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Wrestling Big Data and Winning – Prof. Sidiropoulos and the key to efficient multi-way data analysis

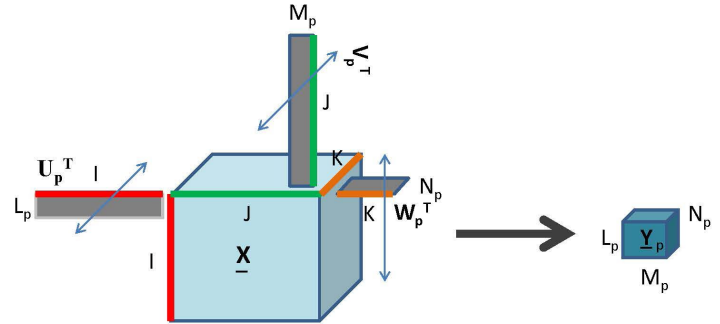
Two years ago, Prof. Nikos Sidiropoulos together with his students and colleagues (Carnegie Mellon University Profs. C. Faloutsos and T. Mitchell, and U of MN Computer Science and Engineering Prof. G. Karypis) embarked on a quest to harness big tensor data analysis to make sense out of huge volumes of data, commonly referred to as “Big Data.” Big Data has become both a blessing and a curse, as the ever-increasing quantities of information have brought significant challenges to scientific inquiry, namely in areas of computation, storage, and communication.

Sidiropoulos has more than 15 years of experience working with tensors—data structures like matrices but indexed by three or more indices instead of just two. Tensors may be thought of as data boxes in 3-D space, or hyper-boxes in higher-dimensional space.

In 2012, with funding from National Science Foundation (NSF), Sidiropoulos and his collaborators began exploring how to analyze big tensors that arise when using functional Magnetic Resonance Imaging (fMRI) to read the brain. The research involved use of fMRI to help determine which parts of the brain are activated by different key words spoken to the human research subject. Scientists wanted to be able to read an fMRI scan after the research session and be able to tell what kind of word was spoken when the scan was recorded. Sidiropoulos’s team also used their tensor dataset analysis in a similar way to aid computers to learn language concepts from Web crawling data.

“The challenge is to analyze big three-way (person-noun-voxel) and higher-way tensors, including time and folded (x,y,z) voxel coordinates to find the latent response structure that explains most of the data variation and to do so in a computation-, memory-, and communication-efficient way,” Sidiropoulos says. “This is no easy task because the tensor sizes that can be handled by traditional analysis software are only a tiny fraction of what we currently need to process Big Data.”

Upon successful completion of this research, the team will be better able to use higher-dimensional, contextual data that will be used



Compressing a big tensor down to a far smaller one for in-memory processing and analysis. The trick is to do it in a way that allows recovering the latent structure of the big tensor from the little one. This is the essence of Sidiropoulos’ multi-way compressed sensing approach.

to aid computers to “learn” language concepts and to apply them in real time. A computer that ‘makes sense’ out of complex human language will enable the computer user to weed through the seas of data on the Web. “Learning new concepts is natural for humans,” says Sidiropoulos, “but very challenging for a machine.”

Sidiropoulos has developed random compression algorithms that take big tensor data and reduce it to smaller sets of data. “The challenge is how to accomplish the reduction while guaranteeing that no essential information is lost in translation—that is, by analyzing the reduced data, it should be possible to obtain the same answer as if the full data were available,” he says. “We developed a generalization of compressed sensing ideas from the linear to the multi-linear regime.”

Whereas compressed sensing operates on vectors, Sidiropoulos’ multi-way compressed sensing operates on low-rank tensors, such as are used in recommender systems like movie-customer-context ratings. Using the contextual information in the third dimension (e.g., weekday or a weekend, alone or with friends) naturally yields a tensor data structure. “In the future, recommender systems will use sophisticated multi-dimensional context information to produce more accurate recommendations for market research and customer profiling,” Sidiropoulos says. “Our research will find good use in the next-generation recommender systems as well.” His U of MN colleague and collaborator Prof. G. Karypis is an expert in recommender systems and is helping with research on high performance computing aspects of this project.

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Minnesota Cup provides a chance to shine before potential investors

Since 2005, the Minnesota Cup, supported by the University of Minnesota, Wells Fargo, and the State of Minnesota, has provided a showcase for fledgling business ventures to pitch their business ideas to potential investors and to compete for cash prizes. In 2005, the first winner—HealthSimple, a developer of education tools for people with diabetes—sold its company to Johnson & Johnson in 2007. Since then, more than 1,100 businesses, entrepreneurs, and inventors have entered the competition that this year included six divisions: high-tech, life science and health IT, clean tech and energy, social entrepreneur, student and general. This summer 57 semifinalists were selected and paired with experience mentors to develop business plans and to face the final selection.

Signals is highlighting three projects from the 2013 competition: Eric Nelson - KidToPro, Muhammad Abdurrahman - Playtabase, and Andrew Frenz - Instapay.

KidToPro – Eric Nelson (EE'12), founder and director of coaching - Semifinalist



Left: (From left) Josh Kennedy, KidToPro Board of Director's member; Stuart Wainstock, Volunteer-Coach with KidToPro; and Eric Nelson, Founder of KidToPro.

Eric Nelson remembers his first U of MN Physics exam during freshman year; he failed it. "I graduated the top of my high school class, but I realized I that I wasn't prepared for the kind of work that was expected at the University level. It was going to take much more work on my part. I was miserable with that exam failure."

But his negative first exam experience was the inspiration four years later for Nelson's "KidToPro" idea that placed as a Minnesota Cup semi-finalist. "I realized that if I wasn't prepared for University, there were a lot of other students out there who were not prepared."

With KidToPro, high school students learn how to master a difficult craft and to exercise a valuable, professional skill in the context of a client relationship before they graduate from high school. "Creating something of real value to someone else inspires these students to give a better "best" effort, working towards a real mission with a rough roadmap for accomplishing it," Nelson says.

Nelson's goal is to dramatically increase the efficacy of young students' learning environments. "I would propose that 16 years of non-stop education is an inefficient and impractical investment of time for 21st century learners, regardless of age," he said. "We need to change our priorities and methods of assessment in public schools K-12 to reflect the priorities we all have in the world outside school. That's where KidToPro comes in."

Nelson, as an undergraduate, began zeroing in, not only the STEM skills gap, but also the low-income family gap. "I come from a low-income family, and I think most of us grow up with a different perception of what we can do, compared to those in higher income levels," he said. "I refer to it as the "prison of poverty" that fosters its own self-defeating beliefs, limitations, and behaviors from generation to generation. I want to break out of that mind prison and to tear

it apart for others. I want to tell students like me that 'you can do amazing stuff, but you must do hard work and provide high value to others.'"

During his early undergraduate experience, Nelson started a real estate sales practice with Keller Williams, learning the mindset required to achieve success, how to set real goals with real consequences, and how to exercise self-discipline to make cold calls and generate leads. He joined the U of MN Entrepreneurship Club. "At the meetings, we heard from working professionals about their accomplishments," he said. "It taught me to see beyond the present and into the future. It also helped me to build my professional network because I made sure to talk with each speaker after his or her presentation."

Nelson realized during junior year that he had been doing a lot of listening but not much hands-on work. He was frustrated. So he implemented an idea for a group called the Entrepreneurship Club (E-Team). "The E-Team comprised 4-6 students volunteering on a project for a local entrepreneurs," he said. "What we accomplished was doing real entrepreneurship, networking with professionals, and giving back to the community that gave us so much."

One of the presenters with whom Nelson had a special affinity, was Stacey Marmolejo, who offered E-Team its second challenge: help the School of Rock provide scholarships to low-income students. What resulted was the 501(c) 3 nonprofit Youth Music Education Foundation (YMEF). Fellow founders Seth Saeugling, Muhammed Abdurrahman, and Ryan Manteufel have each led YMEF as president.

After graduation, Nelson started his own business, as did his former classmates Ben Vanden Wymelenberg and Kevin Groenjes of Woodchuck, Billy Kaye of Connecttome, Parag Shah of Foodsby, and Muhammed Abdurrahman of Playtabase.

"The process took me through a 30-hour sleepless weekend of writing a business plan, going through all the contingency planning and options of different circumstances," Nelson said. He and his peers helped each other by critiquing each other's business plans.

Although KidToPro did not get voted to the next level in the Minnesota Cup the skills learned have already been paying off. Starting a Rally Funding project (one of the many social media crowd funding sources available on the Internet), KidToPro raised its first \$600 needed to create online learning technologies, scholarships and purchase of Raspberry-Pi computers with Google coders for its students participants. "We are now serving about 100 middle school students during the day at Venture Academy (a start-up charter school in Minneapolis) where KidToPro students are building Websites in HTML and CSS. KidToPro also is developing a mobile app to be used by two potential area schools and an after school program dedicated to service low-income high school students," he said.

To watch KidToPro's progress, go to (<http://www.kidtopro.com/>)



Students at Venture Academy write down all the HTML tags and CSS styling they've learned in the last week.

Playtabase – Muhammad Abdurrahman (Ph.D'13, Linguistics) creator and lead team member



Playtabase team members
From left, Chris Jaszewski (EE'13), Muhammed Abdurrahman (Ph.D.'2013 Linguistics), Al Baker (Econ'13), Druv Singh (EE senior), Dingyi Liu (EE senior), and Ahmed Daoud (EE/CE'11). Playtabase received an Honorable Mention in the Minnesota Cup.

“As a child, you see your dad as a something like a superhero. He’s strong, capable, and can reach everything,” says Muhammad Abdurrahman (Ph.D.’13, Linguistics). “After my father experienced multiple debilitating strokes, I watched as he lost control and mobility. I wanted to give him back his super powers and restore his independence.”

While conducting his Ph.D. research, Abdurrahman and his friends in Mechanical Engineering and Computer Science developed the first prototype of reemo™, a wrist-worn wearable remote controller designed to enable intuitive control of physical objects in the real world specifically household appliances through camera-free gesture alone.

Determined to push the solution forward after graduation, Abdurrahman built a talented team including seven members who understood sensors, PCB layouts, and hardware, as well as software debugging. During his recruiting effort, he received responses from alumni as far away as Boston and Silicon Valley. Playtabase™ added Druv P. Singh (EE senior), Dingyi Liu (EE senior), Ahmed H. Daoud (EE and CE ’11), Al Baker (Econ ’13), and Chris Jaszewski (EE’13) among others.

“Our goal for the reemo™ control system was to provide convenience for the user,” says Abdurrahman. “It has great value because it offers a unique and intuitive method of interacting with surrounding electronics. It’s a lot like pointing and clicking with a computer mouse, but for the real world.”

“This allows for interactions to be more intuitive; we are making the world more ‘clickable.’” Baker adds.

The company has registered its name and product: Playtabase™, the product is reemo™.

“We’ve done four prototype iterations, and we’re working on our fifth,” says Abdurrahman. “Most of our product testing involves strapping devices to our bodies and reading the data generated from movement. We’ve met with people who are elderly and people with disabilities as well as medical doctors to consider range of motion concerns, and the value of the characteristics of the product.”

One of the outcomes from the conversations was to make the device wearable. “We made it wearable because there’s a propensity for people to lose and drop remote controls,” Abdurrahman said. “Playtabase™ is made up of young people so everyone has a say in the fun factor of the product; we like it and our friends are excited to get it,”

Abdurrahman says, “Older and disabled people have told us they think our product will be a valuable solution for them as well. One of our supporters who uses a wheelchair and has a service dog, says she likes our system because she doesn’t have to feed or clean up after it as she does with her service dog.”

Playtabase™ has been fortunate to have the guidance of many mentors, chief among them being John Stavig of the Holmes Center for Entrepreneurship at Carlson School of Management. “I took his class for active entrepreneurs last fall, a few months after I started the company, and it helped push me to consider the business plan more deeply,” Abdurrahman says. “Other mentors, like ECE’s Prof. Paul Imbertson, who I know from my time on the Solar Vehicle Project, also have provided encouragement.”

The Minnesota Cup Competition helped Abdurrahman make contacts with additional mentors Darren Cotter and Drew Pearson who both helped the team tighten up its business plan. “I think becoming semi-finalists, and ultimately finalists (i.e. top 18/1,100 competitors) definitely draws increased interest to Playtabase™,” Abdurrahman says.

One of the interesting opportunities for Playtabase™ is that they’ve designed a product that’s useful and attractive to two very different markets, older adults and younger adults. “Older people and others with limited mobility can clearly benefit from the value of the product; however, they usually are not early adopters,” Abdurrahman says. “Fortunately, the super-power like effect our technology provides is very attractive to younger and middle-aged adults who are typically early adopters of new technology and are already investing in next-generation home control systems. The use of gestures is similar to the gaming interaction products like Wii but less exaggerated, so it’s very intuitive and exciting for young and old. This means we can enter the market selling to younger home owners and the like and there’s a long-term value for other generations once the technology becomes more commonplace,” Abdurrahman says.

“A transition phase of connected machines, the so called Internet of Things is coming, and involves new ways of controlling and interacting with appliances both “smart” and normal. Our reemo™ system is positioned well to facilitate this new era of machine control,” says Daoud who joined due to his passion for the dual benefit this application of new technology can bring to help lives while also being fun.

A third opportunity for the Playtabase™ team is the huge paradigm shift enabled by the explosion of wearable technology in the market place. Playtabase™ recently partnered with Dragon Innovation, an experienced manufacturing and shipping team with extensive capabilities in Chinese large scale manufacturing and previously helped high-tech products like the iRobot™ Roomba™ and the Pebble SmartWatch™. The Playtabase™ team is confident that their upcoming pre-sales campaign will accelerate exponentially and build awareness of the benefits of their system.

“We want to change the world, and we are actually doing it,” Abdurrahman says. “Soon you will be pointing and clicking your way through your environment. I wouldn’t want to be doing anything else.”

To watch how Playtabase™ will change the world, go to <http://playtabase.com/>

Minnesota Cup - continued on page 11

Alumnus Robert Demorest (EE'72) dedicated to helping people solve problems



Robert Demorest (EE'72)
President and
CEO of MOCON

What happens when a college student wants to pursue a field but a degree program doesn't exist? The student combines classes from a variety of programs, learns as much as he can, and graduates with a degree from one of the key programs.

What happens after a businesses' entrepreneur leader retires? The leader who follows must have a technical acumen of the product, an ability to communicate and educate, and the inherent knack to hire the right people for the next development steps.

Robert Demorest was the student and became the leader.

Robert Demorest (EE'72) carved out an education in biomedical engineering before it was a degree program at many universities. "I took my engineering classes, my physiology classes, and worked in the animal lab in Diehl Hall refining medical implants and stimulators," he said.

"The process then has the same importance as it does now...work hard, study hard, and stay focused to finish school and get your degree," he says. "Then get a job in your field of study. Taking a job with a small company has its advantages. There's a better chance to make a difference and the team is more likely to listen to your suggestions. A lot of innovation happens at the small company level. It's a good place to take risks—after all, in your 20s you shouldn't be looking for security yet."

Upon graduation, Robert was the first employee hired by Dr. Jerry Timm, one of four founders of the Mentor Corporation, a pioneer in urinary medical devices including bladder stimulators and incontinence control devices.

"It was my job to fabricate the electronic devices, as well as the electrodes needed," he says. "I participated in multiple human surgeries where I scrubbed up and coached the surgeons on placement and attachment of the devices into human bladders. These highly experimental procedures produced highly successful results. It was pretty heady stuff for a guy who was still in his 20s. Dr. Timm was a terrific guide and mentor to me during those early days."

After moving to MOCON, Inc., Robert developed a CO₂ gas cystemeter, a medical device that measures bladder function. By introducing carefully monitored gas into the bladder through a catheter, the gas cystemeter duplicates the sensation one would experience with a filling or full bladder. A healthy bladder will begin involuntary contractions when it "feels" full. But an unhealthy bladder does not produce contractions—a condition that can be life-threatening. With Robert's testing device, a physician easily makes a diagnosis in the clinic exam room, rather than sending a patient to the hospital for special testing.

In moving from the academic lab to industry, Robert says he was acutely aware of the fast pace and deadline adherence expected. "In academia, you work until you have results. In industry, bosses tell

you, 'We want this project completed by this date and the product in the marketplace by this date.' That's why teamwork is so important. It's everyone's responsibility—from design to shipping—to get it done."

Robert joined MOCON in 1974 as a design engineer. MOCON was initially a family business, started in 1966 by his father Les Demorest (BS'52 Physics). The company makes permeation measuring instrumentation for the foods, pharmacy, health care, medical device and electronics industries to ensure quality packaging and shelf life. MOCON went public in 1968 as Modern Controls, Inc., and today is listed on NASDAQ exchange as MOCO.

Robert moved on to sales at MOCON, combining his technical knowledge of products with his ability to easily explain the benefits of the technologies to customers. "It was a perfect fit for me and I really enjoyed it because I was helping people solve problems," he says. "MOCON provided unique products in the industry—not the 'me too' products. To date we have been awarded more than 80 patents and have connections and customers around the world."

Successes propelled Robert to Vice President of Sales and Marketing, then to President in 1995, and to Chief Executive Officer and Chairman of the Board in 2000. "My leadership style blends well with my engineering and sales background," he says. "It was difficult to buffalo me with technical jargon because I knew what they were talking about. I understood what we should be pursuing and not pursuing."

Vision and agility accompanied by long-term and short-term strategies are necessary in industry. "From 'how are we doing' and 'what needs fixing' to 'where are we going to be in five years'—it all must be addressed by leadership," he says. "We live in a time of rapidly changing technology and a company must be flexible in adapting. One cannot be too complacent—a little paranoia is good. Asking the question 'What can our competition do tomorrow that could hurt us' has to be on one's mind. It's a battlefield of anticipation and making the right decision to effect success. Innovation comes from being on the offensive."

Robert's excitement for the business and making things happen led to three industry acquisitions in 2001, 2004, and 2012. Under his leadership from 2000 to present, the company saw a 400 percent increase in revenues. The company now achieves an annual \$55 million in sales, employs 250 staff members (100 of whom are in Europe) and serves worldwide markets. In 2010, MOCON received the Governor's International Trade Award, a Minnesota Trade Office honor, for advancing global trade, developing novel ideas, and expanding the local workforce. In 2006, MOCON received the prestigious Techné Award, which recognized it as one of Minnesota's leading technology companies.

"I am proud that our company is growing and that I have been able to create more jobs for people. In spite of changes in technology, our core values and methodology keep our management process strong."

The biggest challenge facing MOCON and other industries is data analysis—how to get big data to reveal relevant information for decision-making demands. "From distribution statistics and specificity of production values to customer preferences, data must be analyzed to guide business decisions. It's going to take a lot of sophisticated software programs to accomplish that," he says.

Demorest continued on page 11

Crossing Australia, Daedalus finishes in fourth place in the 2013 Bridgestone World Solar Challenge—Cruiser Class

Logging 3,000 kilometers (1,864 miles) across the Australian Outback, Daedalus, the University of Minnesota Solar Vehicle Project, finished in fourth place in the Cruiser Class of the 2013 Bridgestone World Solar Challenge. Daedalus, is the first-ever two-seater design that balances practicality with efficiency. The University team competed in a new Cruiser Class where practicality, not speed, was the goal. This year, the team's car included a few comfort features such as a stereo and actual car seats.

From Oct. 6 to 13, the University team raced from Darwin south to Adelaide and arrived to applause by teams and spectators as they crossed the official finish line.

While traveling along their route on the Stuart Highway, the team encountered wild kangaroos, night time wind storms, beautiful scenery, and a clear view of the Milky Way in the night sky. They had their share of problems as all the teams experienced – a flat tire, fine tuning of the engine. All in all, traveling first through the desert in the north to the cold, windswept plains of the south, Daedalus fared well.

In addition, Daedalus was the only car to use completely student-designed and built motors and motor controllers. The car's two motors have a combined total of about 42 horsepower and can reach a top speed of about 90 miles per hour. During the competition, the team was required to follow the road's speed limit, which is 120 kilometers per hour or about 75 miles per hour.

The University of Minnesota was among 10 teams from around the world competing in the Cruiser Class and more than 45 teams competing in all classes of the World Solar Challenge.

More than 30 University of Minnesota College of Science and Engineering students are part of the current team and 15 were part



2013 U of MN Solar Car - Daedalus

of the race crew. Team members estimate that they've collectively spent more than 30,000 hours over the last 10 months planning and building the solar car.

In addition to significant support from the University's College of Science and Engineering and several academic departments, the U of M's solar car was funded through cash and in-kind donations of parts and materials from more than 50 local and national companies.

The University of Minnesota Solar Vehicle Project (UMNSVP) team has a history of success. The team won first place at the 2011 American Solar Challenge's Formula Sun Grand Prix track race at the Indianapolis Motor Speedway and finished fifth overall in the 2012 American Solar Challenge. UMNSVP was founded by a group of undergraduates in the Institute of Technology in 1991.

For more photos, go to : <http://www.umnsvp.org/>

C-SPIN Hosts NVMTS 2013 International Conference

A total of 97 participants from three continents and 10 countries attended the 2013 Non-Volatile Memory Technology Symposium (NVMTS 2013) held Aug. 12-14, 2013, at the University of Minnesota. Organized and sponsored by the Center for Spintronic Materials, Interfaces and New Architectures (C-SPIN, www.cspin.umn.edu), the symposium focused on both emerging and existing non-volatile memory technologies.

The symposium included a technical program with three keynote speakers, 41 invited talks, and 27 poster presentations from leading academic and industry research groups. Topics included different non-volatile memory technologies and materials ranging from emerging STT-MRAM to RRAM, FeRAM, PCRAM, and new memory concepts and materials such as memory in logic.

The following students received awards for their work:

Angeline Klemm, University of Minnesota – Best Poster in Non-Volatile Memory Technologies for “Spin Transfer Torque Programming and Clock Field Effects for Dipole Coupled Nanomagnetic Arrays”

Xiang Yan, University of Pennsylvania – Best Poster in Non-Volatile Memory Technologies for “Voltage-Time Invariance in Nanometallic R-Ram”

Jin-Won Jung, Tohoku University – Best Poster in Non-Volatile Memory Materials for “Experimental Confirmation of Spin Filtering Interface-Resistance”

Ruomeng Huang, University of Southampton – Power and Travel Award for “Determination of Specific Contact Resistance of Ge₂Sb₂Te₅ Phase Change Materials by Spacer Etched Nanowires”

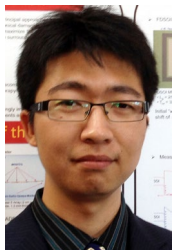
Students



Ph.D. student **Angeline Klemm**, was selected to attend the Sixth IEEE Magnetics Society Summer School in Assisi, Italy, and while there received a Best Poster Award, one of six awardees out of 90 participants from around the world. Her title was “Integration of a Spintronic Interface with Nanomagnetic Arrays and Clock Field Effect.” (Prof. Jian-Ping Wang, advisor)



Ph.D. student **Sohini Roychowdhury** received a Best Poster Award for her “Screening Fundus Images for Diabetic Retinopathy” at the 2013 U of MN Institute of Engineering and Medicine (IEM) Conference and Retreat Poster Session. From 115 posters across five themes, her work was judged the best in the Medical and Biomedical Imaging Theme. (Prof. Keshab Parhi, advisor)



Ph.D. student **Yulong Li** received a Best Poster Award for “Ultrasmall Dosimeters for In Vivo Radiation Cancer Therapy” at the 2013 U of MN Institute of Engineering and Medicine (IEM) Conference and Retreat Poster Session. From 115 posters across five themes, his work was judged one of two best in the Medical Devices Theme. (Prof. Steve Koester, advisor)

Faculty



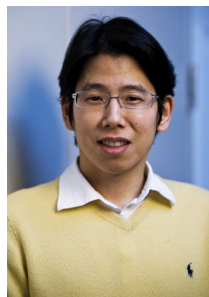
Prof. Massoud Amin received the University of Massachusetts-Amherst 2013 College of Engineering Outstanding Senior Alumnus Award on Oct. 19, where he received his BS and MS in Electrical and Computer Engineering in 1982 and 1985, respectively. In June 2013, Prof. Amin was elected to the Board of Trustees of his alma mater in Cornwall-on-Hudson, NY. Amin’s article “What will it take to build a real smart grid” appeared in *Nature*, *Popular Mechanics*, *Bloomberg News*, and was broadcast on NPR’s “Science Friday,” WNYC News, Minnesota Broadcasters Association quarterly meeting, “Access Minnesota,” Associated Press, “HuffPost Live,” WBEZ Chicago, Power-Technology.com, and FOXBusiness. Amin also was a member of the advisory panel to the film “Electropolis” sponsored by National Geographic and General Electric.



Prof. Rhonda R. Franklin was promoted from Associate to Full Professor, effective fall 2013.



Prof. Ramesh Harjani provided the keynote talk at the IEEE International Midwest Symposium on Circuits and Systems, Aug. 6 in Columbus, Ohio. The title of his talk was “Efficient Power Management Using Fully Integrated DC-DC Converters.” Harjani also provided a keynote talk at the IEEE 10th International Conference on ASIC on Oct. 30 in Shenzhen, China. His topic was “Low Power RF Circuits for Broadband Signals.”



Prof. Chris Kim and his research team (Bongjin Kim and Weichao Xu) won the ISLPED Low Power Design Contest. They presented their research titled “An Adaptive PLL in 32nm SOI for Optimal Processor Power and Performance under Resonant Supply Noise” at the ISLPED Conference. The new phase-locked-loop (PLL) circuit Kim demonstrated in 32 nm basically allows a microprocessor to operate at its peak energy-efficiency point across a wide voltage and temperature range. In addition, *Circuit Cellar Magazine* invited Kim to write an article about the future of VLSI technology. The article appeared in *Circuit Cellar*’s August 2013 issue.



Prof. Steven Koester’s “Artificial Pancreas” research received a Minnesota Partnership Discovery Transformation Grant. The research involves creating a system of automated insulin delivery through continual monitoring of blood glucose. Koester and his co-principal investigator Yogish Kudva, M.D., Mayo Clinic, are developing a graphene-based wireless sensor that can be placed in blood vessels for accurate monitoring of blood glucose levels.



Prof. Mo Li’s group received a grant from the National Science Foundation to develop the next generation opto-electrical neural probes for multimodal interrogation of brain activity. The work will be a collaboration with Prof. Sotiris Masmanidis in the Department of Neurobiology at UCLA. The new probe will integrate large arrays of nanophotonic waveguides and microelectrodes to achieve active control and readout of neural activities. On these probes, the waveguides will emit light pulses to selectively activate or silence a local, optically excitable neuronal population, while the microelectrodes will record the network activity resulting from this stimulation. The research aims to provide neuroscientists with a powerful new tool to decipher the neural-circuitry of behavior, leveraging recent advances in optogenetic techniques.



Prof. Sang Hyun Oh, Dr. Jincy Jose, and their research team's work was featured as a cover article in *Advanced Functional Materials*. They reported using template stripping to create embedded plasmonic nanodisks that can generate tunable plasmonic fields on ultraflat surfaces. The embedded nanodisks are topographically flat and capped with a silica layer to form a laterally homogeneous and biocompatible substrate. The nanoplasmonic architecture hidden underneath creates a tunable plasmonic landscape. Nanostructures also can be embedded in elastomeric materials, which can be peeled off the substrate to create flexible plasmonic membranes that conform to nonplanar surfaces.



Prof. Keshab Parhi received the 2013 Distinguished Alumnus Award from Indian Institute of Technology (IIT), Kharagpur, India. Parhi received his Bachelor of Technology degree in 1982 from IIT. The award was presented at the 59th Convocation on July 27, 2013.



Prof. Murti Salapaka has been appointed to the Vincentine Hermes-Luh Chair in Electrical and Computer Engineering recognizing his extensive contributions to control systems and their applications to nanotechnology.



Prof. Sachin Sapatnekar received a 2013-2014 Fulbright Senior Researcher Award and will be visiting the Universitat Politècnica de Catalunya (UPC) in Barcelona, Spain during 2013-14 to work on research in electronic design automation.



Prof. Jian-Ping Wang and his former students Shihai He, Ying Jing and Hao Wang formed a startup company called Universal Magnetic Systems, LLC (UMS) which will produce multifunctional high magnetic moment and smart magnetic nanoparticles for early disease detection and diagnostic target separation. UMS is focused on scaling up production of those magnetic nanoparticles for life sciences applications. The UMS CEO and co-founder is an ECE alumnus Mr. Claire Hovland.

Alumni



Dr. Hongliang Chang (Ph.D.'05) and ECE Prof. Sachin Sapatnekar's paper "Statistical Timing Analysis Considering Spatial Correlations Using a Single PERT-like Traversal" published at the 2003 International Conference on Computer Aided Design (ICCAD) has won the Ten-Year Most Influential Paper Award by the ICCAD. The award was presented at the ICCAD 2013, Nov. 18 in San Jose, Calif.



Bodhisatwa Sadhu (Ph.D.'12), post-doctoral researcher at IBM's T.J. Watson Research Center, is the author of the top paper downloaded from the IEEE Journal of Solid-State Circuits in May 2013. His paper, "A linearized, low-phase-noise VCO-based 25-GHz PLL with autonomic biasing" was done in collaboration with IBM Yorktown and Carnegie Mellon University, and funded by DARPA. (Prof. Ramesh Harjani, Ph.D. advisor)

Former ECE Faculty



Former ECE Prof. Pramod P. Khargonekar was named assistant director for the Directorate of Engineering (ENG) at the National Science Foundation (NSF) beginning March 2013. Khargonekar leads the ENG directorate with an annual budget of more than \$800 million. ENG invests in frontier engineering research and education, cultivates an innovation ecosystem, and develops the next generation engineer.

Khargonekar was the deputy director for technology at the U.S. Department of Energy's Advanced Research Projects Agency – Energy (ARPA-E) and the Eckis Professor of Electrical and Computer Engineering at the University of Florida, a position he held since 2001 and one he retains while at NSF.

Khargonekar has received many awards and honors, including the IEEE Baker Prize, the American Automatic Control Council's Donald Eckman Award, the Indian Institute of Technology's Distinguished Alumnus Award, and the Web of Science Highly Cited Researcher. He is a Fellow of IEEE.

U of MN IEEE Student Branch hosts first three-day conference



The surveys are tabulated, the ratings are in – the Region 4 IEEE Student Conference, hosted by the University of Minnesota IEEE student group, received high marks. Attendees from 18 universities enjoyed multiple venues around the Twin

Cities Campus, a variety of activities, and, as one attendee stated, “excessively good food.”

The abundant networking opportunities were viewed as the most positive outcome of the event. One student who is completing his Master’s degree decided to apply for his Ph.D. at the University of Minnesota because of the impressions made during the conference.

“This is the first time the regional conference was held in Minneapolis,” said Essam Elnashar, IEEE Student Branch Board Chair, who learned in early July that IEEE U of MN won the bid to host the conference in October. “With only three months to accomplish every detail and a newly-elected board, we realized we needed to get the sponsorships lined up immediately, followed by publicizing the conference. Conferences in the past had been small and low key. This year, we decided to take it to the next level.”

The team devoted excessive hours but said they learned how to organize such an event—a good skill to have. “Sacrifices were made,” says Elnashar.

“This was the first three-day student conference to be offered and we filled the schedule with keynote speakers, multiple competitions, and a project showcase,” said Amith Abraham, IEEE student board member. “We really wanted to showcase the University of Minnesota and our research faculty.”

Technological Leadership Institute (TLI) Profs. Kirk Froggatt and Massoud Amin provided morning and evening keynote presentations, respectively. Breakout session presenters included ECE Profs. James Leger (IEEE Student group advisor), Steve Koester, Marc Riedel, and Beth Stadler, CS&E Prof. Nikolaos Papanikolopoulos, and TLI Prof. Steven Webster. Industry representatives also provided break out sessions: Dr. Greg Mowry from the University of St. Thomas and Dr. Per Danzl of Eaton Corp.

Breakout sessions and competitions as well as the dining events were held around the U of MN Twin Cities Campus in the SSTS classroom center, McNamara Alumni Center, TCF Stadium Club Room, and Keller Hall (home to the Electrical and Computer Engineering (ECE) and Computer Science and Engineering (CS&E) Departments.)

Region 4 IEEE Student Conference sponsors

Platinum – Xcel Energy-Nuclear Division

Gold – Medtronic

Silver – Schlumberger, ETC Aerospace, Emerson Process Management

The College of Science and Engineering and the Department of Electrical Engineering rounded out the financial supporters.

Competition winners

Project Showcase

- First - Matthew Lewis, University of Minnesota
- Second - Samer Koda, East Michigan University
- Third - Anthony Shvets, University of Illinois – Urbana Champaign

MicroMouse Competition (Robotic mouse in maze)



St. Cloud State Team
Micromouse First Place

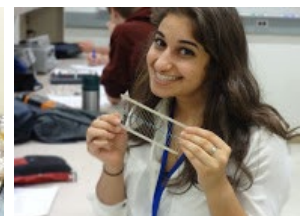
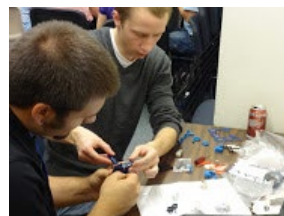
- First - St. Cloud State University - Anil Shah, Anil Timilsina, Matthew Varas, Derek Worcester
- Second - University of Wisconsin-Stout - Lindsay Hintz, John Kalafut, Joshua Miller, Michelle Miller
- Third – University of Illinois –Urbana/Champaign and North Dakota State University - Jesse Braun, Braven Leung, Parker Pavlicek, Shugo Tanaka)

Brown Bag Competition (Electronic parts to use in construction)

- First - Illinois Institute of Technology - Rohit Agarwal, Alejandra Rodriguez
- Second - University of Minnesota - Kevin Bontrager, Luke Everson, Alex Lemaire
- Third - University of Northern Iowa - Colby Easterday, Corey Eichelberger; East Michigan University - Mohammed Esmaeili; and University of Minnesota - Samuel Massman

Ethics Competition

- First – Dordt College - Craig Disselkoen, John Stam
- Second - University of Wisconsin-Stout - Alex Hanke, Jacob Hipke, Matt Petschel
- Third – St. Ambrose University - Willie Burpo, Joseph Chatman, Kathleen Franger



Sidiropoulos continued from page 1

The research is getting noticed. Owing to its significance and its applications towards tackling the complexity of language processing and methods to approximate how the human brain works in processing language, this project was highlighted during Assistant Director of CISE Directorate of NSF Dr. Farnam Jahanian’s testimony to the United State Congress. In addition, in May, Sidiropoulos was invited by the Office of Science and Technology Policy and NITRD to participate in a White House Big Data Workshop.

In his University research lab, Sidiropoulos and his students also are studying robust preference measurement tools for analyzing consumer behavior with particular attention paid to modeling and spotting inconsistencies and outliers. As part of the Presidential Initiative on Enhanced Access to Radio Spectrum (EARS), Sidiropoulos’s other research thrust is focused on efficient crowd-sourced power spectrum sensing strategies using smart phones and featuring very low-rate communication, as well as cognitive beam-forming and scheduling for next generation wireless networks.

Mark S. Lundstrom (BEE'73, MSEE '74) named U of MN OAA recipient

Lundstrom received his Outstanding Achievement Award at the Annual College of Science and Engineering's Leadership Banquet held Nov. 7.

Mark Lundstrom began his outstanding career at the University of Minnesota graduating with a BEE in 1973 and an MSEE in 1974. He completed his Ph.D. from Purdue University, West Lafayette Campus in 1980. Currently, he is Purdue University's Don and Carol Scifres Distinguished Professor, an award given for leadership in microelectronics and nanoelectronics through research, innovative education and unique applications of cyber infrastructure. He was the founding director of the NSF Network for Computational Nanotechnology (NCN) and currently leads the NCN's efforts in electronics. Lundstrom's area of specialization is semiconductor device physics, modeling, and simulation with a focus on the physics and limits of nanotransistors.

"I remember a talk Mark gave in the mid-1990s about the limits of CMOS scaling," Minnesota Nano Center Director and Bordeaux Chair of ECE Prof. Steve Campbell says. "His interpretation recast the problem at its most fundamental and proved to be correct. His observation, that the distribution of electron energies make turning the transistor off difficult for low voltage swing, were borne out over the next fifteen years. The semiconductor industry continues to be unable to solve the basic problem he identified that afternoon. Since that time, I have seen Mark give several talks on aspects of different semiconductor devices. He consistently maintains his objective analysis of device approaches based by a deep insight of semiconductor physics, backed up by sophisticated device modeling."

In 1994, Lundstrom co-founded (with Ph.D. student Nirav Kapadia and Prof. Jose Fortes) the PUNCH project, an early example of cloud computing, designed to share computational tools via the Web providing online micro and nanoelectronics simulation services for research and education. Their work led to the NSF-funded NCN at Purdue and ultimately to nanoHUB.org, which now serves a nanotechnology community of more than 300,000 users worldwide. This center provides user-friendly front ends to dozens of complex device simulation codes and makes the software available through the Web. More than 800 authors have contributed more than 3,000 content items to this global nanotechnology user facility. All one needs is a Web browser to use most of the software.

As Lundstrom's colleague and current Director of the Network for Computation Nanotechnology, Gerhard Klimeck, says, "Mark had initiated a solution that could engage all scientific application developers with a solution to deploy their codes without any rewrite...today's nanoHUB fully embraces that concept."

Lundstrom is a member of the U.S. National Academy of Engineers (2009), Fellow of the Institute of Electrical and Electronic Engineers (IEEE) (2006), the American Physical Society (APS) (2000) and the American Association for the Advancement of Science (AAAS) (2006). Lundstrom's research has been



**University of Minnesota
Outstanding Achievement Award Recipient
Mark S. Lundstrom**

recognized by the IEEE Cleo Brunetti Award (2002), the SRC's Technical Excellence Award (2002), and the Semiconductor Industry Association's University Researcher Award (2005). His contributions to education have been recognized by the American Society of Engineering Education's Frederick Emmons Terman Award (1993), the IEEE Electronic Devices Society Education Award (2006), the SRC's Aristotle Award (2010) and Purdue's own A.A. Potter Best Teacher Award (1996) and D.D. Ewing Best Teacher Award (1995). Most significant to Lundstrom was his selection as the 2009 recipient of the Aldert van der Ziel award, which recognizes a career of distinguished contributions to research and education and is named in honor Prof. van der Ziel's long and distinguished career at the University of Minnesota.

Besides his substantial research and teaching accomplishments, Lundstrom is a prolific author. His books include *Fundamentals of Carrier Transport* (second edition, Cambridge, 2000), *Nanoscale Transistors* with Jing Guo, and *Near-Equilibrium Transport* with Changwook Jeong. According to Phaeton Avouris, IBM Fellow and Manager of IBM's Nanoscience and Nano Technology and Lundstrom's colleague says, "His book *Fundamentals of Carrier Transport* is one of the most highly regarded treatises on the subject." Lundstrom's most cited publications are on the scaling limits of silicon transistors and on the physics of carbon nanotube transistors. He has served as advisor to 25 doctoral dissertation advisees, including former University of Minnesota Provost Chris Maziar.

Currently, Lundstrom is spearheading the nanoHUB-U initiative, which brings the new insights and understanding gained from research in nanoelectronics to an online audience of students and working engineers across the globe.

Innovative Engineers and the U of MN establish education-sharing opportunities in Nicaragua



U of MN Eric Lee (left) and INATEC students work together to construct a micro-hydro turbine.

During ten days in August, ECE Prof. Paul Imbertson, ECE senior Alejandro Ojeda Saint-Martin, and ECE freshmen Steven Maurer and Eric Lee visited Nicaragua to accomplish hands-on engineering, teaching, and networking to strengthen relationships, establish a continuity of services for the projects begun by Innovative Engineers, as well as create plans for new projects.

“We were able to establish a partnership with two universities – Universidad Nacional de Ingeniera (UNI) in Managua and Universidad Tecnologica La Salle (ULSA) in Leon,” Ojeda Saint Martin says. “We will integrate their students so that work will continue on the current La Hermita Wind Turbine Project when U of MN students return to Minnesota. Instrumental to the new partnerships was Mario Aleman who is a local industry business owner and friend of the U of MN for a number of years.

First item on the agenda when the team arrived was to make repairs to the wind turbine in La Hermita. (“Innovative Engineers Expands its Focus,” *Signals*, 2011 Fall, Vol XI, Issue 2.)

“We learned in March that the turbine had stopped working and we were anxious to get it fixed,” says Ojeda Saint Martin. “We went to the site and did an assessment realizing that extensive repairs would need to be made. We took the hardware back to Managua and brought them to INATEC.”



A La Hermita village child tests voltage output with help of Prof. Paul Imbertson.

INATEC is a technical school with whom Imbertson’s team had worked in the past. INATEC and U of MN students worked together to re-solder connections and to repair components.

Upon returning to the site and reinstalling the components, the team found the cause of the problem. Due to the strong winds, the

turbine had been spinning too fast (up to 300 rpms) and overpowering the tower. The team spent the third day cutting the blades to smaller lengths, testing and retesting, and installing an emergency shut off switch—a critically-needed safety feature. Prior to the switch, the villagers were using a stick to stop the turbine blades.

“It should be ok for another eight months,” Ojeda Saint Martin says. “Thanks to our agreements made in Managua, someone from the Nicaraguan University or from INATEC will be checking on the project frequently. This is good because we had no one in the past to check on things.”

The U of MN has a Memorandum of Agreement with UNI to collaborate in academic projects, renewable energy, and societal projects. Prof. Virginia Moncada from the Electrical Engineering Department at UNI says her students are looking forward to working with the U of MN students.

Next steps will be to establish new goals about the current project as well as establishing new projects that will be added to the Nicaraguan universities’ curricula. “It will be a win-win for the students because they will have more involvement in hands-on engineering projects while gaining academic credit for their efforts,” Ojeda Saint Martin says.



Local La Hermita student built a model of the wind turbine.

With plans laid and partnerships ready, Innovative Engineers is recruiting new members to its on campus organization. “We will need more students now to continue plans into the future,” says Ojeda Saint Martin.

For more information: <http://www.innovative-engineers.org/>

ECE students and Circle of Life Academy team up to build 1K turbine

From the 2013-2014 academic year, ECE senior Alejandro Ojeda Saint Martin will conduct a directed research project on the White Earth Indian Reservation with students of the Circle of Life Academy’s STEM project in renewable energy.

“We’ve establish a plan to drive to the reservation one to two times per month and work with Circle of Life Academy Science Teacher Michael Bunker. We will provide STEM education enhancement sessions at no cost to the students who will receive certificates for their participation,” Ojeda Saint Martin says. The Academy hosts 120 K-12 students who will have the opportunity to work with U of MN students, some of whom are members of Innovative Engineers.

The trend toward miniaturization will be a boon in the gas detection realm. "Making things smaller will enable better worker safety," he says. "Detection devices that may be worn comfortably will provide immediate safety information to the wearer."

Food safety will be enhanced with the increased speed and sensitivity of testing. "For our business, providing quick test results of detected pathogens such as *E-coli*, *Salmonella*, and *Listeria* will mean that fewer people get ill," he said. "It's imperative that increased sensitivity be a goal. With detection of minute parts per billion rather than per million, we will be able to react more quickly."

One of MOCON's newest products tests the purity of carbon dioxide (CO₂) in carbonated beverages. As companies expand to

overseas markets, the quality of local waters and CO₂ can be questionable. MOCON's product will be able to detect dangerous contaminants in the low parts per billion range.

Special U of MN Note

Many in the Demorest Family are graduates of the University of Minnesota. In addition to Robert and his father, Robert's son received a Ph.D. in 2011 in Molecular Biology, and his daughter received a Master of Science in English as a Second Language in 2011 and teaches in the Minneapolis Schools. Robert's wife has a BA in Art and his sister has a Ph.D. in Political Science and is a professor at the University of Minnesota – Morris.

Minnesota Cup - continued from page 3

Instapay –

Andrew Frenz and A. J. Larson create a time-saving app for restaurant patrons



Andrew Frenz
(CompE'08)

Have you ever been stuck waiting too long for the check at a restaurant? Minnesota Cup semi-finalist entrepreneurs Andrew Frenz (CompE'08) and A. J. Larson (CompE'06, MSEE'11) are the creators of Instapay – a new mobile app that lets you pay your bill at a restaurant as soon as you are ready to go. "We've been testing it in the market for six months and filed our provisional patent in January," says Frenz.



A. J. Larson
(CompE'06,
MSEE'11)

Frenz and Larson are testing Instapay with two restaurants in Minneapolis – The Local and Devil's Advocate. Integrated into the restaurants' Point of Sale (POS) system, the application eliminates the need to wait for a busy server to bring the bill. Or, when one is eating with others, it eliminates the need to wait for a group bill to be divided into individual tickets.

Instead, customers can see their bill right on their phone, split it with friends, and pay immediately via PayPal or a credit card.

Frenz and Larson entered the Minnesota Cup competition as a way to put their product in front of the local business community, to get helpful feedback, and to network with other entrepreneurs. Frenz and Larson encourage current ECE students to consider participating in the Minnesota Cup.

Of the business plan step Frenz says, "This step enables participants to work with industry mentors. Our mentors were instrumental in focusing our thinking about our message—the story we had to tell—to be clear and concise when selling our brand."

"Through our mentors' guidance, we learned to identify where the "pain point" is most severe and focus on solving that problem," says Larson. "One of our mentors had extensive experience in the restaurant industry and helped us quantify our return on investment to the restaurant owner and to the customer."

"Real customers and real servers are using the app," says Frenz. "We've worked closely with the restaurant owners to ensure our solution is compelling to the restaurant as well as the customer. So far, they are pleased because it helps them turn tables faster and provide better customer service, especially during busy lunch hours."

"The pilots have allowed us to try things and figure out what connects with people and what doesn't," Larson says. "Everyone agrees there should be an easier way to pay than waiting for the check, giving your card to a stranger, and then waiting for your card to be swiped and returned. The question is how best to solve the problem. We believe the best solution is to leverage the mobile technology that people already have in their pocket." The app currently runs on iOS and Android.

"As our product continues to evolve, each milestone we hit gives us confidence that we are headed on the right path," says Frenz. "The Apple app store already has several five star reviews: 'I love it. I love the simplicity. It makes paying a lot easier. I would eat out more often if every restaurant had this!' and, 'I've been waiting for an app like this!'"

For more information about Instapay: go to: <http://InstapayApp.com>.



Department of Electrical and Computer Engineering
University of Minnesota
200 Union Street SE, 4-174 Keller Hall
Minneapolis, MN 55455

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December

ECE Colloquium in 3-210 Keller Hall Annex (www.ece.umn.edu)
Thurs., Dec. 5, 4 p.m. Prof. David Dunlap - University of New Mexico



Join us for the ECE Senior Design Show

Tues. Dec. 10
2 - 4:30 p.m.
Coffman Memorial Union, Great Hall
University of Minnesota - Twin Cities Campus

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David J. Lilja
Department Head

Paula J. Beck
Editor

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