEEE Electromagnetics Award. He joins EECS from the University of Washington, where he was a former Department Chair.

New Faculty



JENNA WIENS

Assistant Professor

PhD, Electrical Engineering and Computer Science, 2014

Massachusetts Institute of Technology

Jenna Wiens' primary research interests lie at the intersection of machine learning and medicine. She is presently focused on developing accurate patient risk

stratification approaches that leverage patient data across time and space, with the ultimate goal of reducing the rate of healthcare-associated infections among hospitalized patients in the U.S. In addition to her work in healthcare, she has developed machine learning methods for the extraction of strategically useful information from player tracking data in the National Basketball Association. Jenna joined EECS in Fall 2014.



LOUISE WILLINGALE

Assistant Professor

PhD, Plasma Physics, 2007
Imperial College, London

Louise Willingale specializes in laser-driven ion acceleration, relativistic laser propagation through underdense and near-critical density plasmas, and proton radiography to study electric and

magnetic fields generated during the laser-plasma interactions. She joins EECS from the U-M Department of Nuclear Engineering & Radiological Sciences. She is a member of the High Field Science group in the Center for Ultrafast Optical Science.

NSF CAREER and Young Investigator Awards



JACOB ABERNETHY

NSF CAREER Award, 2015

Project Title: *Machine Learning Through the Lens of Economics (And Vice Versa)*

Prof. Abernethy will explore a range of deep mathematical connections emerging across two seemingly-disparate research domains: Machine Learning, which focuses on developing algorithmic tools to synthesize data into predictions, and Microeconomic Theory and Finance, which seeks to understand markets, the allocation of resources, and prices.



PRABAL DUTTA

NSF CAREER Award, 2014

Project Title: *Scalable Sensor Infrastructure for Sustainably Managing the Built Environment*

Prof. Dutta will develop advanced sensor technologies that will help to create progress toward the current Federal sustainability goals that mandate that 50% of U.S. commercial buildings become net-zero energy by 2050.



HONGLAK LEE

NSF CAREER Award, 2015

Project Title: *New Directions in Deep Representation Learning from Complex Multimodal Data*

Prof. Lee will develop advanced deep learning techniques to learn a robust representation that allows for holistic understanding and high-level reasoning (such as, analogy making, hypothetical reasoning and temporal prediction, and question answering) from complex, multimodal data.



SOMIN EUNICE LEE

NSF CAREER Award, 2015

Project Title: *Engineering Plasmonic Nanoantenna Architectures for Efficient Nuclear Delivery*

As leader of the bioplasmonics group, Prof. Lee will develop improved methods for gene therapy by delivering corrected genes directly to the cell nucleus of damaged genes more efficiently and with greater control than is currently possible.

**RAJ NADAKUDITI****DARPA Young Faculty Award, 2014**

Project Title: *Fundamental Limits of Eigen-wavefront Based Imaging Through Highly Scattering Random Media*

Prof. Nadakuditi will develop an imaging method that will mitigate the loss in image quality due to the multiple scattering of light in non-transparent media, which includes brain tissue. This research will impact the ability to investigate the structure of brain circuits through the use of optical imaging techniques.

**NECMIYE OZAY****DARPA Young Faculty Award, 2014**

Project Title: *Dynamics-based Information Extraction: A Hybrid Systems Approach*

Prof. Ozay's research will draw from system theory to improve monitoring, diagnostics, anomaly and change detection in critical infrastructure systems. Her research will impact the safety and security of cyber-physical systems.

**BECKY PETERSON****DARPA Young Faculty Award, 2014**

Project Title: *Amorphous Oxide Thin Film Transistors for Switched-Mode Power Supplies*

Prof. Peterson will identify and fabricate device architectures that provide moderately high power handling capability using solution-processed amorphous semiconductors. Such systems could potentially be used in a wide variety of wireless sensing and actuation systems.

**MINA RAIS-ZADEH****ONR Young Investigator Award, 2014**

Project Title: *Acoustic Phonons and Their Interactions With Electrons in Gallium Nitride Ultra-fast Ultra-scaled Resonators*

Prof. Rais-Zadeh will develop micro- and nano-electromechanical systems (M/NEMS) in III-V materials, with a primary emphasis on Gallium Nitride (GaN). The resulting devices are expected to enable sensors for use in harsh environment, high-speed wireless communications, high-efficiency sea-based active electronically scanned arrays (AESAs), and high-performance electronic warfare.

**GRANT SCHOENEBECK****NSF CAREER Award, 2015**

Project Title: *Social Networks – Processes, Structures, and Algorithms*

Prof. Schoenebeck will seek to develop a better understanding of social networks through a rigorous theoretical understanding of complex and strategic network processes, network structure, and algorithms for network properties.

Sloan Research Fellowships

Sloan Research Fellowships are given by the Alfred P. Sloan Foundation to stimulate fundamental research by early-career scientists and scholars of outstanding promise.



PRABAL DUTTA, 2015, for his work in pervasive, low-power platforms.



J. ALEX HALDERMAN, 2015, for his work in Internet security and digital democracy.

EECS Awards



MARY LOU DORF (2014)

EECS Outstanding Achievement Award for providing a rigorous and welcoming introduction to computer science for thousands of students, and for working tirelessly to create a sustainable foundation for undergraduate advising in Computer Science and Engineering.



CLAYTON SCOTT (2014)

EECS Outstanding Achievement Award for fundamental contributions to statistical machine learning theory, particularly in robust anomaly detection and transfer learning, and for important contributions to methodology for numerous applications of machine learning with collaborators in engineering and medicine.



BENJAMIN KUIPERS (2015)

EECS Outstanding Achievement Award for sustained leadership in the fields of Artificial Intelligence and Robotics, for serving as Graduate Program Chair for Computer Science and Engineering, and for leadership on the Robotics PhD program and the Robotics Institute.



DAVID WENTZLOFF (2015)

EECS Outstanding Achievement Award for groundbreaking progress on low power circuits for wireless communication, including the development of both very low power and extremely small radios for body area communication; and for his leadership in co-founding PsiKick, a successful startup company developing ultra-low power wireless sensing platforms.



STEPHEN RAND (2015)

EECS Outstanding Achievement Award for pioneering work in the development and application of laser spectroscopy to the study of materials as well as the development of novel laser systems; and for the establishment of the Center for Dynamic Magneto-Optics (DYNAMO).



HERBERT WINFUL (2014)

EECS Outstanding Achievement Award for contributions to advanced nonlinear optics research, especially tunneling dynamics, nonlinear propagation in periodic media, single-cycle pulses, and fast and slow light, and in recognition of contributions to educational initiatives in Liberia and Ghana, and dedication to student learning and advising.

HKN Professors of the Year

Each year, the U-M chapter of Eta Kappa Nu, the national honor society for electrical and computer engineers, selects two faculty for recognition, one from each division of EECS. The recipients are selected based on a vote by the students.



DAVID PAOLETTI
(CSE 2015)



DAVID WENTZLOFF
(ECE 2015)



PETER CHEN
(CSE 2014)



JESSY GRIZZLE
(ECE 2014)

College of Engineering Awards



TODD AUSTIN

Research Excellence Award
(2015)



JAY GUO

Research Excellence Award
(2014-15)



SCOTT MAHLKE

Education Excellence Award
(2014)



DAVID BLAAUW

Innovation Excellence
Award (2014)



J. ALEX HALDERMAN

1938E Award
(2015)



EDWIN OLSON

Education Excellence Award
(2015)



DAVID CHESNEY

Raymond J. and Monica
E. Schultz Outreach
& Diversity Award
(2014)



STÉPHANE LAFORTUNE

Education Excellence Award
(2014)
Service Excellence Award
(2015)



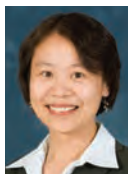
QUENTIN STOUT

Ted Kennedy Family Team
Excellence Award (2014)



ANDREW DEORIO

Thomas M. Sawyer, Jr.
Teaching Award
(2014)



MINGYAN LIU

Education Excellence Award
(2014-15)



DENNIS SYLVESTER

Innovation Excellence Award
(2014)



RONALD DRESLINSKI

Kenneth M. Reese
Outstanding Research
Scientist Award
(2015)



WEI LU

Rexford E. Hall Innovation
Excellence Award
(2015)



HERBERT WINFUL

Service Excellence Award
(2014)



YOGESH GIANCHANDANI

Research Excellence Award
(2014)



ANATOLY MAKSIMCHUK

Outstanding Research
Scientist Award
(2014)

University Awards



VALERIA BERTACCO

Faculty Recognition Award
(2014)



EMILY MOWER PROVOST

Oscar Stern Award for
Depression Research (2015)



JAMIE PHILLIPS

Arthur F. Thurnau Professor
(2014)



MARK BREHOB

Collegiate Lecturer (2015)



DAVE NEUHOFF

Rackham Distinguished
Graduate Mentor Award
(2015)



DENNIS SYLVESTER

Faculty Recognition Award
(2013)



STEPHEN FORREST

Distinguished University
Innovator Award (2015)

National and Professional Honors and Awards



MARK ACKERMAN was elected a Fellow of the Association for Computing Machinery (ACM) for contributions to human computer interaction, with an emphasis on finding and sharing expertise.



DANIEL E. ATKINS III was elected to the National Academy of Engineering, class of 2014, for leadership in development of radix algorithms and cyber-technical collaborative systems.



VALERIA BERTACCO was named an ACM Distinguished Scientist in 2014 by the Association for Computing Machinery.



PALLAB BHATTACHARYA, Charles M. Vest Distinguished University Professor and James R. Mellor Professor of Engineering, was selected to receive the 2015 IEEE David Sarnoff Award “for contributions to near-infrared and visible quantum dot lasers.”



DAVID CHESNEY was awarded a 2014 IBM Faculty Award for his work in teaching software engineering and for his success in encouraging students to leverage new approaches to developing assistive technologies for people with disabilities.



KEVIN COMPTON received an ACM-ICPC Coach Award in 2014 for his work in five times bringing student programming teams from the University of Michigan to the world finals in the annual ACM International Collegiate Programming Contest.



LYNN CONWAY, Professor Emerita, received the 2015 IEEE/RSE James Clerk Maxwell Medal, “for contributions to and leadership in design methodology and pedagogy enabling rapid advances and dissemination of VLSI design tools and systems.” She was also named 2014 Fellow of the Computer History Museum, and gave the 2015 Steinmetz Lecture at Union College.



JASON CORSO received a 2015 Google Faculty Research Award to further his research in computational learning from instructional video content.



RONALD DRESLINSKI was selected for the IEEE Technical Committee on Computer Architecture (TCCA) Young Computer Architect Award in 2015.



PRABAL DUTTA was named one of *Popular Science*’s 2014 Brilliant Ten for his work in developing energy scavenging sensors that could help herald the Internet of Things.



JEFF FESSLER received the 2013 IEEE Edward J. Hoffman Medical Imaging Scientist Award for contributions to the theory and application of statistical image reconstruction methods in nuclear medicine, x-ray, CT, and magnetic resonance imaging (MRI).



MICHAEL FLYNN was elected IEEE Fellow for contributions to analog-digital interfaces.

He was also named Editor-in-Chief of the *IEEE Journal of Solid-State Circuits*.



STEPHEN FORREST, Paul G. Goebel Professor of Engineering and Peter A. Franken Distinguished University Professor, has been named Fellow of the National Academy of Inventors (NAI).

He was also included in a recent Thompson Reuters publication as one of the most influential scientific minds in the world for 2014.



KEVIN FU was recognized by the World Economic Forum in 2014 with its Young Scientist Award for improving the security of embedded computer systems by uncovering their security flaws.

In 2015, he was appointed as one of five new members on the CRA’s Computing Community Consortium Council, which aims to catalyze the computing research community and enable the pursuit of innovative, high-impact research.



J. ALEX HALDERMAN was named one of *Popular Science*’s 2015 Brilliant Ten for his work in Internet security and digital democracy.

National and Professional Honors and Awards



JOHN P. HAYES was honored with the IEEE TTTC Lifetime Contribution Medal for his outstanding contributions to test technology. He also received a 2014 SIGDA Pioneering Achievement Award for his pioneering contributions to logic design, fault tolerant computing, and testing.



ALFRED HERO received the 2013 IEEE Signal Processing Society (SPS) Technical Achievement Award for information-theoretic advances in statistical signal processing and machine learning.



JERZY KANICKI was elected to the Board of Directors of the Society for Information Display. He will serve as Director of the Metropolitan Detroit area.



MARK KUSHNER, George I. Haddad Professor of Electrical Engineering and Computer Science, has been awarded the 2015 IEEE NPSS Charles K. Birdsall Award from the Nuclear & Plasma Sciences Society for his outstanding contributions in computational nuclear and plasma science.



STÉPHANE LAFORTUNE was named Editor-in-Chief of the *Journal of Discrete Event Dynamic Systems: Theory and Applications*.



MINGYAN LIU has been elected IEEE Fellow, Class of 2014, for contributions to modeling of wireless ad-hoc and sensor networks.



SCOTT MAHLKE was elected a Fellow of the IEEE, Class of 2015, "for contributions to compiler code generation and automatic processor customization."



JASON MARS was selected to serve as Program Chair for the 2015 International Symposium on Code Generation and Optimization (CGO).



ERIC MICHIELSSEN has been awarded the 2014 IEEE Antenna and Propagation Society Chen-To Tai Distinguished Educator Award.



RADA MIHALCEA served as general chair for the 2015 Conference of the North American Chapter of the Association for Computational Linguistics (NAACL). It is the largest computational linguistics conference in North America, and one of the largest worldwide.



TREVOR MUDGE received the 2014 ACM/IEEE Eckert-Mauchly Award, which is widely viewed as the computer architecture community's most prestigious recognition, "for pioneering contributions to low-power computer architecture and its interaction with technology."

He also received a Distinguished Achievement Award by University of Illinois Computer Science Department in 2014.



KHALIL NAJAFI, Schlumberger Professor of Engineering and Chair of Electrical and Computer Engineering, received the 2013 IEEE Sensors Technical Field Award "for leadership in microsystem technologies and seminal contributions to inertial sensors and hermetic wafer-level packaging."

He was also selected to receive the 2015 IEEE Daniel E. Noble Award for Emerging Technologies "for leadership in microelectromechanical systems (MEMS), technologies, and devices and for seminal contributions to inertial devices and hermetic wafer-level packaging."



MINA RAIS-ZADEH was named the IEEE Electron Device Society Distinguished Lecturer (2015-2017).



KAMAL SARABANDI, Rufus S. Teesdale Professor of Engineering, has been elected president of the IEEE Geoscience and Remote Sensing Society (GRSS). He began his two-year term January 1, 2015.



MICHAEL P. WELLMAN was selected by the ACM Special Interest Group on Artificial Intelligence as the recipient of its 2014 Autonomous Agents Research Award.

Professorships



STEPHEN FORREST

Peter A. Franken
Distinguished University
Professor

Steve Forrest has been named the Peter A. Franken Distinguished University Professor of Engineering. By taking his name, Prof. Forrest honors Dr. Franken's legacy as the "father of nonlinear optics," as well as the rich history of optics at Michigan. Prof. Forrest is also the Paul G. Goebel Professor of Engineering.

Prof. Forrest is an internationally-renowned researcher, educator, and entrepreneur, and easily one of the most prolific inventors in academia today. As director of the Optoelectronic Components and Materials (OCM) Laboratory, he and his group conduct research on photovoltaic cells, organic light emitting diodes (OLEDs), and lasers & optics. His investigations in these areas span decades, and have resulted in five startup companies (Epitaxx - purchased by JDSU, Sensors Unlimited - purchased by Goodrich, Universal Display Corp., Global Photonic Energy Corp. - now NanoFlex Power Corp., and ASIP Inc. - now part of Avago Technologies), 277 issued patents, and key technologies that are pervasive in the marketplace. In addition, he has graduated 54 PhD students.

Prof. Forrest has received numerous honors throughout his career. Just this past year, he was named a fellow of the National Academy of Inventors, and was named the 2015 U-M Distinguished University Innovator. He is a Fellow of the APS, IEEE, OSA, and a member of the National Academy of Engineering.



JESSE GRIZZLE

Elmer G. Gilbert
Distinguished University
Professor

Jesse Grizzle has been named the Elmer G. Gilbert Distinguished University Professor of Engineering. Prof. Grizzle honors Dr. Gilbert as a researcher in Control and as an entrepreneur who founded the successful company Applied Dynamics more than 50 years ago. Prof. Grizzle is also the Jerry W. and Carol L. Levin Professor of Engineering.

Prof. Grizzle is an internationally renowned researcher in the area of control systems. He has received significant accolades both professionally and in the popular press for his work in the area of bipedal robots. He shares his excitement for the field with local K12 children, who get turned on to science and engineering after visiting his lab.

Prior to his application of nonlinear control theory to robotics, Jesse made important contributions to the design of environmentally friendly powertrains, working in collaboration with Professors Sun (NAME), Kolmanovsky (Aero), Stefanopoulou (ME), and Dr. Cook (ECE), resulting in 16 patents. More recently, he turned his attention to hybrid electric vehicles (HEVs), teaming with Professor Peng (ME) to design a power management control strategy for hybrid electric trucks that was adopted by Eaton in a nation-wide design competition. His invisible algorithms are now part of the HEV technology used in Federal Express trucks.

Wellman Professorships

Prof. Michael P. Wellman endowed the Morris Wellman Faculty Development Professorship in his grandfather's name. Morris Wellman was an engineer who worked for most of his career as a civil servant of the City of New York. The professorship is awarded to junior faculty members in recognition of outstanding contributions to teaching and research.



PRABAL DUTTA, 2015, for his work in pervasive, low-power platforms.



SATISH NARAYANASAMY, 2014, for his work in parallel software systems.



J. ALEX HALDERMAN, 2015, for his work in Internet security and digital democracy.



EDWIN OLSON, 2014, for his work in robotics, automation, and machine perception.

Sakallah Helps to Shape Qatar Computing Research Institute

Prof. Karem Sakallah has taken a leave of absence from the Department for 2014 and 2015 to serve as Scientific Advisor at QCRI, located in Doha, Qatar, and to manage the growth of its Cyber Security Research Area. Sakallah has been involved in the realization and growth of the institute, officially established in 2010, since he was asked to participate in *The Founding Conference for Expatriate Arab Scientists* in 2005. Today, QCRI is staffed with over 100 renowned computer scientists from more than 25 countries and is organized into six areas of computer science research.

Full story + video: eecs.umich.edu/n/qcristory



Sakallah, middle front, at Joint Coordinating Committee meeting in 2012.



Prof. Shai Revzen

Ideas Worth Sharing

TEDxUofM welcomed two speakers from EECS to its stage to “give the talk of their lives in 18 minutes or less.” Profs. Shai Revzen and Herbert Winful spoke about their passion for their work at the sixth annual conference, themed “Constructive Interference.” Prof. Herbert Winful, a specialist in nonlinear optics, gave the talk, “How Hidden Passions can Connect People.” Prof. Winful talked about developing the course “Creative Process,” his experience organizing an evening of music and art for one of his classes to help them deal with the tragic death of a classmate, and closed his talk with a performance of an original work called “Spirit Dreams”. Prof. Revzen, who runs the Biologically Inspired Robotics and Dynamical Systems (BIRDS) lab, gave the talk, “Facing the Unknown, with Robots.” Prof. Revzen is fascinated by the unknown, and believes that the next frontier in robotics is to design robots that can adapt to unforeseen situations. With unlimited robotic assistance tailored to a task in the moment, exploration and discovery could be greatly enhanced. His solution is to build robots that can build other robots specially tailored to the environment.

Full story + video: eecs.umich.edu/n/tedx

Former CSE Chair Now Provost at CMU

Farnam Jahanian, CSE Chair from 2007–2011, was appointed as Carnegie Mellon University’s Vice President of Research in April 2014. In February 2015, Jahanian was named CMU’s Provost. Jahanian led the National Science Foundation Directorate for Computer and Information Science and Engineering (CISE) from 2011 to 2014 while on leave from U-M.



Jahanian, left, with former student and Arbor Networks cofounder Rob Malan, at a farewell party for Jahanian at Michigan in September 2014.

Space Physics Research Lab Gets a New Director and a New Home

Brian Gilchrist has been named Director of the Space Physics Research Laboratory (SPRL) at the University of Michigan. SPRL’s 65-year history began with William Gould Dow, former faculty member and department chair, when he went to Washington after WWII and convinced the leaders that captured V-2 rockets would be utilized for the exploration of near space environments. SPRL grew out of that research.

Recently, SPRL became officially tied to the entire College of Engineering rather than a single department (Atmospheric, Oceanic, and Space Sciences), and Prof. Gilchrist aims to find ways for SPRL to serve the broader engineering community. He sees SPRL having an impact in robotics, autonomous vehicles, distributed sensor networks, and many other areas. He is particularly pleased that SPRL is developing a formal educational mission, having hired its first Associate Director for educational initiatives.



Brian Gilchrist

Relationship With Ethiopia's Addis Ababa Institute of Technology Grows With Research Exchange Program

During a trip to Ethiopia in 2009, Profs. Todd Austin and Valeria Bertacco visited Addis Ababa Institute of Technology to give a talk about Michigan Engineering. Finding great enthusiasm for EECS amongst students there, the pair arranged for the donation of computer equipment for labs and while on sabbatical in 2012 built curriculum and taught. In the years since, Austin and Bertacco have recruited graduate students from AAIT. A broader relationship with Michigan exists now, and in early 2015 Austin and Bertacco were part of a U-M delegation to AAIT that included 10 schools and colleges which are currently engaged in collaborative projects with colleagues in Ethiopia.

The two now hope to build an even stronger relationship between U-M and AAIT through their research exchange program. During the pilot program, which took place this year, three U-M CSE graduate students traveled to Ethiopia for one month to bootstrap research projects with current AAIT students.

This year they were able to start six projects, including an automated recommendation interface, hardware that can process the Sum of Absolute Differences, smart accelerated memory controllers, hardware that decreases security attacks, and a method to verify heterogeneous system delays.

Prof. Bertacco states, "The CSE-AAIT research exchange program is a great opportunity to strengthen our college of engineering's partnership with AAIT and to provide cross-cultural research experiences for our graduate students, preparing them for their future professional career. I hope that in the upcoming years we'll be able to expand the program to encompass additional engineering programs at U-M and AAIT."

Full story + video: eecs.umich.edu/n/aaits



Engineering a Better Future for Ethiopia

Prof. Heath Hofmann and doctoral student Abdi Zeynu traveled to Addis Ababa Institute of Technology (AAIT) in the capital of Ethiopia to bring the latest knowledge in Controls Systems and Power & Energy to a nation in dire need of this expertise. AAIT is one of the largest technical colleges in Ethiopia, but several of its programs are still young. Working under the Ethiopia-Michigan Platform for Advancing Collaborative Engagement (EM-PACE), Prof. Hoffman and Abdi made preliminary visits to the school to assess their goals and needs. During their return this past June, they taught a 3-week course in Electric Machinery and Drives, and provided consultation and support as the school's engineering college expanded its Control and Power programs.

The emphasis on power and controls is of particular importance to Ethiopia's growing infrastructure. The nation is undergoing rapid economic growth, and their current power system is unable to keep up with new construction and new loads. Several ongoing projects focus on harnessing more hydropower plants, and bringing smaller ones to rural areas to power the many remote villages. Prof. Hofmann intends to return to the school in the future to continue teaching and guiding the growing department. Abdi plans to continue his work with Ethiopia in some capacity for the foreseeable future.

Full story: eecs.umich.edu/n/eth

Faculty and Student Outstanding Paper Awards*

2014 MICRO TEST OF TIME AWARD

This award is given in recognition of the most influential papers published in past Micro conferences that have had significant impact in the field. *Effective Compiler Support for Predicated Execution Using the Hyperblock* was originally published in 1992, by **Prof. Scott A. Mahlke**, David C. Lin, William Y. Chen, Richard E. Hank, and Roger A. Bringmann.

“ABS: a System for Scalable Approximate Queries with Accuracy Guarantees,” by Kai Zeng, Shi Gao, Jiaqi Gu, **Prof. Barzan Mozafari**, and Carlo Zaniolo, Best Demo Award, 2014 ACM SIGMOD/PODS Conference, June 2014.

“Accelerating Mobile Applications through Flip-Flop Replication,” by **Mark S. Gordon**, **David Ke Hong**, **Peter M. Chen**, **Jason Flinn**, **Scott Mahlke**, and **Zhuoqing Morley Mao**, Best Paper Award, 13th International Conference on Mobile Systems, Applications, and Services (MobiSys 2015), May, 2015.

“Cavity Optomechanics on a Microfluidic Resonator with Water and Viscous Liquids,” by **Kyu Hyun Kim**, Dr. Guarav Bahl, **Wonsuk Lee**, **Jing Liu**, **Matthew Tomes**, **Prof. Xudong Fan**, and **Prof. Tal Carmon**, Emil Wolf Outstanding Student Paper Award, 2013 OSA Frontiers in Optics.

“Context-Triggered Mobile Network Measurement,” by **Shichang Xu**, **Ashkan Nikraves**, **Hongyi Yao**, David R. Choffnes, and **Prof. Z. Morley Mao**, Best Poster Award, 13th International Conference on Mobile Systems, Applications, and Services (MobiSys 2015), May, 2015.

“Correcting Camera Shake by Incremental Sparse Approximation,” by **Prof. Alfred Hero**, **Prof. Anna Gilbert**, and **Dr. Paul Shearer**, Best Paper Award, 2013 IEEE International Conference on Image Processing (ICIP).

“Decontamination of Mutually Contaminated Models,” by **Prof. Clay Scott** and Gilles Blanchard, Notable Paper Award, 2014 International Conference on Artificial Intelligence and Statistics (AISTATS).

“Decorative Power Generating Panels Creating Angle Insensitive Transmissive Colors and Colored Ultra-thin Hybrid Photovoltaics with High Quantum Efficiency,” by **Jae Yong Lee**, **Kyu-Tae Lee**, **Sungyong Seo**, and **Prof. Jay Guo**, Best Poster Award, 40th Annual Symposium of the American Vacuum Society (AVS) -Michigan Chapter

“Detecting Hidden Propagation Structure and Its Application to Analyzing Phishing,” by **Yang Liu** and **Prof. Mingyan Liu**, Best Applications Paper Award, ACM/IEEE International Conference on Data Science and Advanced Analytics (DSAA2014).

“Directly Heated Four-terminal Phase Change Switches,” by **Muzhi Wang** and **Prof. Mina Rais-Zadeh**, Best Student Paper Award (Honorable Mention), 2014 IEEE International Microwave Symposium (ISM2014).

“An Energy Management Controller to Optimally Trade Off Fuel Economy and Drivability for Hybrid Vehicles,” by **Daniel Opila**, Xiaoyong Wang, Ryan McGee, **R. Brent Gillespie**, **Jeffrey Cook**, **Prof. Jessy Grizzle**, Outstanding Paper Award, 2014 IEEE Transactions on Control Systems Technology (TCST).

“EPIC Modeling of a Two-Talker CRM Listening Task Visual Search,” by **Prof. Gregory H. Wakefield**, **Prof. David Kieras**, Eric Thompson, Nandini Iyer, and Brian D. Simpson, Best Paper Award, International Conference on Auditory Display (ICAD), June 2014.

“From Large Scale Image Categorization to Entry-Level Categories,” by **Vicente Ordonez**, **Prof. Jia Deng**, Yejin Choi, Alexander C. Berg, and Tamara L. Berg, Marr Prize (Best Paper Award), International Conference on Computer Vision (ICCV), December 2013.

“InGaN/GaN Quantum Dot Red ($\lambda = 630$ nm) Laser,” by **Thomas Frost**, **Animesh Banerjee**, **Kai Sun**, Shun Lien Chuang, and **Prof. Pallab Battacharya**, Best Paper Award, 2013 Device Research Conference.

“Joint Design of Continuous [Excitation k-space] Trajectory and RF Pulse for 3D Tailored Excitation,” by **Hao Sun**, **Prof. Jeffrey Fessler**, **Dr. Jon-Fredrik Nielsen**, and **Prof. Douglas Noll**, Magna Cum Laude Award, 2014 International Society for Magnetic Resonance in Medicine (ISMRM).

“Large-Scale Object Classification Using Label Relation Graphs,” by **Prof. Jia Deng**, Nan Ding, Yangqing Jia, Andrea Frome, Kevin Murphy, Samy Bengio, Yuan Li, Hartmut Neven, and Hartwig Adam, Best Paper Award, European Conference on Computer Vision (ECCV), September 2014.

“A Low Phase-noise Pierce Oscillator Using a Piezoelectric-on-silica Micromechanical Resonator,” by **Zhengzheng Wu**, **Vikram Thakar**, **Adam Peczalski**, and **Prof. Mina Rais-Zadeh**, Best Poster Award, 17th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers '13).

“Marginal Likelihoods for Distributed Estimation of Graphical Model Parameters,” by **Zhaoshi Meng**, **Dr. Dennis Wei**, **Dr. Ami Wiesel**, and **Prof. Alfred Hero**, Best Student Paper Award (2nd Place), Fifth IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP 2013).

*Names in **bold** are U-M faculty or graduate students, unless otherwise identified.

Faculty and Student Outstanding Paper Awards*

"A Multi-shank Silk-backed Parylene Neural Probe for Reliable Chronic Recording," by **Fan Wu**, Lee Tien, **Fujun Chen**, Prof. David Kaplan, **Prof. Joshua Berke**, and **Prof. Euisik Yoon**, Outstanding Oral Paper Award, 17th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers '13).

"Outatime: Using Speculation to Enable Low-Latency Continuous Interaction for Mobile Cloud Gaming," by **Kyungmin Lee**, David Chu, Eduardo Cuervo, Johannes Kopf, Yury Degtyarev, Sergey Grizan, Alec Wolman, and **Prof. Jason Flinn**, Best Paper Award, 13th International Conference on Mobile Systems, Applications, and Services (MobiSys 2015), May, 2015.

"A Printed Antenna Beam Former Implemented Using Tensor Transmission-line Metamaterials," by **Gurkan Gok** and **Prof. Anthony Grbic**, Third Place, Student Paper Competition, 2014 IEEE International Symposium on Antennas and Propagation.

"Production Lead Time Problem: Formulation and Solution for Bernoulli Serial Lines," by **Prof. Semyon Meerkov** and **Dr. Chao-Bo Yan**, Best Paper Prize, International Federation of Automatic Control (IFAC) Conference on Manufacturing Modeling, Management and Control.

"Quipu: Simulation of Quantum Circuits via Stabilizer Frames," by **Hector Garcia** and **Prof. Igor Markov**, Best Poster (3rd Place), Society of Hispanic Professional Engineerings 2013.

"Say Cheese vs. Smile: Reducing Speech-Related Variability for Facial Emotion Recognition," by **Yelin Kim** and **Prof. Emily Mower Provost**, Best Paper Award, ACM International Conference on Multimedia, November 2014.

"Small-tip Fast Recovery (STFR) Imaging Using Spectrally Tailored Pulse," by **Hao Sun**, **Prof. Jeffrey Fessler**, **Dr. Jon-Fredrik Nielsen**, and **Prof. Douglas Noll**, Summa Cum Laude Award, 2014 International Society for Magnetic Resonance in Medicine (ISMRM).

"Sources of Error in Full-System Simulation," by **Anthony Gutierrez**, **Joseph Pusdesris**, **Dr. Ronald G. Dreslinski**, **Prof. Trevor Mudge**, Chander Sudanthi, Christopher D. Emmons, Mitchell Hayenga, and Nigel Paver, Best Paper Award, IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS), March 2014.

"Steady-state Functional MRI Using Spoiled Small-tip Fast Recovery (STFR) Imaging," by **Hao Sun**, **Prof. Jeffrey Fessler**, **Dr. Jon-Fredrik Nielsen**, and **Prof. Douglas Noll**, Magna Cum Laude Award, 2014 International Society for Magnetic Resonance in Medicine (ISMRM).

"Student Performance Improvement Using Interactive Textbooks: A Three-University Cross-Semester Analysis," by Alex Edgcomb, Frank Vahid, Roman Lysecky, Andre Knoesen, Rajeevan Amirtharajah, and **Mary Lou Dorf**, Best Paper Award, 2015 ASEE Annual Conference.

"The Charging of Photoconductors in Print Engines by Microplasmas," by **Jun-Chieh Wang**, Seongsik Chang, Napoleon Leoni, Henryk Birecki, Michael Lee, Tom Anthony, Omer Gila, and **Prof. Mark Kushner**, Best Oral Paper Award, 8th Asia-Pacific International Symposium on the Basics and Applications of Plasma Technology (APSPT-8).

"The Dependence of Effective Planning Horizon on Model Accuracy," by **Nan Jiang**, **Alex Kulesza**, **Prof. Satinder Singh Baveja**, and **Richard Lewis**, Best Paper Award, International Conference on Autonomous Agents & Multiagent Systems (AAMAS 2015), May, 2015.

"The Matter of Heartbleed," by **Zakir Durumeric**, **James Kasten**, **David Adrian**, **Prof. J. Alex Halderman**, **Michael Bailey**, Frank Li, Nicholas Weaver, Johanna Amann, Jethro Beekman, Mathias Payer, and Vern Paxson, Best Paper Award, ACM Internet Measurement Conference (IMC), November 2014.

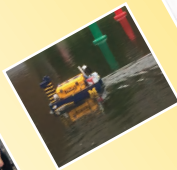
Towards Accurate and Practical Predictive Models of Active-Vision-Based Visual Search, by **Prof. David E. Kieras**, Anthony J. Hornof, Best Paper Award, ACM CHI Conference on Human Factors in Computing Systems, April 2014.

"Visual Localization Within LIDAR Maps for Automated Urban Driving," by **Ryan Wolcott** and **Prof. Ryan Eustice**, Best Student Paper Award, 2014 IEEE/RSJ International Conferences on Intelligent Robot Systems, September 2014.

"Welfare Effects of Market Making in Continuous Double Auctions," by **Elaine Wah** and **Prof. Michael P. Wellman**, Best Student Paper Award, International Conference on Autonomous Agents & Multiagent Systems (AAMAS 2015), May, 2015.

*Names in **bold** are U-M faculty or graduate students, unless otherwise identified.

Student News





MHacks Continues to Innovate as a Leader in Hackathons

Since the first MHacks in February 2013, Michigan students have built the bi-annual event into a sophisticated operation that draws speakers, participative sponsors, and student participants with a variety of technical and non-technical backgrounds.

“Since its beginnings, MHacks has focused on bringing people together to build community, and we want to grow that community as much as possible. Everyone is welcome here,” said Tom Erdmann, a founder and two-time director of MHacks. Well over 1,000 students from 267 schools were represented at the 36-straight hour MHacks V in Winter 2015 to think big, collaborate, and produce creative projects.

“In my experience, MHacks is much more than energy drinks, sleepless nights, and non-stop building,” said a participant. “There’s a greater emphasis on learning and diversity in thought, background, and action. And as a result MHacks is redefining the hackathon and the hacker.”

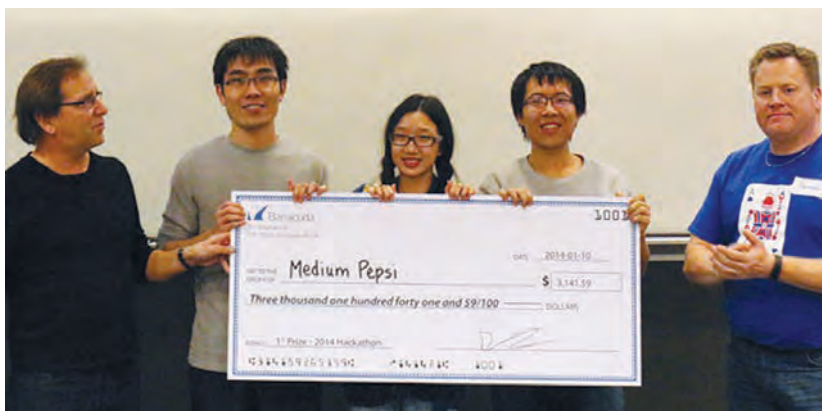
MHacks 6 will take place in the fall of 2015, and the student organizers plan on making it even accessible and productive. Among other things, the agenda includes workshops for new hackers to learn more about developing, creating, and designing, so they will be able to participate in more hacks.

Full story: eecs.umich.edu/n/hack

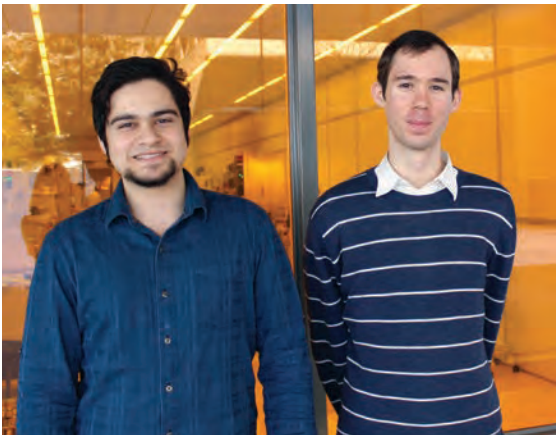
Students Create Card-Playing Bots for Barracuda Programming Contest

About 100 students spent 24 hours on recent January weekend to design and optimize intelligent game-playing “bots” in an annual programming contest at U-M that is run by Barracuda Networks. The bots were programs designed by the students to play a modified version of the traditional card game, “Put,” where the object of the two-player game is to take tricks.

Students formed 45 teams of one to four individuals, and spent about 20 hours designing and improving their bots. 34 teams survived the night and competed in the final competition. The ultimate winners were determined after five brackets of play.



(L - R) Blair Hankins (Barracuda); winning teammates Siyuan Zhou, Baishen Xu, and Bowen Xu; Rich Boys (Barracuda).



A Wearable Device With a Sense of Touch

Paul Myers, EE Senior, and Amin Sandoughsaz, EE PhD student, were selected as finalists for the 2015 Qualcomm Innovation Fellowship (QInF). Their project, “A Wearable Haptic Device with Integrated Sensing and Actuation for Next Generation Communication Systems,” seeks to augment the transmission of audio and video with the sense of touch.

Full story: eecs.umich.edu/n/touch

Small Satellite Wins Big

Iverson Bell, a doctoral student in electrical engineering, took second place and a \$7,500 prize in the 2014 Frank J. Redd Student Competition at the 28th Annual AIAA/USU Conference on Small Satellites (Small Sat Conference). Iverson examined the capabilities of electrodynamic tether technology and developed an experimental facility to simulate key characteristics of the space environment. Iverson also travelled to Washington, D.C. as a representative of the Michigan Space Grant Consortium, part of a national NASA-funded program aimed at increasing the number of students pursuing STEM careers, to urge support.

Full story: eecs.umich.edu/n/sat



Bringing the Problem-Solving Power of Engineering to India

Cameron Polack, senior in EE, is taking engineering to the real world. Cameron is a founding member of the student team BLUElab India. After visiting the village of Dolatpura, India, the team focused their attention on the design of stoves, toilets, and septic systems. Cameron leads the sub-team focused on stove design. The village's current stoves are not properly ventilated and therefore fill homes with smoke. The team made contact with the families they'll be working with via Skype, giving Cameron and other team members who were unable to travel to India in May a chance to meet the residents.

Full story: eecs.umich.edu/n/india



Cameron Polack

BLUElab India students dine with locals in Dolatpura, India.

Getting Psyched at National NSBE Convention

Groups of EECS students attended the National Society of Black Engineers (NSBE) Annual Convention in 2014 and 2015, where they were able to participate in career fairs, competitions, professional workshops, networking events, and elections. The convention is an opportunity for students to broaden their perspectives of the engineering profession while they network with students and professionals from across the United States and the world.

All of the EECS attendees came back excited about their careers and newly connected to many professionals in the field. Kwesi Rutledge, the chapter's Academic Excellence Chair at the time, left the event with a greater sense of connection to his fellow NSBE members and the larger engineering field. "I'm excited to continue to give back to the community on behalf of NSBE," he said. "The mission that helped improve and train a young engineer like me will hopefully do the same for 10,000 young black engineers in the future."

Regarding his trip last year, Dwight Williams said, "Going to the NSBE convention opened many doors for me. From learning more about venture capital to what it takes to make myself a competitive applicant for graduate studies, I learned it all during my time at the national NSBE convention."

Full story: eecs.umich.edu/n/nsbe



Kwesi Rutledge (L) and Erin Moore (R) display personal and U-M chapter awards won at the convention.



Members of the University of Michigan Chapter of NSBE.



Alyssa Kornlyo (L) and David Hiskens (R).

The Crowning of Mr. and Ms. Engineer

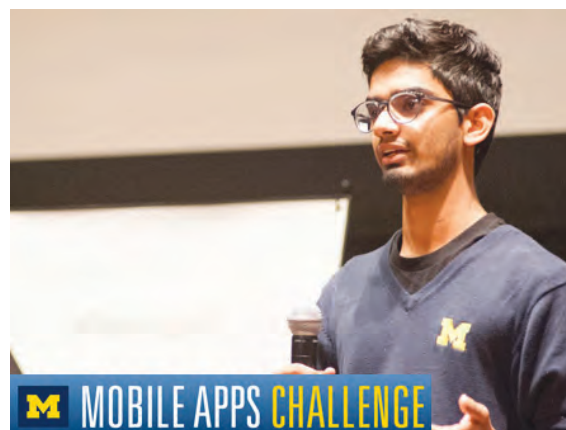
2015's Engineering Games pitted teams from six engineering student organizations in a clash of talent, skill, and problem solving. Representing HKN (Eta Kappa Nu), ECE graduate student David Hiskens and CS senior Alyssa Kornlyo took home the Mr. and Ms. Engineering crowns for a winning performance in the talent portion that was a mashup of Disney's *Frozen* and *Lord of the Rings*. The competition, formerly called Mr. Engineer, raised over \$2,000 for the Detroit Area Pre-College Engineering Program.

Full story + video: eecs.umich.edu/n/hkn

EECS Students Sweep Awards at 2015 Mobile Apps Challenge

The U-M Mobile Apps Challenge is held each year and is open to faculty, students, and staff from across the U-M Ann Arbor campus. It challenges participants to create and submit any type of functioning app. In 2015, the winners were almost entirely computer science students. The only non-CS student was first-place winner Janum Trivedi, who created a spontaneous sharing app called Kandid.

At the April 2015 awards ceremony for the event, Janum was an undeclared freshman with plans to declare in CS soon. He added that CS is "a personal passion of mine."

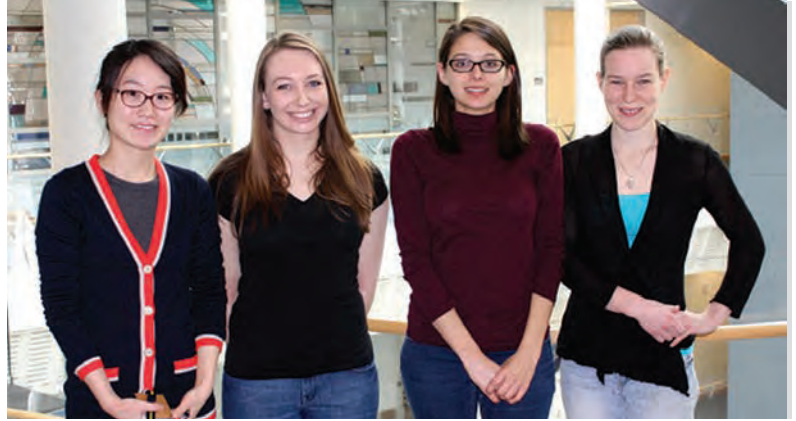


First place winner Janum Trivedi.

CSE Students Attend CRA-W Workshop

Five CSE graduate students, Neha Agarwal, Lauren Hinkle, Yelin Kim, Elizabeth Mamantov, and Dana Wilson, attended the 2014 CRA-W Grad Cohort Workshop in Santa Clara, CA. The Grad Cohort aims to increase the ranks of senior women in computing by building and mentoring nationwide communities of women through their graduate studies.

Students at the workshop interact with senior computing researchers and professionals, who share pertinent information on graduate school survival skills, as well as more personal information and insights about their experiences. The rewards of a research career were emphasized. The women were able to build mentoring relationships and develop peer networks that will form the basis for ongoing activities during their graduate careers.



Yelin Kim, Lauren Hinkle, Elizabeth Mamantov, and Dana Wilson.

Wolverine Soft Sponsors Game Jams and Demo's Results to Kids

Wolverine Soft, the University of Michigan student group dedicated to the development of video games, held its *11th Annual 48-Hour Game Jam* on the weekend of January 17–19, 2015. 70 competitors showed up to produce 17 new games based on the theme “Separate,” which was kept secret until the event began. Teams of four worked – often through the night – to make the deadline, and for their efforts they were awarded medals, trophies, and mysterious “secret achievement”-style golden awards. Golden awards this year included a golden can of Monster for not sleeping during the competition, a golden rock for the most “rock-solid” game idea, a golden Spider for the most “nightmare-fueled” game, and many, many others.

The winners of the contest were team 19, the producers of Polar Coordinator. The team consisted of Kevin Jeon, David Cai, Andrew Yang, and Cameron Flora.



Wolverine Soft also brought video games made during the 2014 Intel-sponsored “Code for Good” Game Jam to the Ann Arbor District Library. The goal of the event was to create complete, playable video games for kids on the subject of science. The resulting games spanned a wide variety of scientific themes, from blood-cell biology and astronomical supernovae to projectile physics and chemical reactions.

Kyle Lady Elected as First Student Member of IEEE-HKN Board of Governors

CSE graduate student Kyle Lady was elected by national chapters of the IEEE-Eta Kappa Nu (HKN) honor society in 2014 to serve as the first student member of the organization’s Board of Governors. Kyle previously served as president and vice president and in other leadership roles for the University of Michigan chapter of HKN. He was also a graduate student advisor for Tau Beta Pi-Michigan Gamma chapter.

IEEE-Eta Kappa Nu is dedicated to encouraging and recognizing excellence in the IEEE-designated fields of interest. Members consist of students, alumni, and other professionals who have demonstrated exceptional academic and professional accomplishments.



The Ensemble of CSE Ladies Aims to Support Graduate Women in CSE

ECSEL, the Ensemble of CSE Ladies, is a new student group on campus that aims to bring together women in computer science by supporting graduate women students in CSE at the University of Michigan. The group's goal is to foster a sense of community among graduate women, support members' academic and career development, help incoming graduate students adapt and thrive in CSE, and generally enable a great graduate experience for their members.

Full story: eecs.umich.edu/n/ecsel



Jobs Data: EECS is #1



The Engineering Career Resource Center at the College of Engineering has issued its 2014-2015 Annual Report, which includes reported placement and salary survey data for students who accepted employment offers from the Dec 2013 – Aug 2014 time period. The report shows that all three EECS undergrad majors – computer engineering, computer science, and electrical engineering – were highly sought by recruiters. Here are two key takeaways from the report:

Most sought: EECS majors were the three majors most requested by organizations recruiting undergraduates through the ECRC, with over 70% of all employers specifically asking for EECS students.

Best compensated: For all categories of employment – Co-ops, Bachelor's Internships, Master's internships, Bachelor's full-time hires, and Master's full-time hires – EECS majors received the highest median monthly salaries.

Full story: eecs.umich.edu/n/ecrc

IEEE Recognized as Best Student Branch in SE Michigan

The University of Michigan student chapter of IEEE was named best IEEE student branch in Southeastern Michigan for 2012–2013. The goal of Michigan's student branch of IEEE is to be an interface between students, technology companies, the EECS department, and the IEEE national organization. It is open to all students on campus. During the past year, the group held many technical and social events, including a Professor Speaker Series, information sessions by a variety of technical companies, and many events to promote fellowship and a fun break from studies. And of course they continue to help run the dB Café along with HKN to provide affordable and yummy food to students, faculty, and staff.

Matt Kneiser, President at the time, said "IEEE opens up many doors for students – professionally and socially. It's great to be part of that process and watch students grow. I get the opportunity to invest in the university in a meaningful way."



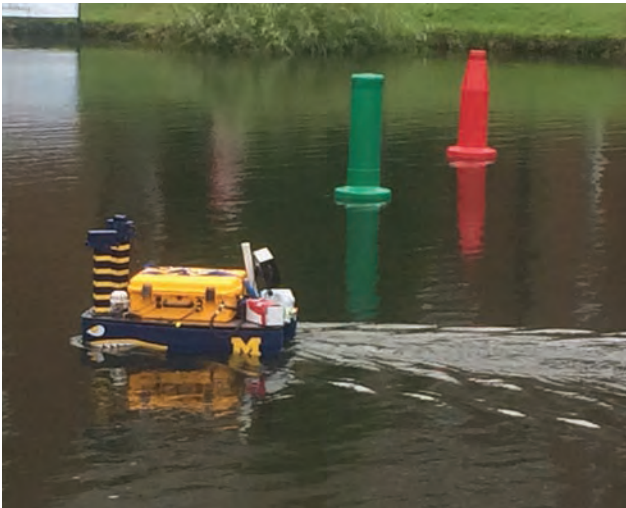
Matt Kneiser and Alex Hakkola, President and Vice President of the Michigan branch of IEEE, accepted the award for Best Student Branch in SE Michigan.

Building Better RoboBoats: UM::Autonomy Takes Third at International Competition

Autonomous vehicles are in hot demand right now, and that's just as true at sea. UM::Autonomy designs, programs, and builds their own autonomous boat every year for the annual RobotBoat competition. This year the team took third prize.

For this year's competition, UM::Autonomy performed a complete hull redesign, motivated by instability in their previous designs. The result was a boat that sat much lower in the water, allowing it to remain stable even through zero-point turns. The team also decided to fully waterproof the boat, allowing more testing time in heavy rain.

"RobotBoat is a platform that allows us to learn things that labs and class projects can't really cover," said Marisa Witcpalek, EE major and team president for the coming season. "The scope of this project is much larger than in-class projects, and it gives us a chance to really get our hands dirty with debugging and solving real-world problems."



(L - R) Cyrus Anderson, Ryan Jackson, Lance Cummins, Marisa Witcpalek, Dan Snyder, Jeremy Lipshaw, and Parker Howard.

Inspiring Young Women to Follow the Beauty of Science and Engineering

EE and vocal performance major Alexandria Strother entered the Miss Washtenaw County contest on a whim, and is now using the platform to introduce young women to STEM fields. "When I was younger, I had no concept of what an engineer was," she explains. "So I go to classrooms and go through what STEM is and what different things you can do in STEM. You don't need to push women into STEM, you just need to show all people at a young age that it's cool and there's a reason why you should do this." In her efforts to grab the attention of her young audiences, Alexandria highlights the many real world experiences her engineering major has exposed her to – from friends working at such well-known companies as SpaceX and Intel, to her own experiences as an intern at a BP oil refinery. She sees a future for herself working in the power industry, while performing when she can. *Full story: eecs.umich.edu/n/wash*



Miss Washtenaw County, Alexandria Strother.

CS student Anna Dai says she decided to run for Miss Wayne County because "Miss America is a role model for so many young girls in our country and I want to be that inspiration. I feel that being a Chinese American and Computer Science student makes me an atypical contestant, but that is also what makes me someone who Miss America needs in order to inspire even more young girls in this country and take another step toward diversity and inclusion." For her pageant platform, Anna chose Girls Who Code (GWC), a national non-profit dedicated to closing the gender gap in technology and engineering sectors. She partnered with the organization to create one of the first after-school GWC clubs in Michigan, and instructed 6th to 8th grade girls at Cranbrook Kingswood Middle School in the fundamentals of computer science and beginning level JavaScript. Anna plans to pursue a master's degree in CSE and then work for a company that utilizes the power of technology to make the world a better place and to solve humanitarian issues.

Full story: eecs.umich.edu/n/dai



Miss Wayne County, Anna Dai.



2015: AURUM

U-M Solar Car Team: First in the Nation for a Quarter Century

In July of 1990, the University of Michigan Solar Car Team's legacy began with their first race. Now, with 8 national championships, 5 top-three world podium finishes, and 1 international victory under their belts, the multidisciplinary team is the most successful solar car team in the nation. Their most recent feat, a first-place victory in Abu Dhabi's first-ever Solar Challenge race, ushered in the team's 25th anniversary.

The team has just unveiled their newest car, AURUM, for its upcoming races in 2015 and beyond.



1990: Sunrunner



1993: Maize and Blue



1995: Solar Vision



1997: Wolverine



1999: Maize Blaze



2001: M-Pulse



2003: Spectrum



2005: Momentum



2007: Continuum



2009: Infinium



2011: Quantum



2013: Generation

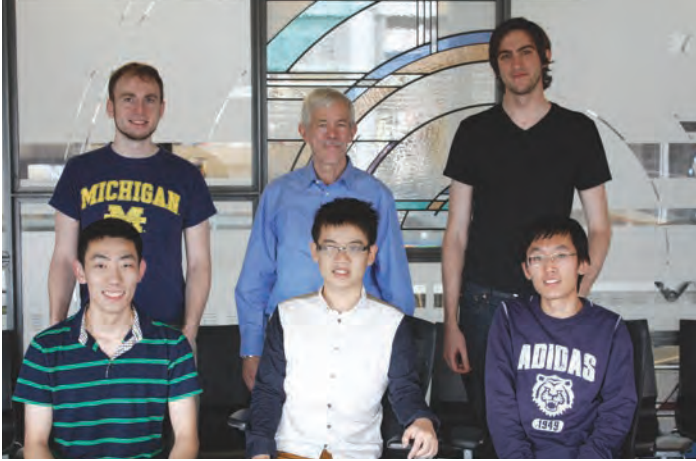
Championship Wins

American Solar Challenge

1990, 1st; 1993, 1st; 1997, 6th; 1999, 19th; 2001, 1st; 2005, 1st; 2008, 1st; 2010, 1st; 2012, 1st; 2014, 1st

World Solar Challenge

1990, top-three; 1993, 11th; 1999, 9th; 2001, top-three; 2005, top-three; 2007, 7th; 2009, top-three; 2011, top-three; 2013, 9th



(L - R) Asst. Coach Dennis Matveyev, Head Coach Prof. Kevin Compton, Asst. Coach Mark Gordon (Bottom L-R) Chun Wu, Zhou Sun, Yujie An.

U-M Programming Team The Victors Advanced to ACM World Finals

The Victors, a team of U-M computer science students, advanced to the 39th Annual ACM-ICPC World Finals after competing in the East Central North American regional competition at Grand Valley State University in November 2014.

The ACM-ICPC is the largest and most prestigious computer programming competition in the world. Over 125 teams competed in the regional competition, of which three advanced to the finals. Worldwide, over 10,000 teams compete in regionals, and around 120 advance to finals.

The Victors team consisted of three students: CS student Zhou Sun and CSE graduate students Chun Wu and Yujie An. The team coaches were Prof. Kevin Compton, CSE graduate student Mark Gordon, and UM-Dearborn alum and ICPC competitor Dennis Matveyev.



Brian Margosian, Ben Wang (team captain), Jake Moline (electrical division lead), and Gwyn Cunningham (electrical division lead).

Go Blue and Drive Green

The Michigan Hybrid Racing Team focused on innovation and in-house design on their new 2015 racecar. This year's car featured the first team-designed electric powertrain, a new engine, smaller and lighter form factor, and first complete aerodynamics package with wings.

This is the fourth year the team traveled to compete in the Formula Hybrid Competition, where it was one of the few cars to make it through all of the inspections. U-M took home a final placement of 6th.

The Formula Hybrid Competition challenges teams from colleges and universities around the world to collaboratively design and build a formula-style electric or plug-in hybrid racecar. Each year the team designs and constructs a completely new vehicle to take to Loudon, New Hampshire.



L - R: Clifford Frieler (Northrop Grumman), Steven Schultz (Northrop Grumman), Daya S. Khudia, Bryce Wiedenbeck, David Devecsery, Aaron Snook, and Jon Hansen (Northrop Grumman).

CSE Grad Student Honors Competition

CSE held its eleventh annual CSE Graduate Student Honors Competition on November 5, 2014. CSE faculty and industry sponsors from Northrop Grumman ranked the finalists' presentations. The competition provides an opportunity for finalist competitors to give a summary presentation on a research topic in front of an audience.

1st Place: Bryce Wiedenbeck: "Analyzing Very Large Simulation-Based Games"

2nd Place: David Devecsery: "Eidetic Systems"

Honorable Mention: Aaron Snook: "Graph Isomorphism and the Lasserre Hierarchy"

Honorable Mention: Daya S. Khudia: "Pervasive Approximate Computing: Anomalies are Your Friends"

EECS Course News

Michigan Mobile Phone Ensemble Stretches, Challenges Performers and Audience

An appreciative crowd was audience to a unique and thought-provoking series of performances on Saturday, April 18, 2015, as the Michigan Mobile Phone Ensemble, under the direction of Prof. Georg Essl, performed 12 original works at its Winter Final Class Concert. The performances took place in Stamps Auditorium at the Walgreen Drama Center on the U-M North Campus.

The mobile phone ensemble was formed in the context of Prof. Essl's multi-disciplinary course, "Building a Mobile Phone Ensemble," which was first taught in Fall 2009 and which merges engineering practices, mobile phone programming, and sound synthesis with new music performance, composition, and interactive media arts. Students in the class design and develop their own new mobile phone instruments and compose new performance works that explore the creative potential of their imaginations.

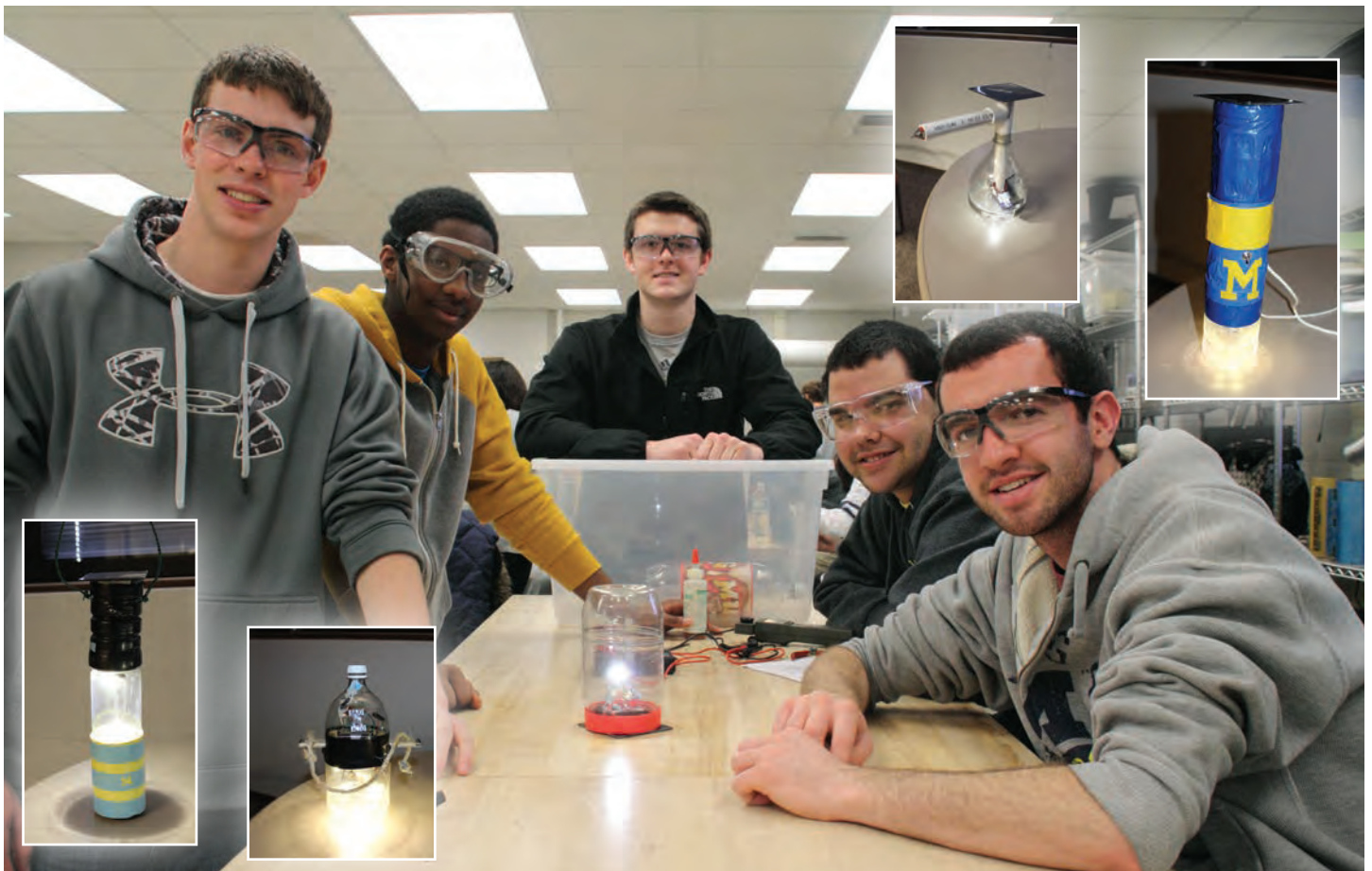
Video: eecs.umich.edu/n/phone



First Year Students Create Solar Lanterns for a South American Village

Students in Prof. Jamie Phillips' first year course, Solar Power: Renewable Energy from the Sun, partnered with the student group, BLUElab Sa Nimá, this past year. The group's mission is to develop community health in a sustainable manner. For their major design project, students in the class built lanterns powered by the sun out of materials easily available to the community of Samox, Guatemala.

Video: eecs.umich.edu/n/solar



Students Show Off Their Final Course Projects

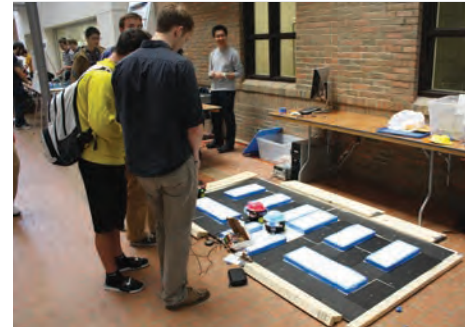
A number of EECS students presented their final course projects at special events throughout the year. These include special showcases open to projects from a variety of courses, to a presentation of all projects in a single course. Students, faculty, and sometimes even parents were able to see the results of hard work, creativity, and skill.



Eng 100: Gaming for the Greater Good introduces first-year engineering students to programming and computer science through the development of computer games.



EECS 100: Solar Power exposes students to solar energy collection and storage, and more generally, to electrical circuits, micro-controllers, wireless technology, and energy/power.



EECS 373: Embedded System Designs focuses on the principles and practices of modern embedded systems design.



EECS 430: Radiowave Propagation and Link Design teaches the fundamentals of electromagnetic propagation and radiation; radiowave propagation; and antennas.



EECS 452: Digital Signal Processing Design Laboratory teaches real-time digital signal processing (including theory, software and hardware).



EECS 467: Autonomous Robotics is a theoretical and hands-on introduction to robotics from a computer science perspective.



EECS 494: Computer Game Design and Development exposes senior-level students to both the design and development aspects of computer game design.



EECS 498: Hands-on Robotics teaches students how to build robots using the CKBot modular robot system.

Students Earn Prizes for Improving Image Processing in EECS 556

EECS 556: Image Processing

Prof. Jeff Fessler

Sponsor: KLA-Tencor (2014), Apple (2015)

2014:

1st Place: *Unified Blind Method for Multi-Image Super-Resolution and Single/Multi-Image Blur Deconvolution*, by Rebecca Malinas, Yaohui Li, Abhishek Bafna, and Tatyana Dobrev

2nd Place: *MRI Bias Field Correction Based on Tissue Labeling*, by Zhen Zeng, Lianli Liu, Jie Li, and Jiyang Chu

2015:

1st Place: *Object Boundary Detection Using Decoupled Active Contours*, by Madan Ravi Ganesh, Adeline Hong, and Leyou Zhang

Full story: eecs.umich.edu/n/556



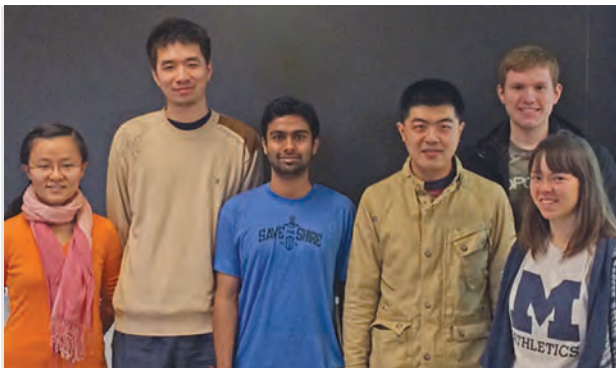
Prof. Jeff Fessler, Madan Ravi Ganesh, Leyou Zhang, Adeline Hong, and judge Farhan Baqai.



(L - R) Zhen Zeng, Lianli Liu, Jie Li, Jiyang Chu, and judges Eliezer Rosengaus and Jing Zhao.



(L - R) Rebecca Malinas, Yaohui Li, Abhishek Bafna, Tatyana Dobrev, and judges Eliezer Rosengaus and Jing Zhao.



EECS 583 2013 Optimization Contest Champions: Yijia Tang (Benchmark 4 winner), Lin Hao Peng (Overall 3rd place), Balaji Soundararajan (Overall 1st place), Hongyi Yao (Overall 2nd place), Randy Piper (Benchmark 2 winner), and Kelsey Rosenthal (Benchmark 3 winner).

EECS 583: Advanced Compilers

Prof. Scott Mahlke

1st Place: Balaji Soundararajan, achieved a geometric mean of 1.22x speedup on the four benchmarks

Runner-up: Hongyi Yao, Lin Hao Peng, achieved 1.21x and 1.20x speedups on the four benchmarks

1st Place on individual benchmarks: Yijia Tang, Kelsey Rosenthal, Randy Piper, and Yi Wang

Students Build Apps for Grace

EECS 481: Software Engineering. Students designed assistive technologies for Grace, a young woman with athetoid cerebral palsy. The projects were designed to help Grace more easily communicate and engage in social activities.

Some projects leveraged a unique touchscreen operating system, called ASK Interface, which was developed in a previous class and is now being commercialized by former student Chris McMeeking, who is now Dr. Chesney's teaching assistant. Using the ASK platform, Nicole Griebble, Nicholas Augustyniak, Maxwell Warner, Stephen Woodruff, and Zoltan Nemeth created JamMaster Grace, which allows a user to compose music on a tablet device. Other students used a device from MIT called the MaKey MaKey for their projects, including one called KeyUp that was designed to help people with disabilities to type more quickly. Full story + video: eecs.umich.edu/n/grace



Dalton Zautke, Nick Ashcroft, Rachael Miller, Michael Skrzyński, and William Liu designed JamMaster Grace.

EECS 413: Monolithic Amplifier Circuits

Prof. Michael Flynn

Sponsor: Tektronix (2014), Apple (2015)

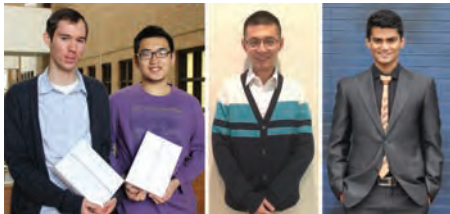
1st Place (2014): *Adaptive Bandwidth PLL*, by David Choo, Shiqing Gao, Poornashree Rajendra, and Michael Mistaleski

2nd Place (2014): *Inductorless Wideband Balun-LNA With Noise Cancellation and Gain Boosting*, by Zhixiong Zhang, Anton Frolenkov, and Yongdong Li

1st Place (2015): *An Ultra-Low Power Energy Harvester With Integrated MPPT Circuit*,
by Paul Myers, Tianyu Huang, Di Hu, and Rifat Sheikh

2nd Place (2015): *An Integrated Ultra-Low Power CMOS On-Chip Thermal Sensor*, by Seyed Amin Sandoughsaz Zardini, Chester Liu, Kanghwan Kim, and Shengshuo Lu

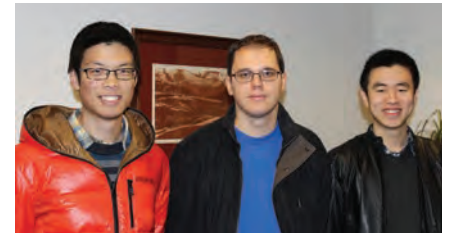
Full story: eecs.umich.edu/n/413



(L - R) Paul Myers, Tianyu Huang, Di Hu, and Rifat Sheikh.



(L - R) Seyed Amin Sandoughsaz Zardini,
Chester Liu, Kanghwan Kim, and
Shengshuo Lu.



(L - R) Zhixiong Zhang, Anton Frolenkov,
Yongdong Li.



(L - R) David Choo, Shiqing Gao,
Poornashree Rajendra, Michael Mistaleski.

EECS 511: Integrated Analog/Digital Interface Circuits

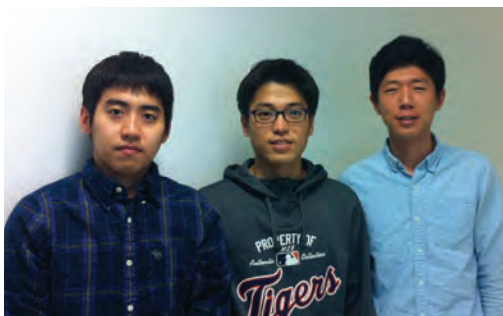
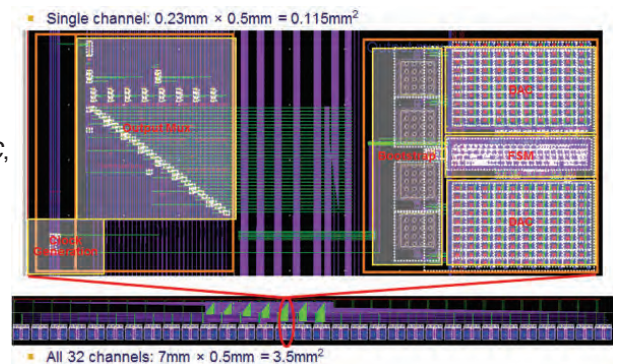
Prof. Michael Flynn

Sponsor: Analog Devices, Inc.

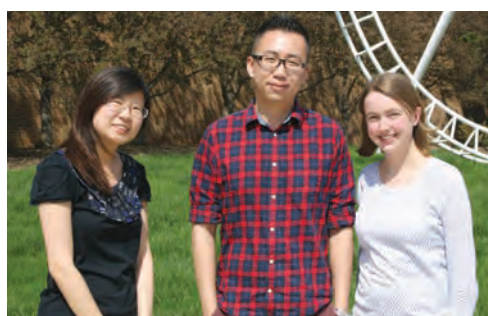
1st Place: *A 1GS/s 7-bit Low Power, Time-interleaved Asynchronous SAR ADC*,
by Nan Zheng, Yiqun Zhang, and Laura Freyman

2nd Place: *A Frequency Linearized VCO-based Analog-to-Digital Converter*,
by Tae-Kwang Jang, Sunmin Kim, and Myungjoon Choi

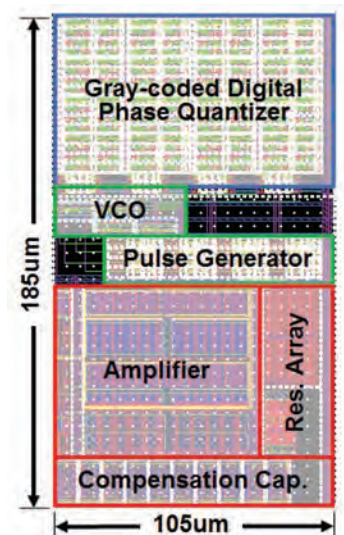
Full story: eecs.umich.edu/n/511



(L - R) Sunmin Kim, Tae-Kwang Jang, and Myungjoon Ch.



(L - R) Yiqun Zhang, Nan Zheng, Laura Freyman.



Individual Honors and Awards



Forest Agostinelli (CSE graduate student) received an NSF Graduate Research Fellowship to continue his studies in multi-column neural networks and deep learning.



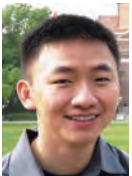
Armin Alaghi (CSE graduate student) received a Rackham Predoctoral Fellowship for his research on stochastic computing.



Ali Al-Heji (ECE graduate student) was named a Dow Sustainability Fellow at Michigan, for his commitment to finding interdisciplinary, actionable, and meaningful sustainability solutions on local-to-global scales.



Christopher Boyd (ECE graduate student) was awarded an NSF Graduate Research Fellowship for his work on MEMS inertial sensors.



Chia-Hsiang Chen (ECE graduate student) earned an Intel Corporation Ph.D. Fellowship for his work designing low-power and error-resilient circuit techniques for digital signal processing applications.



David Chen (ECE graduate student) received a NASA Earth and Space Science Fellowship to pursue research that will help improve extreme weather prediction.



Pin-Yu Chen (ECE graduate student) received a Rackham International Student Fellowship for his work applying signal processing techniques to big data analysis.



Thomas Chen (ECE graduate student) was awarded an NSF Graduate Research Fellowship to pursue his research in the design of efficient artificial neural networks for computer vision.



Meghan Clark (CSE graduate student) was awarded an NSF Graduate Research Fellowship to continue her studies in the areas of embedded systems, ubiquitous computing, and the smart grid.



Nicholas Cliff (ECE graduate student) was named the 2014 Graduate Student of the Year by the U-M Student Life Office.



Stephanie Crocker (ECE graduate student) received an NSF Graduate Research Fellowship to support her work on integrating renewable energy sources into the power grid.



Zakir Durumeric (CSE graduate student) was selected as one of MIT Technology Review's Innovators Under 35 in 2015 for his work in developing quantitative, measurement-based approaches to Internet threats. He also received a Google PhD Fellowship in Security for the 2014–15 academic year.



Benjamin England (CS undergraduate student) was selected as a 2014 Thiel Fellow to pursue an innovative or scientific project for commercialization.



Branden Ghena (CSE graduate student) was awarded an NSF Graduate Research Fellowship to continue his studies in embedded systems, in which he aims to create Internet of Things devices that are useful and usable.



Helen Hagos (CSE graduate student) was named a Dow Sustainability Fellow for her work in developing an organized waste disposal system in Ethiopia.



Jason Heeb (ECE graduate student) received a National Defense Science and Engineering Fellowship to support his work developing systems to wirelessly charge or power electronic devices.



David Hong (ECE graduate student) was awarded an NSF Graduate Research Fellowship to support his studies applying machine learning and signal processing techniques to big data problems.



Chang-Hong Hsu (CSE graduate student) received a Chia-Lun Lo Fellowship for his work in developing solutions to ensure the correctness and reliability of modern microprocessors.



Amr Ibrahim (ECE graduate student) received a Rackham International Student Fellowship to support his research in the area of sub-millimeterwave (Sub-MMW) radar systems.



Alyssa Kody (ECE graduate student) earned an NSF Graduate Research Fellowship to pursue research in powering wireless embedded systems.



Avish Kosari (ECE graduate student) received a Rackham International Student Fellowship to continue her research on ultra-low power radio technology and the design of a low-power RF power amplifier.

Individual Honors and Awards



Girish Kulkarni (ECE graduate student) earned a Rackham Predoctoral Fellowship to support his dissertation research on Carbon Nanoelectronic Heterodyne Sensors for Chemical and Biological Detection.



Duc Le (CSE graduate student) was selected for a Graduate Student Research Assistantship by the Mary A. Rackham Institute.



Doowon Lee (CSE graduate student) received an IBM PhD Fellowship to continue his studies in improving the dependability of computer systems. He also received a Rackham International Student Fellowship to support his work in this area.



Seungku Lee (ECE graduate student) received a Rackham Predoctoral Fellowship to support his dissertation research on Large-Signal Modeling of Intrinsically Tunable and Switchable Ferroelectric FBARs for Frequency-Agile Communication Systems.



Elizabeth Mamantov (CSE graduate student) was awarded an NSF Graduate Research Fellowship to continue her studies in embodied cognition, robotics, and cognitive architecture. She was also selected as a 2014 Microsoft Graduate Women's Scholar.



Daniel Molzhan (ECE graduate student) received a Dow Sustainability Fellowship for his research aimed at upgrading the current electric system for the 21st century.



Parinaz Naghizadeh (ECE graduate student) has been named a 2014 Barbour Scholar, a distinction awarded to women of outstanding academic and professional achievement who are natives of Asia.



Gopal Nataraj (ECE graduate student) received a fellowship from Innovative Signal Analysis, Inc. (ISA) to support research that aims to generate higher-quality and faster MRI images.



Mridul Mishra (ECE graduate student) received a Rackham Non-Traditional Fellowship to pursue his studies in wireless communications.



Steven Parkison (ECE graduate student) was awarded an NSF Graduate Research Fellowship to support his research on machine learning for autonomous vehicles.



Sanae Rosen (CSE graduate student) received the Margaret Ayers Host Award from the Rackham School of Graduate Studies for her scholastic achievement and her interest in promoting the success of women in the academic community.



Byeongseop Song (ECE graduate student) received a Rackham International Student Fellowship to continue his studies in the area of optoelectronics.



Hamidreza Tavafoghi (ECE graduate student) was awarded a Dow Sustainability Fellowship to support his research in energy economics.



Elaine Wah (CSE graduate student) received a Rackham Predoctoral Fellowship for her research on algorithmic trading.



Karl Winsor (CS undergraduate student) was named a Goldwater Scholar for the 2015–16 academic year.



Dana Wilson (CSE graduate student) was selected as a 2014 Learning Analytics Fellow by the Provost's Learning Analytics Task Force.



Cheng Zhang (ECE graduate student) received a Rackham Predoctoral Fellowship for research on nanophotonic materials and devices.

EECS and CoE Awards

Undergraduate

CoE Epeians Emerging Leader Award

Lauren Bilbo (EE) – 2014

CoE Arlen R. Hellwarth Award

Jacob Durrah (CS) – 2015

CoE Distinguished Academic Achievement Award

William Liu (CS) – 2014

Paul Myers (EE) – 2014

Scott Su (CE) – 2014

Maureen Daum (CS) – 2015

Scott Su (CE) – 2015

Jacob Winnick (EE) – 2015

CoE Undergraduate Distinguished Leadership Award

Jill Bender (CS) – 2014

Isabel Martin (EE) – 2014

Lauren Bilbo (EE) – 2015

Jamie Sookprasong (CS) – 2015

CoE Henry Ford II Prize

Lauren Bilbo (EE) – 2015

CoE Marian Sarah Parker Prize

Genevieve Flaspohler (CE) – 2015

CoE Roger M. Jones Fellowship

Allison McDonald (CS) – 2015

EECS Outstanding Achievement Award

Philip Bunge (CE) – 2014

Paul Myers (EE) – 2014

Carolyn Vlach (CS) – 2014

Maureen Daum (CS) – 2015

Genevieve Flaspohler (CE) – 2015

Zelin Zhang (EE) – 2015

EECS Outstanding Research Award

Noah Klugman (CE) – 2014

Benjamin Mehne (CS) – 2014

Kwesi Rutledge (EE) – 2014

Joshua Adkins (CE) – 2015

Joeson Wong (EE) – 2015

Rui Zhang (CS) – 2015

EECS Outstanding Service Award

Amit Kalay (CS) – 2014

Shannon Liu (EE) – 2014

Aditi Rajagopal (CE) – 2014

Sarah Paris (CE) – 2015

Alexandria Strother (EE) – 2015

Austin Yarger (CS) – 2015

EECS William L. Everitt Student Award of Excellence

Aaron Crasner (EE) – 2014

Mark Isaacson (CS) – 2014

Benjamin Wang (CE) – 2014

Seth Goldstein (CE) – 2015

Matthew Grossman (CS) – 2015

Yixin Ma (EE) – 2015

EECS William Harvey Seeley Prize

Gideon Billings (EE) – 2014

Jay Mulani (EE) – 2015

EECS Commercialization/Entrepreneurship Award

Jamie Sookprasong (CS) – 2014

Scott Su (CE) – 2014

Prateek Sachdeva (CS) – 2015

Matt Schulte (CE) – 2015

Jay Zhang (EE) – 2015

Graduate

CoE Graduate Distinguished Leadership Award

Nicholas Clift (ECE) – 2014

Mai Le (ECE) – 2014

Elizabeth Dreyer (ECE) – 2015

Cheng Zhang (ECE) – 2015

Richard F. and Eleanor A. Towner Prize for Distinguished Academic Achievement Award

Nick Asendorf (ECE) – 2014

Armin Jam (ECE) – 2014

Elaine Wah (CSE) – 2014

Elnaz Ansari (ECE) – 2015

Richard F. and Eleanor A. Towner Prize for Outstanding GSIs

Hamid-Reza Ossareh (ECE) – 2014

Bryce Wiedenbeck (CSE) – 2014

Jonathan Beaumont (CSE) – 2015

Michael Benson (ECE) – 2015

Mai Le (ECE) – 2015

Marian Sarah Parker Prize

Elaine Wah (CSE) – 2015

EECS GSI Award

Jonathan Beumont – 2014

Branden Ghena – 2014

Robert Goeddel – 2014

Luis Gomez – 2014

Emily Graetz – 2014

Seungku Lee – 2014

Maruthi Ravichandran – 2014

Alex Roper – 2014

Armin Sarabi – 2014

Aramis Alvarez – 2015

Reed Coke – 2015

Mark Dong – 2015

Rahul Jha – 2015

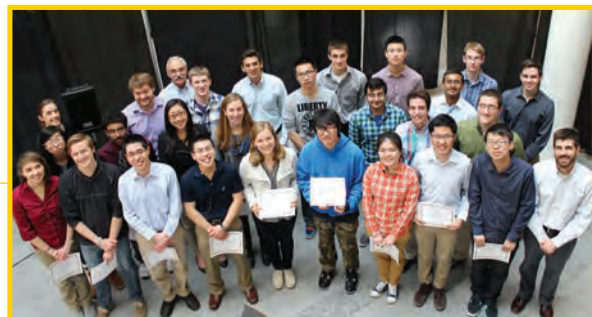
Jonathan Kurzer – 2015

Shaobo Liu – 2015

Brian Tierney – 2015

Richard F. and Eleanor A. Towner Prize for Outstanding PhD Research

Armin Alaghi (CSE) – 2014



Student-Alumni Connections

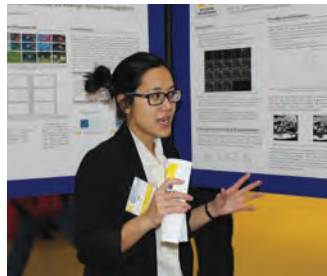
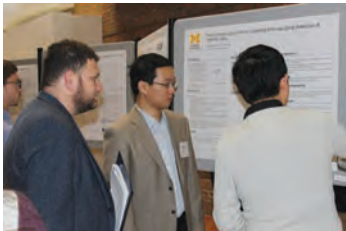
Students and Alumni Celebrate Research and Progress at Engineering Graduate Symposium

The CoE Engineering Graduate Symposium is an annual event designed to highlight graduate research for current and prospective students. ECE students typically present more than 80 posters that span the broad range of their research, from colorful solar cells to improved memory for tiny computers.

The 2014 event brought together current students and alumni active in the industry when thirteen ECE alumni returned to campus to judge the presentations, meet with students, and enjoy a casual reception at the end of the day.

Scott Hanson (BSE MSE PhD EE '04 '06 '09) returned as the recipient of the Arbor Networks PhD Research Impact Award. Dr. Hanson is the co-founder, CTO and VP of Engineering of Ambiq Micro, a startup semiconductor company that has big plans to lead the low-power revolution in electronics by powering the Internet of Things. He gave a presentation to a crowd of current and prospective students about his experiences with entrepreneurship and developing new products.

Full story: eecs.umich.edu/n/sym



Dr. Scott Hanson presents a lecture as the Arbor Networks PhD Research Impact Award winner.



Returning alumni with several current students and faculty after a morning reception.

Poster Session Winners:

Azadeh Ansari, HEMT-Based Read-out of a AlGaIn/GaN Thickness-mode Resonators (2013); An 8.7 GHz Temperature-Compensated Gallium Nitride Micromechanical Resonator (2014)

Justin Foley, Selection Rule-based Transmission Filtering of a Single-layer Dielectric Grating (2013)

Jun Hou, Mitigating Power Fluctuations in Electrical Ship Propulsion Using Model Predictive Control with Hybrid Energy Storage System (2013)

Armin Jam, Micromachined Frequency Beam Scanning Patch Array Antenna at J-Band (2013)

Jonas Kersulis, Instanton Analysis: Understanding Wind-related Transmission Grid Vulnerability (2014)

Duc Le, Modeling Pronunciation, Rhythm, and Intonation for Automatic Assessment of Speech Quality in Aphasia Rehabilitation (2014)

Joel LeBlanc, Joint Camera-Blur and Pose Estimation from Aliased Data (2014)

Brian Moore, OptShrink: An Optimal Algorithm for Estimating a Low-rank Matrix Buried in Noise (2013)

Seokjun Park, 79.5pJ/pixel Bio-Inspired Time-Stamp Based Optic Flow Sensor for Micro Air Vehicles (2013)

Matthew Prelee, Energy Efficient Source Localization on a Manhattan Grid Wireless Sensor Network (2013)

Mohammad Rasouli, A Supervisory Control Approach for Dynamic Cyber-Security (2014)

Abhinav Sinha, Generalized Proportional Allocation Mechanism Design for Multi-rate Multicast Service on the Internet (2013)

Chu-Hsiang Teng, Polarization-controlled Single Photon Emission from Site-controlled InGaIn Quantum Dots (2014)

Alan Teran, Heterojunction n-ZnSe/p-ZnTe Solar Cells (2013)

Tianpei Xie, Multi-sensor classification via Consensus-based Multi-view Maximum Entropy Discrimination (2014)

Xiang Yin, Synthesis of Supervisors for Centralized and Decentralized Discrete-Event Systems (2014)

Alumni News



Avegant's Glyph – The Future of Multimedia Experiences

Allan Evans (MSE PhD EE '07 '10) and Ed Tang (BSE EE '11) are taking consumer virtual reality to the next level with their company Avegant, founded in 2012. Their first product, called the Glyph, is a wearable, mobile personal theater with built-in premium audio. It is the first head-mounted display coming to market with a virtual retinal display. It promises an entirely new way to view video that differs from similar-looking devices by projecting light directly into your eye in a way that mimics natural vision.

The company is chock full of Michigan alumni. From the EECS Department, this includes the co-founders Allan Evans (CTO), Ed Tang (Chief Strategy Officer), Neil Welch (VP of Engineering; BSE PhD EE '03 '08), and Aaron Easch (Hardware Lead; BSE MSE EE '06 '07).

Allan and Ed crowdfunded their device with a Kickstarter campaign in January 2014, aiming for \$250,000 – by the time the deadline came, they'd collected \$1.5M. The Glyph has been winning awards and gaining lots of media attention since it first appeared as a prototype, and the company recently announced \$24M in Series B funding. It is currently available for pre-order, and possibly on the shelves by the time this newsletter is published.
Full story: eecs.umich.edu/n/ave



L - R: Avegant employees and Michigan alumni Emma Kessler, Andrew Gross, Edward Tang, Jonathan Zagel, Allan Evans, Aaron Easch, Grant Martin, Neil Welch.



AVEGANT



Allan Evans
Co-founder and CTO



Ed Tang
Co-founder and
Chief Strategy Officer

Daniel Reeves Co-Founds Goal-Tracking Company Beeminder

Need a little help to stay on track with your life goals? Daniel Reeves (CSE PhD 2005) has created Beeminder, an on-line service that leverages your monetary pledge to help you stick to your goals.

Born from his need to stay motivated and power through the dissertation writing process while a student at Michigan, Dan and future Beeminder co-founder Bethany Soule (also a Michigan graduate) created a series of incentive schemes and productivity hacks that they called the Voluntary Harassment Program. It was such a motivator that Dan finished his PhD that year and then asked Bethany to marry him. Later, the two built a simple website for friends that combined the idea of tracking goals with monetary wagers. This laid the foundation for what would later become Beeminder.

Today, Beeminder is a motivational tool for setting “goals with a sting.”

Beeminder allows you to pledge money to stay on track for any quantifiable goal, such as losing weight, saving for a vacation, or increasing the number of pushups you can do. The program graphs your progress over time and tracks your results along a “yellow brick road” to your goal. Beeminder prompts you to easily add progress data when needed, or accepts data automatically from a number of compatible digital devices, and integrates with popular fitness and productivity sites to help you keep pace with your achievements. The motivating sting behind the service: If you go off track for your goal, you lose your pledge money.

Beeminder was recently noted in a *Wall Street Journal* article about the Quantified Self movement, which Beeminder considers itself at the center of. It's all part of Beeminder's goal: to help people use data to change their own behavior.

Daniel Reeves completed his PhD in CSE as a student of Prof. Michael Wellman (also an avid Beeminder user) in 2005, then spent four years at Yahoo! Research in New York City before co-founding Beeminder in 2010. His research has focused on the application of game-theoretic and computational techniques to strategic behavior in games, particularly for eCommerce-inspired market mechanisms. He is one of the creators of and top competitors in the annual international Trading Agent Competition.



Kathryn Clay, A Policy Leader in the Natural Gas Revolution

Dr. Kathryn Clay (MS EE '96; PhD Applied Physics '04) believes, "The only way to make real progress for the country is to find the common ground upon which we can move forward to advance everyone's interests." A natural coalition builder, Kathryn implements this philosophy in her current job as Vice President of Policy Strategy at the American Gas Association (AGA), and it's as helpful now as it was during her career on Capitol Hill where she influenced key energy policy.

Kathryn's political baptism by fire came after graduation when she received a prestigious science fellowship with the American Association for the Advancement of Science (AAAS) in Washington D.C. While in Washington, she helped usher three bills into law while a member of the professional staff of the House Committee on Science, and later with the Senate Committee on Energy and Natural Resources. One of these bills was the Energy Policy Act of 2005. Kathryn was also an influential leader in drafting the Energy Independence and Security Act (EISA) and the America COMPETES Act, both of which passed in 2007.

Today, as the Vice President of Policy Strategy for the American Gas Association (AGA), Kathryn is leading the drive to keep America competitive and secure through the adoption of natural gas as a key alternative fuel for vehicles. "Natural gas is half the price of gasoline or diesel," said Kathryn, "and it's projected that by 2035, households using natural gas for heating and appliances will have just one-quarter the energy costs of all-electric homes."

Full story: eecs.umich.edu/n/clay



Alumni Build Web Service to Connect Renters With Properties

Three former University of Michigan students are making a name for themselves in the growing Ann Arbor startup scene with cribspot.com. The startup helps college students find suitable places to live, while also helping landlords manage their properties.

The founders, Tim Jones and Evan Dancer, former Computer Science students, and Jason Okrasinski, a former Ross Business student, all graduated in May 2013 with the same goal in mind, to make the off-campus housing search as easy as possible.

Cribspot.com is a simple website that makes searching local rentals easy because it brings together thousands of listings on one searchable map. The startup differs from their competitors because they provide numerous resources for renters like neighborhood guides, advice for first-time renters, and tips from locals.

Full story: eecs.umich.edu/n/cribspot



Kevin Gardner, Evan Dancer, Tim Jones, Jason Okrasinski, and Alex Gross.



Won-Pyo Hong: To the Galaxy and Beyond

Won-Pyo Hong (MSE PhD EE '84 '88) leads one of the most innovative branches of Samsung Electronics Co., Ltd, which itself stands among the 15 largest companies in the world, and he credits his education at Michigan as one of his most significant assets. "Michigan taught me a comprehensive approach to understand issues and challenges, and to figure out the best way of overcoming them," said Won-Pyo.

After working at Bell Communications Research, Inc. (1988-94) and Korea Telecom Corporation (1994- 2006), Dr. Hong joined Samsung in 2007 in the Network Infrastructure Business Division. Within a year, he became head of the Global Product Strategy Team

for the Mobile Communications Business Division. It was in this role that he was responsible for the overall product strategy of the Samsung GALAXY mobile phone series, one of the most hotly anticipated and ultimately best-selling mobile devices in history.

He managed GALAXY's design, product specifications, key features (such as the super sharp AMOLED display, multi-core processors, and LTE-A connectivity), and key applications, as well as its USP's (Unique Selling Points) and portfolio for regions.

In 2012, Dr. Hong was named President of Samsung's Media Solutions Center (MSC). Established in 2008, MSC quickly became one of Samsung's fastest growing internal organizations, now operating in 10 countries. In 2015, he was named President and Chief Marketing Officer of Samsung Electronics. He is also Head of its Global Marketing Office.

The future for Samsung, says Dr. Hong, is connected living and the Internet of Things, an already huge market that is expected to more than triple between now and 2020. "Moving forward, I want to continue to make meaningful innovations in the consumer electronics industry - especially in the area of IoT," said Won- Pyo. "But I also want to become a person that advises and guides the younger generation to achieve their goals in Information and Communications Technology."

Full story: eecs.umich.edu/n/hong

James Mickens: Advancing Computing in Industry and in Academia

James Mickens (PhD CSE '08) always saw himself as a professor, but after getting his PhD he joined Microsoft Research in order to jump into research full force without worrying about grants or teaching. Now that some time has passed, he's back in the world of academia; Mickens joined the faculty at Harvard as an Associate Professor of Computer Science beginning Fall 2015. This comes after an appointment in the Fall of 2014 as an MLK Visiting Professor at Massachusetts Institute of Technology, where he was affiliated with the Parallel and Distributed Operating Systems group.

After receiving his PhD from the University of Michigan, Mickens became a researcher in the Distributed Systems group at Microsoft's Redmond lab. While there, his research focused on data center storage systems for large-scale computation. He also studied the client-side of web applications, designing new ways to improve their performance, reliability, and security.

Much of his research focuses on the problems that arise when distributed systems must scale to many users and many machines. He is also inspired by what he sees around him every day, and how the seemingly impossible can be made possible.

He states, "You have a problem that seems insurmountable and then you think what is the question or what is the approach that will make this possible? The best researchers are smart but they're not necessarily Einstein-level smart. They're able to determine the right path in order to get to a conclusion."



Steve Mollenkopf, New CEO of Qualcomm

Steve Mollenkopf received a letter in 1994 from his brother that included a small *EE Times* clipping about Qualcomm, a tech company that was hiring. Having just graduated from U-M with his master's degree in electrical engineering, he went to California to attend its RF recruitment day, and took a chance on the company. Twenty years later, on March 4, 2014, Steve was unanimously elected as just the third CEO of Qualcomm, Inc., which had become the largest fabless semiconductor producer in the world.

Over the course of his 20 years at Qualcomm, Steve held a variety of leadership positions including COO and directing the chipset business. He helped Qualcomm become the world's largest mobile chipset supplier and the global leader in LTE technology; Qualcomm now powers the majority of 3G and 4G devices commercially available today. In 2011, as COO of Qualcomm, he engineered the \$3.1B acquisition of Atheros Communications Inc. This deal is Qualcomm's largest acquisition to date for the Company, and Qualcomm Atheros is now a leading provider of wireless and wired technologies for the mobile, networking, computing and consumer electronics markets.

Steve envisions a world of universal connectivity in which your smart phone will provide you with the information you need – before you even know you need it. In this interconnected world, phones will sense the world around us using tiny circuits integrated into everyday objects like TVs, light switches, and even ourselves. To get there, he is relying on the 31K employees at Qualcomm, most of whom are engineers working round the clock in 116 countries worldwide.

Steve received the 2013 ECE Alumni Merit Award, and gave the talk, "What it Takes to Lead in Technology" to a packed room of students and faculty.

Full story: eecs.umich.edu/n/moll



Nader Najafi: A Dream that Saves Lives

Miniature wireless sensing and computing devices have the potential to improve people's health, even save lives. Twenty years ago, Dr. Nader Najafi (MSE PHD EE '88 '92) had a dream to be part of this reality. He turned that dream to action when he left a promising career at IBM to return to Michigan and start his own company. As founder, CEO, and President of Integrated Sensing Systems, Inc.



Nader Najafi



Pediatric Heart Implant

(ISS), Dr. Najafi is now leading the development of some of the most advanced micro-scale medical technology in the world. The company's flagship device, the Titan™ Wireless Implantable Hemodynamic Monitor (WIHM), monitors cardiovascular health in patients of all ages, and may help curb the growing epidemic of congestive heart failure (CHF).

ISS was formed as a microsystems manufacturing company with Nader's brother, ECE Chair Khalil Najafi, and his PhD advisor, Prof. Kensall Wise. The company built three business divisions: a medical division to develop wireless, battery-less, intelligent, miniature, sensing implants; an industrial arm that produces sensors; and a manufacturing arm that allows companies to use their facilities.

By developing sensing systems for medical applications, ISS is poised to make a profound difference in people's lives. Medical monitoring devices are among the most important pieces of equipment in modern health care, and there are few diseases

in need of more reliable monitoring than CHF. Once diagnosed, CHF is monitored primarily by direct observation, patient feedback, and echocardiography. It is a clumsy system with much room for error.

Thanks to its size, its wireless capabilities, and its lack of a battery, the Titan™ WIHM offers a safe solution for retrieving this data anywhere, even at home. Physicians can gather data from anywhere with an Internet connection. The Titan™ is in its final testing stages in Europe, and awaits FDA approval in the states. It has already demonstrated the ability to save lives.

Full story: eecs.umich.edu/n/naj



Babak Parviz: The Visionary Behind the Glass

Dr. Babak Parviz (MSE PhD EE '97 '01; also MS Physics '97) lives at the intersection of human limitations and technologically augmented human potential. As Google Distinguished Engineer and Director at Google [x], he led development of Google Glass, and before that was developing potentially life-changing glucose monitoring contact lenses as a faculty member at the University of Washington. He is currently VP at Amazon, working on top secret projects that not even Google Glass can see.

Babak conducted research into the smallest of microsystems during his years as a graduate student at Michigan. "We had the perfect combination of smart people, mentorships, good colleagues, good students, and also the wherewithal, the experimental facilities to really explore and make big things happen," said Babak. In 2001, after a stint at a photonic device start-up company, Babak pursued a postdoctoral research fellowship in Chemistry and Chemical Biology at Harvard. By 2009, he had made headlines with his bionic contact lens prototype, complete with LEDs and circuitry.

His work has been put on display at the London Museum of Science and has received numerous honors, including *Popular Science's* Best of What is New (2013); CNN10 Invention (2013); *Time* magazine's Best Invention of the Year (2008 and 2012); a Lifetime Achievement Award at the 2015 Golden Mousetrap Awards; and the IEEE Circuits and Systems Industrial Pioneer Award.

Babak received the 2014 ECE Alumni Merit Award, and gave the talk, "Computers That We Can Wear" to a packed room of students and faculty, including a group of awestruck children from a local robotics school group. *Full story: eecs.umich.edu/n/par*

Oz Pearlman: An Engineer's Magic Moment

Oz Pearlman (BSE EE '03) is a professional magician and mentalist. His performances have made him one of the most well-known in this field, with shows on six continents and clients that would leave an A-list celebrity starstruck. And now, in his latest endeavor, the engineer-turned-wizard has taken on America's Got Talent.

Oz began life as somewhat of a prodigy. Ranking nationally in math test scores at the age of 12, he had no problem graduating early and coming to U-M by the time he was 16. It was in those formative years he had his first exposure to magic – he was chosen as a magician's audience volunteer on a cruise to Bermuda. From there on, he was hooked. At U-M, Oz performed at private parties and restaurant gigs. His performance evolved to incorporate mentalism tricks, which involve manipulating audiences and "reading the participant's mind."

After graduation, Oz worked as a project manager on Wall Street for three years, performing for his staff and coworkers, partly to keep everyone happy. While he lived in Manhattan, he had the opportunity to network with major players in the magic world while he continued his corporate shows and private parties. He eventually made the switch to full-time performer.

At the same time, Oz took on the world of long-distance racing. After only a few years of training, he ran the fastest 50-mile race in the world for that year. After conquering that distance, he took on triathlons, and now participates in grueling ultramarathons, races exceeding 130 miles in extreme conditions.

Now, with a bigger audience than ever thanks to AGT, he has a chance at mainstream popularity. In the meantime, he'll keep wowing crowds, running marathons, and living life as the amazing, magical Oz. *Full story: eecs.umich.edu/n/oz*



Mitch Rohde and Quantum Signal's School-Sized Playhouse

Mitch Rohde (BSE EE '94; MS EE:S '96; MS PhD BME '97 '00) co-founded the company Quantum Signal, LLC in 2000 with his doctoral advisor, Professor Emeritus Bill Williams. The company is now a hotbed of cutting edge research that spans disciplines and captures the imagination.

Mitch's goal with Quantum Signal was to transfer advanced signal processing technologies from the research lab into real-world applications. Started in his bedroom while still a student at Michigan, a trademark of the company is its diversity of applications. Quantum Signal has its hands in nearly every hot field of the moment. Self-driving and remote controlled vehicles, wireless sensing, video game design, facial recognition, video analysis, and robotics are just some of the areas that fill the company's endless labs and work centers.

Quantum Signal created a skin care analysis device that is used around the world; a machine to recover forensic information that is still in use by the Secret Service; a video game, Rustbucket Rumble; and a tactical driving simulator. The company was the first to receive license plates under the new automated vehicle testing law, and has specialized in autonomous vehicles. In 2010, Quantum Signal was named to *Crain's Detroit 25* Companies to Watch. In 2013, Quantum Signal was featured by the Detroit News for its innovative culture and environment. Mitch wanted to create a fun, relaxed environment for his staff and engineers – and with video games lining every workspace, his pet passion, it seems he's succeeded.

Full story: eecs.umich.edu/n/mit



Richard Sheridan Creates a Joyful Workplace

Rich Sheridan (BSE MSE Comp. & Comm. Science, '80, '82), co-founder and CEO of the software design and development company Menlo Innovations, has recently authored a book entitled "Joy, Inc." in which he shares his approach for creating a happy and productive workplace.

Menlo Innovations is well-known for priming openness and collaboration amongst all employees through unique practices. Their workplace practices include requiring most employees to work in pairs, having open workspaces, allowing pets and babies in the office, having a daily stand up activity, and creating work authorization boards. This approach draws more than 2,500 visitors a year to the Menlo office to see the results in practice.

Rich Sheridan founded Menlo in 2001 with 3 other partners. He and his partners decided that the company's purpose would be to bring joy to the world through software, and to teach this method to others.

His desire to share these methods for creating a joyful culture are what drove the development of his book. The book is directed towards anyone that wants a healthier, happier atmosphere at work with a blueprint on how to achieve this culture. Sheridan tries to create a culture that removes the fear and ambiguity that comes with some traditional workplaces, and he tries to bring happiness into the lives of clients and the end users.



Cover art for Joy, Inc., Rich Sheridan's book about creating a joyful workplace.

EECS Students and Alums are Flying High With Drone Startup SkySpecs

SkySpecs, the U-M startup that develops and produces autonomous aerial vehicles for commercial and industrial use, continues to grow within the drone industry. The company recently won the first place prize of \$500,000 in the Accelerate Michigan Innovation Competition and joined a four-month accelerator program in New York City.

SkySpecs was founded by Sam DeBruin (COO, current CSE graduate student) Danny Ellis (CEO, BSE AERO) and Tom Brady (CFO, BSE AERO). The company's core team also includes EECS alumni Jonathan Bendes, Anthony Bonkoski, Andrew Dennison, Ryan Morton, and Aerospace Engineering alumni Isaac Olson and Pat Senatore.

SkySpecs is currently in the process of launching their first product, the Guardian. This product will help prevent collisions from aerial drones, buildings, trees, people, etc. through their object detection and avoidance system. This past summer, SkySpecs was cleared by the Federal Aviation Administration (FAA) to carry out wind turbine inspections by drones all across the United States.

Full story: eecs.umich.edu/n/drone



Michael Stonebraker Chosen for Turing Award – the “Nobel Prize of Computing”

Michael Stonebraker (MSE EE '66, PhD CICE '71) received the A.M. Turing Award – considered “the Nobel Prize of Computing” – from the Association for Computing Machinery (ACM) in 2014 “for fundamental contributions to the concepts and practices underlying modern database systems.”

Stonebraker invented many of the concepts that are used in almost all modern database management systems and founded multiple successful database companies based on his pioneering work. While on the faculty at UC Berkeley from 1971–2000, he was the main architect of the INGRES relational database management system (DBMS), the object-relational POSTGRES DBMS, and the federated data system, Mariposa.

He moved to MIT in 2001, where he has been an advocate of the “no size fits all” approach to database systems architecture and has developed database architectures for specialized purposes. In whole, Stonebraker’s work has been fundamental in enabling the “big data” industry.

Stonebraker’s PhD advisor at Michigan was the late Arch Naylor, who was on the faculty from 1960-1994. Stonebraker’s dissertation was entitled, “The Reduction of Large Scale Markov Models for Random Chains.”

Michael Stonebraker is currently on the faculty at the Massachusetts Institute of Technology where he is an adjunct professor of computer science.

Full story: eecs.umich.edu/n/turing



Peter Tchoryk - An Entrepreneurial CEO

On July 20, 1969, the young son of a machinist watched in awe as the fuzzy black and white images of the Apollo 11 lunar landing danced across the television screen. "My interest in science and creating things was driven by that event," said Peter Tchoryk, MSE EE '94 who is now CEO of the Michigan Aerospace Corporation (MAC). At MAC, Peter's been able to combine his passions for scientific research and entrepreneurial creation, helping to launch three MAC spin-off companies to date.

In 1996, after 11 years in R&D at the Environmental Research Institute of Michigan (ERIM), Peter became the first employee hired at MAC. The primary goal of the company, founded by U-M faculty members Len Fisk

and Paul Hays, was to improve weather forecasting by developing technology that could measure the winds of the upper atmosphere. Today, MAC applies their technologies to a wide array of applications, including remote sensing of wind, temperature, and density from ground, air, and space; environmental sensing; big data; and energy. The company is also committed to commercializing technology.

Peter has been responsible for launching three MAC spin-offs, including OptoAtmospherics and Springmatter, both based in Ann Arbor. Founded in 2014, Springmatter is the realization of Peter's dream to invest in entrepreneurs and entrepreneurial activities dedicated to improving the world. It offers an alternative to the traditional VC investment model by concentrating on in-kind assistance. Their current portfolio includes companies dedicated to autism and neurodevelopment disorders, ocular diagnostics, cancer detection, machine learning software, and intelligent water management networks. "Springmatter is trying to find solutions for complex problems and promote meaningful, sustainable companies and products," Peter said. "This is what I want to do, and it is the best way I can think of to make the biggest impact."

Full story: eecs.umich.edu/n/peter



Bringing WIMS² Technology to Silicon Valley



Sassan Teymouri (BSE MSE EE '81 '83) and Shahin Hedayat (BSE MSE EE '81 '83) have been named the inaugural Corporate Outreach Directors for the Center for Wireless Integrated MicroSensing and Systems (WIMS²). One of their primary charges is to strengthen the connection between Michigan and Silicon Valley. Their past experience and high-level relationships make them uniquely qualified to accomplish the goal. Sassan and Shahin delivered a talk to WIMS² students and faculty that was full of practical advice for prospective tech entrepreneurs as well as insights into Silicon Valley trends and business practices.

Shahin has been an entrepreneur since 1997. He co-founded four companies: Centillum Communication, Beceem Communication, Enverv, and Apixio, serving in a variety of roles including President, CEO, and Chairman. Centillum, Beceem, and Enverv reached maturation through IPO and acquisitions, establishing over \$4B of shareholder value. Prior to 1997, Shahin held technical and managerial roles at Cirrus Logic for 11 years, eventually becoming VP of Engineering and overseeing a \$90M product line. He is named on 9 U.S. patents.

Sassan has more than 30 years of experience in the architecture and design of complex storage products for high performance computing and analytical markets. He served as VP of engineering in several enterprise companies, as CEO of a startup, and was part of the team that took Jaycore Network, Inc. to successful IPO in 1999 with more than \$1.2B in market cap. Currently, he is a technology and business development member of the High Performance Computing team at EMC, which is the world's largest storage company. He is named on 9 U.S. patents.

"We see this as a new, creative way to accelerate the flow of WIMS² technology from the lab to the marketplace," said Prof. Yogesh Gianchandani, Director of WIMS².

Full story + video: eecs.umich.edu/n/wims





Irma Wyman: Computer Pioneer and Advocate for Women in Engineering

Irma Wyman (BSE EngMath '49) was a pioneer in the field of computers, working on some of the earliest programmable machines ever made. As the first female vice president at Honeywell, she knew success – but she also knew firsthand how rare she was to succeed in a field where women were scarce.

There were about seven women in Irma's incoming freshman engineering class, and she was one of two who graduated. Her grades were good enough to qualify her for Tau Beta Pi, the engineering honor society, but it was not yet open to women. Unable to find a job upon graduation, she continued with a job she had as a student at Willow Run Research Center. During a visit to a Navy research facility, she encountered a prototype programmable computer that could solve the problems she was doing by hand, and Irma said she just "ate it up."

By the mid '50s, Wyman had experience with at least eight early computers. Her background led her to a position with a startup company in Boston, which was acquired by Honeywell. This began a long career at Honeywell, where she ultimately became the company's first female vice president.

Her experiences led Irma to establish the Irma M. Wyman Scholarship to support women in engineering, computer science, and related fields. In 2001, Irma received the Alumni Society Medal from the College of Engineering, and in 2007, she was awarded with an honorary doctorate from the University of Michigan.

Full story: eecs.umich.edu/n/irma



Nick Yang: Investing in the Age of Robotics

Nick Yang (BSE EE '97) has always been ahead of his time. As an undergraduate student at Michigan, Yang and several classmates developed a working prototype of a product similar to Microsoft's XBOX Kinect – which launched 15 years later. No one bought the product, but Nick caught the fever of entrepreneurship.

After graduating from Stanford in 1999, Nick founded the company ChinaRen, Inc. with two former classmates. ChinaRen, Inc. was a highly successful online community site in China – five years before the official launch of Facebook. "Back then it was called web/online communities, not social networking," said Nick.

Just two years later, at the age of 24, Nick sold ChinaRen for \$35 million to Sohu.com. He went on to start the mobile Internet business called KongZhong in 2002, a company focused on wireless value added services. When he took KongZhong public just two years later at the age of 29, he became the youngest CEO of a company listed on the US stock exchange. His third company, Monkey King, specialized in mobile search, and became the most popular wireless search engine in China. He left that company about three years ago to begin the next phase of his career as an angel investor.

"We're getting into a new age, and that age is the age of robotics," said Nick, "the age of smart everything. I'm focused on investing in robotics and sensors and everything related to it. The market is going to be huge." Nick is interested in investing in emerging technologies, interesting companies, and especially in people with great ideas. He's already invested in seven companies around the world, and is going to invest in more, even as many as 50. "One is going to be a home run," he says.

Full story: eecs.umich.edu/n/yang



Dawson Yee: Kinect-ing Xbox to the World

Dawson Yee (MSE EE '87), Hardware Architect for New Consumer Products Group at Microsoft, was the Hardware System Engineer and Architect for Xbox 360 Kinect and Xbox One Kinect. Xbox 360 Kinect became the best-selling product in consumer electronics history – selling more than eight million units its first holiday season and extending the capabilities of Xbox well beyond a pure gaming machine.

“Both versions of Kinect have high precision optical, thermal, mechanical, and electrical sub-systems – all of which have to come together and work in harmony. It also has to be reliable, safe, and affordable,” said Dawson, who was responsible for balancing all of these elements and overseeing the hardware design that made it possible. “When I went to work on Kinect, which has lasers and all types of semiconductor technology, I reached into my toolbox and remembered what I learned in my classes at Michigan twenty years earlier.”

Dawson is thrilled that his work on Kinect has bred creativity and enhanced lives beyond videogames. “The Kinect projects are really great,” he said, “because the knowledge I’m applying is contributing to a greater good.” Some of his favorite (non-Xbox) Kinect applications are related to the health field. For example, doctors in Toronto are utilizing Kinect to manipulate X-ray images without having to touch a computer – thereby helping mitigate contamination. Other medical uses involve using Kinect for physical therapy and rehabilitation.

Dawson is currently working on top secret projects at Microsoft. He is also helping connect fellow alumni, co-hosting an alumni event in Seattle, WA with colleague and fellow alumnus Babak Parviz.

Full story: eecs.umich.edu/n/yee



Dawson Yee

Alumni Briefs

CNN | 10

During the past two years, two of our alumni were responsible for technology featured in CNN | 10, the top 10 modern inventions that are expected to transform society as we know it. Google Glass, invented by Babak Parviz, was included in the 2013 list, and the Glyph, invented by Allan Evans and Ed Tang, made the 2014 list.



Babak Parviz

Ed Tang



Syed B. Ali



Steven Mollenkopf



Larry Page

Top CEO's

Two alumni were recognized in an *Electronics Weekly* list of 2014's top semiconductor CEOs. Syed B. Ali (MSE EE '81), founder, president, and CEO of Cavium, Inc. and Steve Mollenkopf (MSE EE '93), CEO of Qualcomm, Inc. took two of the list's top ten spots.

Larry Page (BSE CE '95), founder and CEO of Google, was named one of the top 5 IoT (Internet of Things) CEOs by the *Computer Business Review* in 2015. He was also voted the #1 CEO by the career website, Glassdoor, which also ranked his company the #1 tech company to work for in the U.S.

1960's

Ralph Kroy (BSE EE '60; and BSE ME '56) recently contacted EECS hoping to hear whatever happened to the Stump Speakers Stump. We found out that the "Stump" was used by the Stump Speakers and members of the engineering debating team in the 50's and the 60's. Ralph entered the Army as a commissioned officer after receiving his mechanical engineering degree, and used the public speaking experience he got as a Stump speaker to better lead others. While stationed at Belle Isle in Detroit, he became impressed with radars and computers and came back for his degree in electrical engineering. If Ralph could still stand and speak on the stump, he'd be able to tell us about his experiences solving problems on the space shuttle's main engine design as well as the Delta and Atlas rocket launch systems. He says his degrees from Michigan as well as being a graduate of the Henry Ford Trade School helped him solve many design and manufacturing problems, led to electric motor patents, and helped him resolve a patent dispute.

1970's

Patrick L. Colestock (MSE PhD EE '73 '75; also MSE Math '73) was named a Los Alamos National Laboratory Fellow in 2009 in recognition of his sustained, outstanding scientific contributions and exceptional promise for continued professional achievement. Patrick is a leader in applied plasma physics for accelerator applications and trans-ionospheric sensing in the Los Alamos National Laboratory's Space and Remote Sensing Group. He has made pioneering contributions to the historic cyclotron resonance heating experiments on the Tokamak Fusion Test Reactor and the Princeton Large Torus. He also helped optimize the performance of the Main Ring and Tevatron at Fermilab. Mr. Colestock has testified before Congress on the future of fusion reactors and has served on several technical review panels of the National Science Foundation and Nuclear Regulatory Commission.

Zachary J. Lemnios (BSE EE '76) was elected Fellow of IEEE, class of 2014, "for leadership in advanced technologies for defense and security systems." Mr. Lemnios is Vice President, Research Strategy and Worldwide Operations at IBM's Thomas J. Watson Research Center. He is responsible for the formation and execution of the IBM Research strategy and operations across IBM's twelve global laboratories and network of collaboratories. During the years 2009-2012, Mr. Lemnios was Assistant Secretary of Defense for Research and Engineering for the U.S. Department of Defense. He was also Director of the Microsystems Technology Office during the years 2003-2005, and Deputy Director of Information Processing Technology Office for the Defense Advanced Research Projects Agency (DARPA) from 2002-2003.

1980's

Ivan LaHaie (MSE PhD EE '77 '81) was elected Fellow of IEEE, class of 2014, "for contributions to near-to-far field radar signature transformations and radar measurement error mitigation." Dr. LaHaie is principal scientist at Integrity Applications, Inc., at the Ann Arbor office.

David G. Mazur (BSE EE '81) vice president and B-2 program manager, Northrop Grumman Aerospace Systems, was selected by the National Defense Industrial Association (NDIA) to receive its 2014 Rear Adm. Robert H Gormley Combat Survivability Leadership award. He received the award November 13, 2014 during NDIA's annual *Aircraft Survivability Technical Forum*. Throughout his career, David Mazur has been involved with the B-2 program and low observable technologies. He has also served as program manager for Northrop Grumman's work on the X-47A unmanned air vehicle, a forerunner to the U.S. Navy's low-observable relevant X-47B Unmanned Combat Air System. David earned his master's degree in electrical engineering from the Air Force Institute of Technology, and has taken executive management courses at the University of Michigan and UCLA.



Jon Fraleigh (BSE CE '82) has been named senior VP of worldwide sales at BrightPoint Security, a leading Threat Intelligence Platform provider for automation, curation, and sharing of threat intelligence to fight cyber threats. He was most recently senior VP of worldwide sales at Q1 Labs/IBM Security Systems Division, where he grew revenue from \$10 million to \$200 million over six years, and expanded sales into more than 90 countries.



Dean Drako (BSE EE '87), President and CEO of Drako Motors, debuted his company's flagship product, Drako DriveOS™.

Drako Motors is an electric sports car software platform provider, and its DriveOS is a



high performance, single vehicle control unit operating system with four wheel torque vectoring. The software was already instrumental in setting a new lap record for street-legal electrical cars at Germany's Nürburgring Nordschleife - the world premier testing site for car driving dynamics.

Harry L. Husted (MSE EE:S '89) received the SAE International Lloyd L. Withrow Distinguished Speaker Award. Mr. Husted is Executive Director, Powertrain Electronics at Delphi Powertrain Systems, where he leads a global team in developing and implementing gasoline and diesel powertrain electronics. He has held a variety of positions within the company, including manager for the Hybrid Vehicle Systems Group, and Chief Engineer for Product Integration & Controls. Prior to joining Delphi, he led the establishment and staffing of a new engine controller design center in Singapore.

Elizabeth Klee (BSE EE '89) was appointed chief information officer of Urban Science, an automotive retail consulting firm in Detroit, in 2014. Prior



to joining Urban Science, Klee served as managing director at Accenture, where she remains a partner. She also served as Accenture's internal IT Global Application Managing Director for HR, Legal, and Client Team solutions, where her work ultimately impacted over 270,000 employees working in 120 countries. Elizabeth has been a member of the Michigan HighwayT board, and an active participant in the Michigan Council of Women in Technology.

1990's

Sheila Hemami (BSE EE '90) was named Chair of Electrical and Computer Engineering at Northeastern University in Boston, MA in 2013. More recently, she was elected Vice President of Publication Services and Products (PSPB) for IEEE for a one year term. She received her master's and PhD degrees from Stanford, and most recently was a professor at Cornell University. Her research interests include multimedia signal processing, image & video compression & transmission, and visual psychophysics. Prof. Hemami served as the editor-in-chief of the *IEEE Transactions on Multimedia* from 2008-2010.



Thomas J. Treutler (BSE CE '90) is Partner and Managing Director of the Vietnam offices of Tilleke & Gibbins, one of the largest law firms in Southeast Asia with 450 lawyers and staff. Tom was named a Band 1 Leading Lawyer in intellectual property law in Vietnam for the sixth year in a row in 2014 by Chambers Asia, and his firm was named Vietnam IP Firm of the Year for three of the last four years by *Managing IP* magazine. He is a USPTO qualified patent attorney that advises on intellectual property law. Tom is founder of Vietnam Pony Baseball and Little League, and his 16U travel team, called the Hanoi Capitals, has qualified for the Colt World Series in Indiana this summer (August,



2015). He has also appeared on 8 episodes of the well-known Vietnamese-American Entertainment program Thuy Nga Paris By Night as a Vietnamese language MC and in comedy sketches.

Tony Fadell (BSE CE '91) sold his latest company, Nest, to Google in 2014 for a reported \$3.2B. Mr. Fadell is an entrepreneur and master designer of computing electronics. He started several companies before joining Apple, where he led development of the iPod and later became strategic advisor to Steve Jobs. After leaving Apple to spend more time with family, he founded Nest Labs and created the self-programming Nest Learning Thermostat. Mr. Fadell will continue to oversee Nest within Google, and also has responsibility for the Google Glass division.



Steven Dail (BSE EE '91) was named Teacher of the Year by Farmington Public Schools. Mr. Dail teaches AP (Advanced Placement) Physics, IB (International Baccalaureate) Physics, Conceptual Physics and sometimes Forensics Science at Harrison High School. He also provides extracurricular activities in STEM, and developed the Harrison RoboHawks robotics club. His classroom style has been likened to episodes of *Bill Nye the Science Guy*. He is pictured with his wife Janet, who came to surprise him with the news. He said, "I happened to be wearing a special shirt that day."



Vinod Subramanian (MSE EE '92; also MSE PhD Applied Physics '92 '96) was appointed to the post of Rector Magnificus at VU University Amsterdam, effective September 2, 2015. Dr. Subramanian was formerly the director of the FOM (Fundamental Research on Matter) Institute for Atomic and Molecular Physics in Amsterdam and a professor at the University of Twente.



Jennifer Rexford (MSE PhD Cpt Sc&Eng '93, '96) has been named Chair of the Department of Computer Science at Princeton University. She is in her tenth year with Princeton, where she is the Gordon Y.S. Wu Professor in Engineering. Her goals as Chair include recruiting top faculty to capitalize on the tremendous opportunities for research and education in the field, expanding the interface between computing and the real world, and managing the growth of her growing and engaged department.



Claude Gauthier (MSE PhD EE '97 '99), co-founder and CTO of OmniPhy Semiconductor, had a great year! He married Andrea this past March, and his company was named one of the "20 Most Promising U.S. Semiconductor Solution Providers" by *SiliconIndia* in 2015. The small private company offers leading-edge IEEE 802.3 automotive, consumer, and industrial semiconductor interface designs, which have been integrated by companies representing 70% of the world's television-set production this past year.



2000's

Smita Krishnaswamy (BSE CE '02, MSE PhD CSE '04, '08) joined the faculty at Yale University in Fall 2015 as an assistant professor in the Department of Genetics. Prior to that, she was a Postdoctoral Research Scientist & Scholar at Columbia University working on computational systems biology. Her first-author research paper was recently published in *Science* magazine. Entitled, "Conditional Density-based Analysis of T Cell Signaling in Single-cell Data," the paper focuses on single-cell data to obtain a better understanding of how cells process signals.



Samuel Miller (BSE CE '02) served in the US Air Force for seven years after graduating from U-M, and flew the F-15E Strike Eagle as a Weapon Systems Officer. He was stationed in England for three of those years and spent six months in Kabul, Afghanistan at the Headquarters for the International Security Assistance Force. Samuel finished his last year in the Air Force at Nellis Air Force Base in Las Vegas, where he taught classes on enemy surface-to-air missile systems. He left the military and headed to the Wharton School at the University of Pennsylvania. After graduating with his MBA in 2011, he moved to New York City and worked for Wells Fargo Securities before joining Credit Suisse, where he focuses on corporate lending. Samuel says he gets back to Ann Arbor every couple of years for MBA recruiting and it always brings back loads of great memories. Go Blue!



Dhruv Gupta (BSE CS '03) co-founded FitHo, a web and mobile based weight management program that provides customized diet plans and exercises, in 2011. FitHo was acquired in 2015 by Practo, an Indian healthcare startup that



helps patients find doctors and book appointments online. Gupta states, "I have always been personally passionate about fitness. With the growing incidence of weight and lifestyle disorders across the world, I recognized a huge need for developing technology that would help people to get healthier through the use of personalized advice. This could mean tips and encouragement on eating right or exercising. The idea was that you could use your mobile phone like your personal trainer or nutritionist, and this is what led to the development of the app."

Maysam Ghovanloo (MSE PhD EE '03 '04) professor at Georgia Tech and director of the GT Bionics Lab, invented a new wearable technology for people with disabilities. It is a Tongue Drive System that uses a headset and a small tongue barbell to control a wheelchair. A video about the device shows an individual steering a wheelchair with just moving his tongue, thanks to a magnetic tracer embedded in the barbell. The technology grew out of Dr. Ghovanloo's work replacing a computer mouse with a tongue-based device. The work appeared in *Science Translational Medicine*, and was covered by the NBC, BBC, and other major news sources.



Michael McCorquodale (MSE PhD EE '00 '04) recently joined Cortera Neurotechnologies in Berkeley, CA as its CEO. Cortera is leveraging advances in semiconductor technology to develop deep brain stimulation medical devices for the treatment of neuropsychiatric disorders such as PTSD and generalized anxiety disorder. Cortera aims to dramatically improve the quality of life for patients suffering from these currently intractable neurological disorders. The company has been capitalized by a grant through



President Obama's BRAIN Initiative and is collaborating with UC Berkeley, Lawrence Livermore National Lab and UCSF in its development efforts. Michigan connections abound, says Dr. McCorquodale. One of the company's co-founders, Prof. Michel Maharbiz (now at UC-Berkeley), served as faculty advisor to Dr. McCorquodale's wife, Dr. Ruba Borno, while both were at Michigan. Additionally, some of Cortera's current staff are former members of Dr. McCorquodale's first company, Mobius Microsystems, which was founded based on his PhD research at Michigan. Mobius was acquired by Integrated Device Technology (NASDAQ: IDTI) in 2010.

Ruba Borno (MSE PHD EE '03 '08) has been named Cisco's new Vice President of Growth Initiatives and Chief of Staff to the CEO-designate, Chuck Robbins. Prior to this position, Dr. Borno worked as a Principal at The Boston Consulting Group and was a core member of the Technology, Media & Telecommunications, and People & Organization practice areas. She advised enterprise and consumer technology executives on organizational change, increasing operational effectiveness, and accelerating business growth. During her time as a graduate student at Michigan, Dr. Borno developed energy scavenging microsystems. Her research was published in ten peer-reviewed papers, multiple book chapters, and was featured in *Wired*, *Business Week*, *New Scientist*, *CNN Money*, *Conservation*, and others. She will be the youngest member of the executive team at Cisco.



Stephen Plaza (BSE CE '03, PhD CSE '08) co-authored a paper published in *Nature* entitled, "A Visual Motion Detection Circuit Suggested by Drosophila Connectomics". Plaza's paper provides key insights into neuronal computations. In 2010, Stephen decided to



combine his experience in computer programming, electrical circuits, logic simulation, and parallel computation and algorithms by working at Janelia Farms for the FlyEM project. In early 2012, Stephen became the project manager for FlyEM. His main goals are to explicitly define and monitor all project requirements and encourage greater synergy between the large, interdisciplinary team that composes FlyEM.

James Boerkoel (MS PhD CSE '08, '12) joined the faculty in the Computer Science Department at Harvey Mudd College in Fall 2013, where he is the director of the newly formed Human Experience & Agent Teamwork (HEAT) Lab. The goal of the HEATLab is to develop techniques that augment humans' own cognitive and physical abilities to create integrated human-agent teams that are more capable than their individual counterparts.



Héctor J. García (PhD CSE '13) was selected for induction into the Bouchet Graduate Honor Society. The purpose of the Bouchet Society is to recognize outstanding scholarly achievement and promote diversity and excellence in doctoral education and the professoriate. He also placed third in the technical poster competition at the SHPE 2013 Conference for his poster, "Quipu: Simulation of Quantum Circuits via Stabilizer Frames." Mr. Garcia's research focuses on the design of efficient tools that identify and analyze potential advantages and pitfalls in emergent quantum information processing technologies. He designed Quipu – a novel quantum-circuit simulator that takes advantage of speed-ups offered by group-theory techniques.



Dongyoon Lee (MS PhD CSE '09 '13) received the ProQuest Distinguished Dissertation award from the Rackham Graduate School for his dissertation, "Holistic System Design for Deterministic Replay." Lee is an Assistant Professor in the Computer Science department at Virginia Tech.



Yi-Chin Wu (MSE PhD EE:Sys '11 '14) received the ProQuest Distinguished Dissertation Award in 2014 for her dissertation, "Verification enforcement for opacity security property." Her research brings Discrete Event Control Theory to the analysis and design of secure systems. Dr. Wu says that we can no longer solve security and privacy threats by only examining the implementation of each specific system. We need to approach the problem theoretically to design complete systems that are secure. Yi-Chin is currently a postdoctoral research in the TerraSwarm Research Center based at UC-Berkeley, which is addressing the huge potential (and associated risks) of pervasive integration of smart, networked sensors and actuators into our connected world.



2010's



Mona Attariyan, center, with award. She is pictured at the conference with Prof. Jason Flinn and colleagues from Michigan.

Mona Attariyan (PhD CSE '12) received the inaugural Dennis Ritchie Doctoral Dissertation Award from ACM SIGOPS for her dissertation, "Improving Software Configuration Troubleshooting With Causality Analysis." This award recognizes research in software systems. Dr. Attariyan joined Google cloud infrastructure in August 2012, where she works on Google Compute Engine. Google Compute Engine provides virtual machines on top of Google infrastructure for users outside Google. On the side, she also enjoys working on large-scale analysis of genomic data.

2015 Homecoming Award Winners in EECS



CoE Merit Award Winner for ECE:
Rick Wallace
CEO and President,
KLA-Tencor



CoE Merit Award Winner for CSE:
Michael Rhodin
Senior Vice President
for Watson, IBM



CoE Recent Engineering Graduate Award:
Garlin Gilchrist
Deputy Technology Director
for Civic Community
Engagement, City of Detroit



CoE Alumni Society Medal Award:
Ashraf Dahod
Co-founder, Chairman,
and CEO, Altistar
Networks, Inc.

EECS will be celebrating Homecoming in the Department on Friday, October 9, 2015. We hope you can join us.

Homecoming event and lecture schedules can be found at: eeecs.umich.edu/n/hc

Alumni Explore Lots of EECS-related Engineering With Their Kids

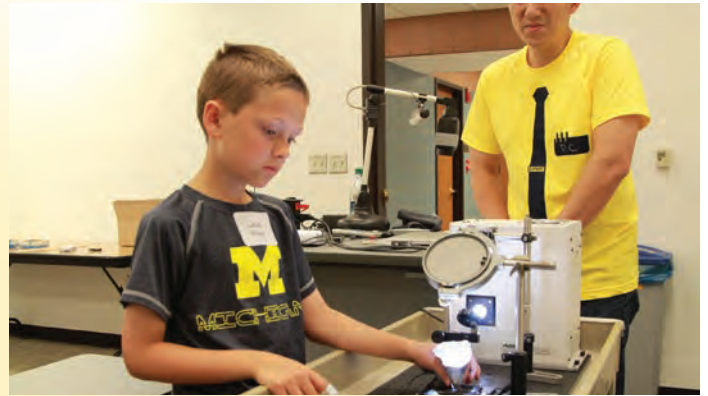
They took the campus by storm. 380 alumni and children stretched across North Campus on June 25 and 26, dabbling in drones and bones, rockets and radioactives.

No, it wasn't a hostile takeover. It was the third annual Xplore Engineering summer camp, designed especially for alumni to introduce the children in their lives to the joy of engineering through a variety of hands-on experiences. EECS faculty hosted several workshops of their own, most of which premiered this year.



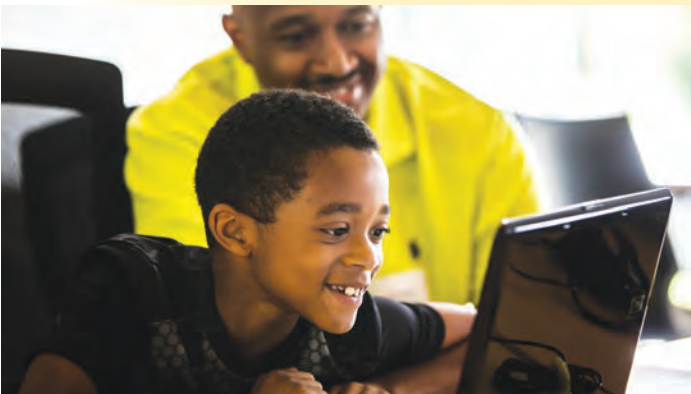
Computer Imaging: Build Your Own Camera

In this workshop run by Prof. Jason Corso, kids learned about the centuries-old technology still at work in their camera phones, built their own pin-hole cameras, and learned about lenses and memory storage.



Solar Solutions: Harnessing the Sun's Energy

Attendees in Prof. P.C. Ku's workshop built their own solar concentrators to get a look at how solar panels use the sun's energy to make power.



Computational Linguistics

The Language and Information Technology lab, directed by Prof. Rada Mihalcea, led a workshop that explored how our computers interpret and understand our language, and all the different ways this can be used.



Navigating the Robot Maze

In this workshop, led by graduate student Brandon Ghena, kids got to build a robot with the ability to find its way through a maze using sensors. Each participant programmed the robots themselves and then competed against other students.

AROUND THE COUNTRY WITH OUR ALUMNI!



Alumni have been meeting at various locations across the country, gaining valuable connections and learning about some of the key initiatives and research happening in the department. Jobs have already resulted from connections made at these events.

ISSCC

Every year, faculty members of the Michigan Integrated Circuits Laboratory (MICL) host an alumni and friends reception at the *International Solid-State Circuits Conference*. The conference happens the first week of February at the San Francisco Marriott. If you are attending or live close by – please stop in!



MTT-S

With so many of our alumni, faculty, and students attending the *IEEE International Microwave Symposium*, we returned to the conference in 2015, held in Phoenix, AZ on May 19, 2015.

"It was really nice to be able to talk with different generations of alumni," said Kamal Sarabandi, Rufus S. Teesdale Professor of Engineering and Director of the Radiation Lab. "Some of those who attended found out for the first time that colleagues they've known for years were also alumni."



We were also in **Detroit** (October 8, 2014), **Palo Alto** (November 20, 2014), **Seattle** (March 19, 2015), **San Francisco** (May 7, 2015), **Alaska** (June 23, 2015, coinciding with the *Solid-State Sensors, Actuators and Microsystems Conference*), **Chicago** (July 1, 2015, coinciding with the *American Controls Conference*), and **Boston** (August 27, 2015)!

The Gift of an Education:

Paul and Ruth Bauhahn Fund the Next Generation of Life-changing Technology



Ruth E. (MA Education '74) and Paul E. (MS EE '69, MS Physics '72, PhD EE '77) Bauhahn.

“Learning can be very rewarding and fun and challenging. The challenging part is the part that adds another dimension to your life. And it will pay off.”

– Ruth Bauhahn

“It’s important to encourage students to get advanced degrees. These are the people who are producing some of the best new products. These individuals are doing work that benefits all of humanity. They are needed by everyone.”

– Paul Bauhahn

Paul E. and Ruth E. Bauhahn answered the department’s call to come to the aid of our students by establishing the Ruth E. and Paul E. Bauhahn Fellowship Fund to support full-time graduate students in Electrical and Computer Engineering.

The Bauhahns know firsthand the value of a Michigan education. In his work as a research scientist at Honeywell, Paul developed microwave, millimeter wave and micromechanical devices, and worked with lasers for diverse applications. He retired with thirteen patents. Ruth taught 8th grade math at Wayne-Westland schools before she and Paul moved to Minnesota. She then engineered her own career change, joining Medtronic as a software technician. She became a human factor scientist in product development, and retired with five patents related to the design of medical devices for spinal cord stimulation.

Both Paul and Ruth are passionate about leveraging technology to improve health. Paul recalls working with Professor Kensall D. Wise, who bridged the worlds of health and engineering. “When I was there,” said Paul, “he [Prof. Wise] was putting a sensor on the end of a catheter and running it up through a vein to convert the pressure waves in the heart to electrical signals. Later he went on to develop a multi-electrode interface to the brain. He was a great guy.”

Ruth told us she’s very proud of the fact that Michigan was bridging the world of engineering, medicine, and industry 30 years before many other schools were getting in the game. At Medtronic, Ruth worked with neuromodulation systems and implantable drug delivery systems for chronic pain, common movement disorders, psychiatric disorders and urologic disorders. “Deep Brain Stimulation (DBS), which is a treatment

for movement symptoms of Parkinson’s disease, essential tremor and dystonia, is a particularly exciting area,” she said.

The Bauhahns’ interest in technology that can directly help society is a major motivating factor for their donation. The Paul E. and Ruth E. Bauhahn Fellowship Fund may one day support the education of a Michigan student working on cancer treatment, or understanding the human brain, or improving medical imaging, or using big data and genomics to understand illness, or even designing stents – all projects happening right now in the department.

After a lifetime immersed in impactful and rewarding work, the Bauhahns felt it appropriate to offer whatever help they could so that future generations could do the same. And for the Bauhahns, an advanced education offers unparalleled rewards for the individual, and for society.

Believing also in the importance of early education, Paul and Ruth have been working with local schools to help improve students’ skills in math and science. After he retired, Paul taught physics with calculus at a local community college. But the students were not proficient in algebra or trigonometry. He was deeply concerned, knowing that a strong background in these areas can set a student on a path that can change lives. A path that one day may take them to Michigan.

Larry D. Leinweber Gives \$2.4 Million to Fund Scholarships in Computer Science

Michigan-based entrepreneur and business leader Larry D. Leinweber sees an opportunity to help build a stronger economic foundation for the state. He envisions Michigan as a home for more software companies and wants to help build a pipeline of talent to make that vision a reality, with a special emphasis on retaining computer science students whose home state is Michigan.

In pursuit of this goal, Leinweber has chosen to give \$2.4 million to the College of Engineering to establish scholarships that will support motivated undergraduate students from Michigan enrolled in the study of computer science.

Leinweber knows firsthand the challenge of building a successful software firm in Michigan, which is located far from the major tech centers on the country's east and west coasts. He is President and Chief Executive Officer of New World Systems, the software company he founded in Troy, Michigan in 1982. Today, New World Systems is one of the largest privately-held software firms in Michigan and employs over 400 people. New World provides public safety and public administration software solutions to cities, counties, schools, and other public sector entities.

"The software applications we develop are complex, large scale, and have taken years to build," says Leinweber. "Finding and retaining talented people in Michigan to build and support these kinds of big, complex applications has been and remains a challenge."

Under the program established by Leinweber's gift, scholarships emphasizing academic achievement and promise will be awarded to second-year, third-year, and fourth-year engineering students majoring in computer science who are state residents. Three or more awards will be made each year, and a student may receive the scholarship for a maximum of three years. Preference will be given to students declaring a desire to work in the Michigan software industry after graduation.

Leinweber's gift will also create the Leinweber Software Scholars Society, which will connect current and past scholarship recipients to each other, the University community, and the Leinweber family. The society is intended to facilitate the development of a network of software professionals and opportunities within the state and to encourage software engineers to pursue their futures in Michigan.

"Our hope," said Leinweber, "is that the Leinweber Software Scholars Society can help those students who want to stay in Michigan do so by engaging them in activities that will lead to employment or venture development in Michigan." It is hoped that the impact of the Society will be magnified as students in the program build their own networks of connections in the state.

Full story: <http://www.eecs.umich.edu/n/larry>



Thanks to our Donors

The Department thanks the donors named below as well as those who gave anonymously during the past two years. Your support is essential in keeping the Department strong and ensuring that the best students attend Michigan to receive the education they deserve.

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We would like to thank the many EECS alumni who contribute their time and talent to the department. They are providing extremely valuable assistance to our students, faculty, and department as a whole as guest speakers, career panelists, graduate symposium judges, recruiters, or mentors. During the past year, the following individuals participated in one or more of these activities.

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Partners; Co-founder and
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eLab



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President and CEO, GW
Lisk Co., Inc.



Navin Shenoy
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Charlotte Decker
CIO, UAW,
Retiree Medical
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Nino Masnari
Distinguished Professor of
Electrical and Computer
Engineering, North Carolina
State University



David Tarver
Founder, Telecom
Analysis Systems; CEO,
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Karen Fireman
Former Economic
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Barclays



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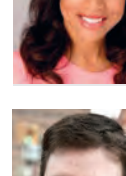
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CEO, Menlo Innovations



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Thomas Frank
Executive Director
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Erin Teague
Director of Product
Management, Yahoo



Georges Harik
Founder, imo and
Co-Founder,
Harik Shazeer Labs



Marc Weiser
Founder and Managing
Director, RPM Ventures

In Memoriam

CLASS OF 1930 – 39

Olan D. Snively ('34; 4/26/2014)
Walter F. Courtis ('35; 2/8/2011)
John F. Lamb ('36 '40; 12/1/1983)
Albin G. Dembowski ('37 '38; 6/29/2013)

CLASS OF 1940 – 49

John Strand ('41; 10/4/2013)
Joseph B. Tate ('41; 1/25/2011)
Alan G. Teague ('42; 12/16/2008)
Thomas H. Marshall ('43; 12/09/2013)
John F. Lourim ('44; 7/10/2014)
Max R. Luikart ('44; 2/19/2015)
William E. Baker ('47; 10/24/2010)
Harry Crows ('47 '48; 9/29/2013)
Spencer W. Roberts ('47 '48; 6/18/2013)
George R. Brewer ('48 '49 '52; 1/7/2014)
James B. Mitchell ('48 '56; 1/8/2014)
Richard C. Pomeroy ('48; 11/24/2013)
LeRoy D. Taylor ('48; 11/08/2013)
Donald E. Yost ('48; 10/2/2014)
Fusajiro Aburano ('49; 10/18/2014)
Ju C. Tu Ju ('49 '56; 6/12/2012)
Gerald R. Pearsall ('49; 6/29/2009)
Ward D. Stoeper ('49; 5/18/2015)

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John K. Baguley ('50 '51; 6/24/2014)
Leo G. Durand ('50; 12/11/2014)
Lenhard A. Forsberg ('50 '52; 4/23/2015)
Frank W. Gruenthal ('50 '52; 10/14/2013)
Arthur J. Miller ('50; 10/12/2013)
Lorenzo O. Olsen ('50; 4/27/2014)
Donald J. Schoonover ('50; 1/10/2015)
John H. Smedley ('50; 6/9/2012)
William S. Wright ('50; 10/3/2011)

Robert S. Burch ('51; 3/20/2015)
Edward J. Kowalczyk ('51; 1/20/2004)
Donald D. Walker ('52 '55 '58; 6/15/2014)
Jack S. Gillette ('53; 10/22/2013)
James A. Hamburg ('53 '54; 3/14/2014)
Robert E. Scott ('53 '61; 11/2/2013)
Martin W. Story ('53; 4/25/2015)
Richard T. Carnicom ('54; 11/28/2010)
Roger D. Conklin ('54; 11/25/2014)
William G. Elliott ('54 '56; 3/24/2014)
Benedict R. Jacobellis ('54; 10/1/2013)
Thomas M. Waltz ('55; 6/11/2014)
James E. Stevens ('56; 2/28/2012)
Eric M. Aupperle ('57 '58 '64; 4/30/2015)
Dennis A. McKinney ('57; 1/1/2014)
Richard L. Miller ('57 '62; 1/4/2014)
Clarence H. Ristad ('57; 3/26/2008)
Robert S. Vansickle ('57; 4/11/2015)
Alan D. Simmons ('58; 1/13/2015)
Steve S. Popovich ('59; 6/15/2014)
David G. Arnold ('59; 12/11/2009)
Harold E. Bibb ('59; 7/11/2011)
Hansford W. Farris ('59; 12/7/2014)
Samuel M. Thomas ('59; 4/3/2015)

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John A. DeBliek ('60; 7/30/2014)
Estel E. Reed ('60; 8/1/1983)
Carl E. Rice ('60; 10/12/2014)
David R. Allen ('61; 12/11/2007)
Dale W. Gieske ('61; 1/19/2015)
Gerald H. Parshall ('61; 5/5/2014)
Robert A. White ('61; 3/25/2015)
William E. Walsh ('62; 11/4/2013)
David V. Wilson ('62; 12/29/2014)
Roy W. Sikorski ('63; 2/14/2013)

Donald P. Tate ('63; 7/31/2014)
William W. Parker ('64 '66 '69; 4/11/2014)
Robert C. Briggs ('65; 3/14/2015)
Frederick J. Gozdzik ('65; 1/18/2013)
Alvin L. Neller ('65; 8/13/2014)
Jay W. Weinberger ('65; 9/21/2013)
Daniel S. Broder ('67; 6/8/2009)
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Robert M. Perlstein ('69; 4/10/2015)
Robert M. Vukovich ('69; 8/9/2014)

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Duwayne D. Oosterbaan ('71; 11/20/2010)
Thomas J. Hart ('72 '73; 11/4/2011)
Phillip G. Cretens ('73; 3/7/2013)
Francis B. Hoogterp ('73; 10/15/2012)
Eddie A. Abdo ('74; 10/11/2013)
Thomas A. Niemi ('75; 12/29/2014)
George A. Te ('78 '80; 11/7/2013)

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Jan D. Wolter ('81 '83 '88; 1/1/2015)
Curtis J. Anderson ('82; 12/2/2013)
Kevin R. Bernard ('82 '84; 6/28/2008)
Chet Juszczak ('83; 4/9/2011)
Adam H. Zysnarski ('89; 1/27/2014)

CLASS OF 1990 – 2000

Gregory W. Posey ('95 '97; 1/7/2014)

Eric M. Aupperle (1935 – 2015): Leader in Shaping the Internet

Eric Max Aupperle (BSE EE and Math '57; MSE NERS '58; Instm.E. '64), renowned president of Merit Network and Research Scientist Emeritus, played an important role in the history of the technological revolution created by the Internet.

Throughout his career, Mr. Aupperle was an employee of the University of Michigan. He served as Associate Director for Communications (1981–1989), Interim Director of Information Technology Division Network Systems (1990–1992), and as a researcher and lecturer in the Department (1963–2002).

Eric was hired as the first employee of Merit in 1969. His job was to implement a computer network that linked the University of Michigan, Michigan State University, and Wayne State University. In 1973, the network was formally dedicated, and for the first time a researcher at Michigan, for example, was able to run a program at Michigan State or Wayne State. A year later Eric was appointed director of Merit, and he would serve as Merit's first president from 1988 to 2001.

In 1976, Merit interconnected with Telenet, a spin-off of ARPANET, which ultimately connected Merit users with the world. The next major milestone in Eric's career occurred after the National Science Foundation established NSFNET in 1985 with the goal of networking five new recently-funded supercomputing centers. Within just a year, network traffic far exceeded capacity, and Merit won NSF's bid to upgrade NSFNET to meet the demand. "Almost overnight," recalled Eric, "Merit's role of providing networking services to our member universities and a handful of other Michigan-based organizations was extended to include an extremely significant, highly visible national networking function." Leaders in the field agree that Eric's leadership changed the world, and greatly impacted the Internet as we know it today.

Full story: eecs.umich.edu/n/eric



Ernest S. Kuh (1928 – 2015): Pioneer in Electronic Circuit Theory and EDA

Ernest S. Kuh (BSE EE '49) was a pioneer in electronic circuit theory and electronic design automation. He served as department chair and dean at UC-Berkeley, where he spent most of his career as a faculty member. As a devoted Michigan alumnus, he established the Ernest and Bettine Kuh Distinguished Faculty Scholar Award in Electrical and Computer Engineering in 2012.

Prof. Kuh received his master's degree from MIT in 1950, and his PhD degree from Stanford University in 1952. After graduation, he accepted a position at AT&T Bell Labs, and then transitioned to his career as an academic at UC-Berkeley in 1956. His research led to a seminal paper on state-variable approaches to network analysis in 1965, and textbooks on circuit theory and synthesis that were widely taught in classrooms for two decades.

While Dean of Engineering at Berkeley, he developed the Berkeley Industrial Liaison Program which led to key interactions with industry and helped guide his change in research focus to electronic design automation (EDA). He served on the board of ECAD, founded in 1982, which would become Cadence Design Systems. At this time, computer-aided design was in the early stages of moving from mechanical to electronic, and Prof. Kuh was instrumental in the transition. He received the EDA's highest award, the Phil Kaufman Award, in 1998.

Prof. Kuh was inducted into the Silicon Valley Hall of Fame in 2008 and has received numerous additional awards and honors, including the IEEE Education Medal, the Kirchhoff Award, the IEEE Circuits & Systems Society Award, and the ASEE Lamme Medal. At Michigan, he received the U-M Distinguished Alumnus Award and the U-M College of Engineering Medal. He is a fellow of IEEE and AAAS, and a member of the National Academy of Engineering.

Full story: eecs.umich.edu/n/kuh



Photo by Peg Skorpinski

Hansford Farris (1919 – 2014)

Hansford Farris (PhD EE '58) spent his career as a faculty member of the EECS Department, while serving in important administrative roles over the course of his career. From 1963 to 1965, he was Associate Director of the U-M Institute of Science and Technology and served as the first Director of its Industrial Development Division. Prof. Farris served as Department Chair from 1965 to 1968, followed by a five-year term as Associate Dean of the College of Engineering. Twice during his tenure at Michigan, Prof. Farris served as Acting Dean for the College.

Among his major projects at Michigan were the initiation of the College of Engineering's Instructional Television System, an off-campus interactive, distance learning television network. During the mid-70s, he wrote and narrated *Future Without Shock*, a series of half-hour programs on the role of the engineer in modern society.

Prof. Farris received the HKN Outstanding Teacher Award in 1961–62, and the Amoco Outstanding Teacher Award in 1976. His alma mater, Eastern Kentucky State University, awarded him the Distinguished Alumnus Citation in 1974. After his retirement in 1982, Prof. Farris moved to Gainesville, Florida and initiated the Electrical Engineering program at the University of North Florida.

Full story: eecs.umich.edu/n/far



John Holland (1929 – 2015)

John Henry Holland (MA Math '54; PhD Cpt&Com Sc '59), University of Michigan professor of psychology, computer science, and complex systems, was a pioneer in what became known as genetic algorithms.

Prof. Holland earned the first PhD in computer science at Michigan in 1959, under the advisement of Prof. Arthur Burks. He soon became one of the first professors in the University's Department of Computer and Communication Science.

Prof. Holland is best known for his role as a founding father of the complex systems. In particular, he developed genetic algorithms and learning classifier systems. These foundational building blocks of an evolutionary approach to optimization are now included in all texts on optimization and programming. He was unique in that he took ideas from evolutionary biology in order to transform search and optimization in computer science, and then he took what he discovered in computer science and used it as fuel for a rethinking of evolutionary dynamics.

In the mid-1980s he joined a number of Nobel laureates in physics and economics to found the Santa Fe Institute, the premier institution devoted to the study of complex systems. Up to his death, Prof. Holland was an external professor and member of the executive committee of the board of trustees at SFI.

Around 1990, Prof. Holland played a major role in the founding of the U-M Center for the Study of Complex Systems at U-M. His reputation was the drawing card for many of the center's new faculty.

In 1993, Prof. Holland received U-M's highest award for senior faculty, the Russell Lectureship. A year earlier, he was awarded a prestigious MacArthur "genius award." He was an energetic mentor of students — undergraduate and graduate — and of young faculty. Up to a year ago, he regularly taught an undergraduate introduction to complex systems, and in the last three years, in his mid-80s, published two books: "Signals and Boundaries" and "Complexity: A Very Short Introduction." These join his earlier books in shaping the study of complex systems, including "Adaptation in Natural and Artificial Systems" (1975), "Hidden Order" (1995), and "Emergence: From Chaos to Order" (1998).



EECS Faculty

The primary departmental affiliation (either CSE or ECE) for each faculty member is listed first, followed by any secondary appointments in other departments (a key for the acronyms is found on page 143).



Abernethy, Jacob
Assistant Professor
CSE



Ackerman, Mark S.
George Herbert Mead
Prof. of Human-Computer
Interaction
CSE, SI



Anastasopoulos, Achilleas
Associate Professor
ECE



Austin, Todd
Professor
CSE, ECE



Azadegan, Reza
Assistant Research
Scientist
ECE



Balzano, Laura
Assistant Professor
ECE



Baveja, Satinder Singh
Professor
CSE



Bertacco, Valeria
Professor
CSE



Bhattacharya, Pallab K.
Charles M. Vest Dist. Univer.
Prof. James R. Mellor
Prof. of Engineering
ECE, AP



Blaauw, David T.
Professor
ECE, CSEs



Brehob, Mark
Collegiate Lecturer
CSE



Cafarella, Michael J.
Assistant Professor
CSE



Chen, Peter M.
Arthur F. Thurnau Professor
CSE



Chesney, David
Lecturer
CSE



Cho, Jae Yoong
Assistant Research
Scientist
ECE



Chowdhury, Mosharaf
Assistant Professor
CSE



Compton, Kevin
Associate Professor
CSE



Corso, Jason
Associate Professor
ECE, CSE



Darden, Marcus
Lecturer
CSE



Das, Reetuparna
Assistant Professor
CSE



Deng, Jia
Assistant Professor
CSE



DeOrio, Andrew
Lecturer
CSE



Dick, Robert
Associate Professor
ECE



Dorf, Mary Lou
Lecturer
CSE



Dreslinski, Ronald
Assistant Professor
CSE



Durfee, Edmund
Professor
CSE, SI



Dutta, Prabal
Associate Professor
CSE



England, Anthony W.
Dean of CECS, UM-Dearborn
Professor
ECE, AOSS AP



Essl, Georg
Assistant Professor
CSE



Fessler, Jeffrey A.
Professor
ECE, BME, RAD, AP



Finelli, Cynthia
Associate Professor
ECE



Flinn, Jason
Professor
CSE



Flynn, Michael P.
Professor
ECE



Forrest, Stephen R.
Peter A. Franken Dist. Univ.
Prof.; Paul G. Goebel Prof.
of Eng.
ECE, MSE, PHY, AP



Freudenberg, James S.
Professor
ECE



Fu, Kevin
Associate Professor
CSE



Galvanauskas, Almantas
Professor
ECE



Gianchandani, Yogesh
Professor
ECE, ME, AP



Gibson Bond, Jeremy
Lecturer
CSE



Gilchrist, Brian E.
Professor
ECE, AOSS, AP



Grbic, Anthony
Associate Professor
Ernest and Betty Kuh
Dist. Faculty Scholar
ECE, AP



Green, Scott
Assistant Research
Scientist
ECE



Grizzle, Jessie W.
Elmer G. Gilbert Dist. Univ.
Prof.; Jerry W. and Carol L.
Levin Prof. of Eng.
ECE, ME



Guo, Lingjie
Professor
ECE, Macro, ME, AP



Halderman, J. Alex
Associate Professor
CSE



Hayes, John P.
Claude E. Shannon Prof. of
Engineering Science
CSE



He, Guohong
Assistant Research
Scientist
ECE



Hero III, Alfred O.
R. Jamison and Betty
Williams Prof. of Engineering
ECE, BME, STATS



Hicks, Matthew
Lecturer
CSE



Hofmann, Heath F.
Associate Professor
ECE



Honeyman, Peter
Research Professor
and Lecturer
CSE



Islam, Mohammed N.
Professor
ECE, BME, IntMed



Jagadish, H.V.
Bernard A. Galler
Prof. of EECS
CSE



Jamin, Sugih
Associate Professor
CSE



Jenkins, Odest Chadwicke
Associate Professor
CSE



Hiskens, Ian A.
Vennema Professor
of Engineering
ECE



Juett, James
Lecturer
CSE



Kamil, Amir
Lecturer
CSE



Kanicki, Jerzy
Professor
ECE



Kieras, David
Professor
CSE, PSYCH



Kim, Hun Seok
Assistant Research Scientist
ECE



Koutra, Danai
Assistant Professor
CSE



Ku, Pei-Cheng
Associate Professor
ECE



Kuipers, Benjamin
Professor
CSE



Kushner, Mark J.
George I. Haddad
Prof. of EECS
ECE, AP, ChemE, NERS



Lafortune, Stéphane
Professor
ECE

EECS Faculty



Laird, John
John L. Tishman Prof.
of Engineering
CSE



Lasecki, Walter
Assistant Professor
CSE



Lee, Honglak
Assistant Professor
CSE



Lee, Somin Eunice
Assistant Professor
ECE, BME



Li, Tao
Assistant Research
Scientist
ECE



Liepa, Valdis
Research Scientist
ECE



Liu, Mingyan
Professor
Assoc. Chair for
Graduate Affairs
ECE



Lu, Wei
Associate Professor
ECE, AP



Madhyastha, Harsha
Assistant Professor
CSE



Mahlke, Scott
Professor
Associate Chair
CSE



Maksimchuk, Anatoly
Research Scientist
ECE



Mao, Z. Morley
Associate Professor
CSE



Markov, Igor
Professor
CSE



Mars, Jason
Assistant Professor
CSE



Mathieu, Johanna
Assistant Professor
ECE



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Professor
CSE, AP



Meerkov, Semyon M.
Professor
ECE



Michielssen, Eric
Professor
Assoc. VP for Adv.
Research Computing
ECE



Mihalcea, Rada
Professor
CSE



Miller, Carl
Assistant Research
Scientist
CSE



Morgan, Andrew
Lecturer
CSE



Mower Provost, Emily
Assistant Professor
CSE



Mortazawi, Amir
Professor
ECE



Mozafari, Barzan
Assistant Professor
CSE



Mudge, Trevor
Bredt Family Prof.
of Engineering
CSE



Munson, Jr., David C.
Robert J. Vlasic Dean
of Engineering
ECE, AP



Nadakuditi, Rajesh Rao
Assistant Professor
ECE, AP



Najafi, Khalil
Schlumberger Prof. of
Engineering and Chair,
Electrical and Computer
Engineering; Arthur F. Thurnau
Professor
ECE, BME



Narayanasamy, Satish
Associate Professor
CSE



Nashashibi, Adib Y.
Associate Research
Scientist
ECE



Nees, John
Associate Research
Scientist
ECE



Neuhoff, David L.
Joseph E. and Anne P. Rowe
Professor; Sr. Associate Chair
ECE



Noble, Brian
Prof. and Assoc. Dean for
Undergraduate Education
CSE



Norris, Theodore B.
Gérard A. Mourou
Prof. of EECS
ECE, AP



Olson, Edwin
Associate Professor
CSE



Ozay, Necmiye
Assistant Professor
ECE



Paoletti, David
Lecturer
CSE



Papaefthymiou, Marios
Prof. and Chair, Computer
Science and Engineering
CSE



Peikert, Christopher
Associate Professor
CSE



Peterson, Rebecca
Assistant Professor
ECE



Pettie, Seth
Associate Professor
CSE



Phillips, Jamie
Professor
Assoc. Chair for
Undergraduate Affairs
ECE, AP



Pierce, Leland E.
Associate Research
Scientist
ECE



Pollack, Martha
Professor and
University Provost
CSE, SI



Pradhan, Sandeep
Associate Professor
ECE



Prakash, Atul
Professor
CSE



Radev, Dragomir
Professor
CSE, SI



Rais-Zadeh, Mina
Associate Professor
ECE, ME



Rand, Stephen C.
Professor
ECE, PHY, AP



Revzen, Shai
Assistant Professor
ECE, EEB



Ringenberg, Jeff
Lecturer
CSE



Sakallah, Karem
Professor
CSE



Sarabandi, Kamal
Rufus S. Teesdale
Prof. of Engineering
ECE



Schoenebeck, Grant
Assistant Professor
CSE



Scott, Clayton
Associate Professor
ECE



Seymour, John
Assistant Research
Scientist
ECE



Shi, Yaoyun
Associate Professor
CSE



Shin, Kang
Kevin and Nancy O'Connor
Prof. of Computer Science
CSE



Singh, Jasprit
Professor
ECE, AP



Soloway, Elliot
Arthur F. Thurnau Professor
CSE, SI, SOE



Stark, Wayne E.
Professor
ECE



Steel, Duncan G.
Robert J. Hiller Prof.
of Engineering
ECE, BioPHY, PHY, IOG, AP



Stout, Quentin
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CSE, AERO



Strauss, Martin
Professor
CSE, MATH



Subramanian, Vijay
Associate Professor
ECE



Syed, Zeeshan
Assistant Professor
CSE



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Professor
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Assistant Professor
CSE



Teneketzis, Demosthenis
Professor
ECE



Terry, Fred L.
Professor
ECE, AP



Tsang, Leung
Professor
ECE



Ulaby, Fawwaz T.
Emmet Leith Dist. Univ. Prof.;
Chen-To Tai Prof.;
Arthur F. Thurnau Professor
ECE

EECS Faculty



Volkovich, Ilya
Lecturer
CSE



Wakefield, Gregory H.
Associate Professor
ECE, SMTD, OTO



Wellman, Michael P.
Professor
CSE



Wenisch, Thomas F.
Associate Professor
CSE



Wentzloff, David D.
Associate Professor
ECE



Whitaker, John F.
Research Scientist
ECE



Wiens, Jenna
Assistant Professor
CSE



Willingale, Louise
Assistant Professor
ECE



Winful, Herbert G.
Arthur F. Thurnau Professor
ECE



Winick, Kim A.
Professor
ECE



Yagle, Andrew E.
Professor
ECE



Yanovsky, Victor P.
Research Scientist
ECE



Yoon, Euisik
Professor
ECE, BME



Zhang, Zhengya
Assistant Professor
ECE



Zhong, Zhaohui
Associate Professor
ECE

Affiliated Faculty

Abney, Steve, Associate Professor, *LING, SI, CSE*

Adar, Eytan, Associate Professor, *SI, CSE*

Atkins, Ella, Associate Professor, *AERO, CSE*

Cain, Charles A., Richard A. Auhl Professor, *BME, ECE*

Chestek, Cynthia, Assistant Professor, *BME, ECE*

Collins-Thompson, Kevyn, Associate Professor, *SI, CSE*

Cundiff, Steven, Harrison M. Randall Collegiate Professor of Physics, *PHY, ECE*

Dillahun, Tawanna, Assistant Professor, *SI, CSE*

Eustice, Ryan, Associate Professor, *NAME, CSE*

Gilbert, Anna, Professor, *MATH, ECE*

Goldman, Rachel S., Professor, *MSE, ECE*

Guan, Yuanfang, Assistant Professor, *CMB, CSE*

Johnson-Roberson, Matthew, Assistant Professor, *NAME, CSE*

Krushelnick, Karl, Professor, *NERS, ECE*

Kurabayashi, Katsuo, Professor, *ME, ECE*

Lynch, Jerome P., Associate Professor, *CEE, ECE*

McClamroch, N. Harris, Professor, *AERO, ECE*

Mei, Qiaozhu, Associate Professor, *SI, CSE*

Merlin, Roberto D., Peter A. Franken Professor of Physics, *PHY, ECE*

Michailidis, George, Professor, *STATS, ECE*

Nagy, Andre, Professor, *AOSS, ECE*

Najarian, Kayvan, Associate Professor, *CMB, CSE*

Newman, Mark W., Associate Professor, *SI, CSE*

Nguyen, Long, Associate Professor, *STATS, CSE*

Romero, Daniel, Assistant Professor, *SI, CSE*

Ruf, Christopher S., Professor, *AOSS, ECE*

Stefanopoulou, Anna, Professor, *ME, NAME, ECE*

Sun, Jing, Professor, *NAME, ECE*

Tewari, Ambuj, Assistant Professor, *STATS, CSE*

Thomason, Richmond, Professor, *LING, PHIL, CSE*

Tilbury, Dawn, Professor, *ME, ECE*

Weimerskirch, Andre, Associate Research Scientist, *UMTRI, CSE*

Ye, Jieping, Associate Professor, *CMB, CSE*

Zhou, Shuheng, Assistant Professor, *STATS, CSE*

AP – Applied Physics
AERO – Aerospace Engineering
AOSS – Department of Atmospheric, Oceanic & Space Sciences
BioPHY – BioPhysics
BME – Biomedical Engineering
CEE – Civil and Environmental Engineering
ChemE – Chemical Engineering
CSE – Computer Science & Engineering
CMB – Computational Medicine & Bioinformatics
ECE – Electrical & Computer Engineering
EEB – Ecology and Evolutionary Biology
IntMed – Internal Medicine
IOG – Institute of Gerontology
LING – Linguistics
Macro – Macromolecular Science & Engineering
MATH – Mathematics
ME – Mechanical Engineering
MSE – Materials Science and Engineering
NAME – Naval Architecture and Marine Engineering
NERS – Nuclear Engineering and Radiological Sciences
OTO – Otolaryngology
PHIL – Philosophy
PHY – Physics
PSYCH – Psychology
RAD – Radiology
SI – School of Information
SMTD – School of Music, Theatre & Dance
SOE – School of Education
STATS – Statistics
UMTRI – University of Michigan Transportation Research Institute



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