

SIGNALS

Department of Electrical and Computer Engineering
Spring 2015, Vol. XIV, Issue 3

Note from the department head



Spring just ended in Minnesota, and we have transitioned to summer. One of the most enjoyable transitions for me each year is the college's commencement ceremony. I have had the opportunity to attend about ten commencements as a representative of the department. After each of these events, I come away feeling more energized and optimistic about what is yet to come as I see the tremendous accomplishments of our graduating seniors and the obvious joy of their friends and family. Our future is being passed into good hands.

This is also a time of transition for the department's leadership. The last day of my term as head of the department was June 30. It has been an honor and a privilege to lead our outstanding faculty, staff, and students for the past ten years. Thanks to the hard work, commitment, and dedication of many people the department is in great shape, making this a good time for me to pass the reins on to someone else. I am excited to return to those activities which originally drew me to a career as a professor—teaching and research—and to have time again to work more closely with our students.

Professor Randall Victora has been chosen by Dean Steven Crouch to serve as our next department head. Professor Victora is a long-time member of the department who specializes in the theory and modeling of magnetic materials. He has received numerous awards for his research, is a Fellow of the IEEE and the American Physical Society, has served as the President of the IEEE Magnetics society, and has served as the department's Director of Graduate Studies for several years. I know that he will bring a fresh perspective to the department's administration, and will lead us to even greater success and prominence.

I end my final column in this newsletter with a special thank you to our alumni, friends, and supporters for your generous contributions over many years. Your support has been critical to giving our students exciting new opportunities, and that extra edge to push us all from very good to excellent. One of the real pleasures of this job has been getting to know so many of you personally. Thank you.

David J. Lilja
Louis J. Schnell Professor

The Internet of Things: a local perspective

ECE and Keller Hall play host to IoT Fuse 2015

March was an exciting month for the Department of Electrical and Computer Engineering (ECE). Keller Hall, where the department is housed, played host to a one-day conference titled IoT Fuse 2015 on the Internet of Things on March 19, 2015. It was organized by the IoT Minneapolis Meetup group and presented some lively conversations that gave us an insight into what lies ahead in a connected world. Patrick Delaney, an ECE alumnus, was one of the organizers of the conference, and we had the opportunity to ask him some questions after the event. Here is what he had to say about his interest in IoT, the key points of the conference, and the road ahead:

Tell us about your interest in IoT. When were the seeds of interest first planted?

I have had a wonderful time building my two businesses, particularly my second one, designing and manufacturing LED solar lamps. I am fascinated with the concept of being able to work with and design new gadgets, as I am sure many people within this space are. I started working with network-connected gadgets as far back as 2011, when I began developing connected solar products. However at the time the phrase, “Internet of Things,” had not yet hit mainstream. I think the phrase “Internet of Things,” went from the “Buddy Holly,” level of popularity to the “Elvis,” level of popularity some time last year. I became acquainted with some semiconductor devices, which were specifically marketed toward industrial Internet of Things applications, and started to notice the word pop up in the news more and more. Large companies such as CISCO started to put a lot of marketing dollars into the phrase, and people unaffiliated with the tech world started to refer to it. That’s the point at which I decided to start a Meetup.com group here in the Twin Cities around the concept; it became something to rally people around.

How has your interest in IoT evolved over the years?

The Internet of Things is not a real thing; it’s just a conceptualization. It’s a way to get people together around a topic. There are certain technology areas which are associated with it such as wireless connectivity, distributed computing enabled by cheaper processors, big data tools and analytics, as well as the emergence of rapid development, prototyping and agile software methods. That being said, we are living in very exciting technological times in which the edge of the internet can potentially be pushed further out via cheaper, smaller devices. Thus, my approach has been to look at the conceptualization as a “group,” i.e. the truth about the “Internet of Things,” is pluralistic. There are different perspectives from different industries, which help inform each other as a whole. That being said, as an electrical engineer I have been pushing myself very hard (re)learning to code. The basic

skills I learned in C++ and MATLAB back at the University of Minnesota have proved to become more relevant over time as I go forward learning Java, Python, and start to understand more about software architecture.

How is the MN tech industry poised to participate in the Internet of Things?

From a historical-cultural perspective, Minnesota is very well positioned—we were the first place to realize commercialized networking with the advent of Engineering Research Associates and Control Data Corporation. Adapting hardware for computing and networking is in our DNA—we are arguably the strongest Midwestern state by far in this area and have been for over half a century. The Information Technology and Innovation Foundation have ranked Minnesota as the second highest performing tech state in the nation after Massachusetts. We have over 400 different software companies, particularly within the mobile space, which is arguably the first wave of the Internet of Things. We also have a vast, diverse industrial base. So overall, I believe that as long as we can continue to learn to collaborate and listen to each other, to manage the vast technological challenges associated with bringing connectivity to physical things, we will continue to be one of the leading states, if not the leading state in this area. Of course we are not an island, and will work with many different parts of the world to make this happen. The world is faced with managing a whole new type of IT architectural challenge, we will be a significant contributor because of our technological talent, but also because we are a Midwestern state, where we live and interact with all sorts of industries and “things,” out there in the real world which can be transformed with the power of distributed computing and wireless connectivity.

[Details on the ranking are available here:

<http://www.govtech.com/state/Top-Tech-States-Ranked-in-New-Economic-Report.html>]

What is the IoT Minneapolis Meetup group about?

Within the theme of collaborative learning @iotmpls was formed as a way to bring people together so that we can learn from each other and try to take in different perspectives about how we see the present state of technology shaping up in various industries. It’s like the story of the six blind men: one goes out and says, “Hey, I think this is a rope,” the next goes out and says, “No, it’s a pillar,” the next goes out and says, “No, it’s a wall.” Turns out, they were all right in their own way—they were looking at an elephant, feeling the trunk, leg, and belly. This is a type of technological phenomenon and age where it is beneficial to take in different perspectives on the subject and try to imagine a better world. So each month, we pick a different industry or technological vertical, and bring in real people, folks who live and breathe Internet of Things—either they started a business that harnesses a certain form

of connected device, or they are a hacker or researcher with an incredible depth of knowledge on a particular subject, such as “open hardware,” or “remote monitoring of biosensors.” Each person gives a 5-10 minute talk, and then we open up to the audience for questions and collaborative learning and suggestions. Almost without fail, there is an incredible amount of learning and perspective exchange that takes place—for me at least! But people keep coming back; we usually get around 50-70 people there. Of course, networking afterwards is a significant part of the value as well. Some terms that have been coined by some of our presenters and contributors have included, “IoT architecting,” “system of systems engineering,” “real-life mouse,” (referring to Playtabase), and “hardware as a service,” all of which entail various aspects of the present-day ecosystem that can be leveraged to create new business models and occupation types.

How was the idea for IoT Fuse 2015 conceived?

In the software development world, there are a number of homegrown conferences that take place on a regular basis to delve into a topic, such as the Midwest Python Summit, and Mobile March. My friend Justin Grammens, who is part of the senior management of a local software company Code42, came to me with the idea of putting together our own Internet of Things conference. He was



one of the founders of Mobile March [a conference that explores trends in mobile technology], which

has been going on for about five years now. The University’s Department of Electrical and Computer Engineering was kind enough to sponsor our location, and we found interesting local speakers within the IoT Space, and marketed the event through various avenues. We ended up selling out completely, and had a wonderful set of speakers. The venue worked out great and we can’t thank the University enough for providing the space.

What was the purpose of the conference?

While @iotmpls is more about the individuals and different perspectives on a monthly basis, typically within a more entrepreneurial realm, IoT Fuse was about fusing together all walks of life, including large corporate interests, within the space. While I tend to be someone who is

biased toward scrappy entrepreneurial startups because of my background, it is important to realize that one of our competitive advantages here in Minnesota is our large corporate environment. So, about half of our presenters were entrepreneurs and hobbyists, while corporate presenters comprised the other half.

What are some takeaways from IoT Fuse 2015?

What came out of IoT Fuse is that there is an interesting interplay between the large corporate players already out there providing all sorts of software and hardware tools and perspectives, and the individuals who are looking



to strike out on their own and do something totally innovative. While large companies do not tend to excel at completely breakthrough innovation, they provide the process and control necessary to have a stable environment that a given entrepreneur can pick from in terms of technical

tools to utilize. The trick for the entrepreneur or startup CTO is of course being able to pick and architect the right tools, which have the correct amount of overhead and features to fit a given situation. Next year will be even better, and we will continue to propel Minnesota to the top of the IoT scene!

Patrick Delaney is a 2008 B.E.E. graduate from ECE. Always the entrepreneur, he started with a landscaping business called “Forest Restorations”, which removed



invasive species from homeowners’ properties. A trip to Nicaragua was a turning point for him. While there, he learned of the lack of access to electricity, which triggered a project in his mind: solar powered lighting systems. He drew on the advice of Professors Bruce Wol-

lenberg, Ned Mohan, and Paul Imberston to guide him. Patrick graduated and started working full time, but this project was never far from his mind. While working for a Chicago-based manufacturer, he learned the ropes of manufacturing in the electronics assembly hub of Shenzhen, China. Based on this experience, Patrick formed another small business designing and manufacturing LED solar lamps for developing countries and non-profits in the US.

IoT: opportunities, concerns, and challenges

The following is an extract of an interview with Grant Erickson, also an ECE alumnus, who focuses our attention on some of the challenges and concerns that coexist with the opportunities of living in a connected world. Currently employed at Nest, Grant gives us an insight into how some of these concerns can be addressed while individuals and organizations can reap the benefits of connectedness.

Disclaimer

The views and opinions expressed in this article are solely those of the author and do not necessarily reflect or represent those of the author's employer, Nest Labs.

On how IoT will change the tech industry:

As we look back at some of the substantial retail data breaches of the past couple of years, the scale of many was enormous. Consumers reacted with outrage and some with their wallets in the form of boycotts. A number of retailers attempted to ensure their customers were protected via credit monitoring. These retailers internalized and directly bore the substantial costs associated with that monitoring in addition to the losses in sales from reduced customer visits. As customer visits to many of the retailers have inched back to pre-breach levels, the long-term sense of personal violation consumers have experienced is less clear.

As Internet-connected devices become more and more pervasive, they not only will start to outnumber Internet-connected people but they will also have the chance to reach further into customers' personal lives. Consequently, breaches in IoT have the potential to not only reach a scale eclipsing these retail breaches of the past in number, but also to spark a greater sense of personal violation for customers and a stronger reaction from them. I believe these risks and their consequences will lead industry to spend more time up front planning and designing the security of their ecosystems and their consumers' data, leading to a more offensive and proactive approach rather than a defensive and reactive one.

In the spectrum from the short all the way to the long-term, IoT will continue to place a tremendous emphasis on communications technologies: hardware and software alike. In addition, there will be a continuing and growing emphasis on data. Take a simple example from the Nest Learning Thermostat's Time-to-Temperature feature. By simply gathering data over a short period of time about how quickly your home's HVAC system can heat or cool your home, it can then analyze that data to provide real customer convenience and value by letting them know, reliably, how long it will take to get comfortable. In the mid to long-term, I believe inherent in the Internet of Things is the internet. Consequently, today's varied patchwork of communications technologies will continue to consolidate and converge around those technologies that can provide a secure and energy-efficient means to transport IPv6 traffic to and from IoT devices to cloud services and mobile applications.

On significant IoT opportunities:

One area of substantial economic benefit and growth is that of convenience and efficiency. Our lives are already incredibly busy and the demands for our attention ever increasing. The costs of energy and resources continue to increase. Products and services that leverage their connectedness to provide consumers with greater convenience and efficiency while also working to save them time, money, and other resources are well-positioned to reap this economic benefit and growth.

A great example is the Nest Learning Thermostat. With the Nest Learning Thermostat, even though it is incredibly easy relative to any thermostat you might have previously owned, there's no need to program it with your and your family's schedule. Just set it to the temperatures that make you comfortable at the times you want them and the Nest Learning Thermostat figures out and establishes a schedule for you. From there, with features like Auto-Away and Rush Hour Rewards (with participating energy providers), your Nest Learning Thermostat helps you save both money and energy, by using less of your heating and cooling systems when you or your family are not at home, or when your utility needs to shed load to accommodate increased energy grid demands.

On concerns and controversies:

The confidentiality, availability, authenticity, and integrity of the data gathered, processed, and derived by the IoT systems that you use, own, and surround you are critically important. For example, your car and your mo-

bile phone—if you have either—have the potential to know your whereabouts throughout the days, weeks, and years. You, as a customer, should have the assurance that the data undergirding that knowledge is only shared with entities you explicitly authorize, cannot be known by any entities outside of those you authorize, and cannot be embellished or otherwise edited by anyone other than you or the devices you own and use on your behalf.

There are ways in which companies can best address these challenges and concerns. Establish a formal, crisp, and clear information privacy policy with your customers. Demonstrate to customers through both communications and actions that the confidentiality and integrity of their data is important. Allow customers to opt into having their data gathered and shared, make it clear to them the purposes for which it is being gathered and shared, and for how long it will be gathered and shared. Allow them to opt back out if they no longer wish to gather or share. Ensure that technical architecture and design processes are in place such that the confidentiality, integrity, and longevity of customer data are designed in from the start rather than addressed as an after-thought. These technical architecture and design facets need to be thought of end-to-end, from the various communications hardware and software used on the IoT devices themselves, all the way to the cloud computing, storage infrastructure, and mobile applications these devices increasingly rely upon.

On design challenges that can impact widespread implementation of IoT:

We are in a time of great enthusiasm and growth for this nascent market, not unlike that of the PC revolution in the late 1970s through the early 1990s, the consumer Internet revolution of the mid-1990s through the mid-2000s, and the mobile revolution underway since the mid-2000s. By getting out ahead of the information security challenges mentioned earlier, doing right by the customer, and providing a maximum of convenience and value with a minimum of hassle and worry for the customer, companies will engender an environment of low regulation and commensurately high-innovation and growth. On the other hand, one or two prominent and not even necessarily catastrophic failures may serve to slow and cool the market, and dampen industry and consumer uptake.

On experience with Nest changing expectations regarding technology and its future:

My time and experiences at Nest have reinforced my appreciation and respect for the fact that most consumers—particularly mainstream consumers—are not interested in technology in and of itself. They are interested in solutions, convenience, experiences, and delight. Building those solutions for customers demands a company with an end-to-end consumer view and world-class team of people with unassailable talents in a diversity of fields: sales, marketing, communications, operations, supply chain, design, logistics, manufacturing, packaging, software, hardware, quality assurance and systems integration, and customer support. It needs a team of people who both demand and deliver excellence in all that they do, excellence not only within their area of specialization but also cross-functionally.

Technology enables great products and experiences; however, world-class teams bring them to life. Technology has a very bright future when it is focused on solving problems for people, providing the supporting infrastructure to delightful customer solutions, and making the seemingly impossible, possible.

About Grant:

Grant Erickson graduated with his B.E.E. degree in 1996, and his MSEE degree in 1998, both from the Department of Electrical and Computer Engineering at the University of Minnesota. He led the San Francisco Bay Area chapter of the University of Minnesota Alumni Association for 16 years. Grant currently works for Nest Labs, resides in Sunnyvale with his wife Jessica, daughter Grace, and golden doodle Charlie. Some of Grant's other passions include architecture and design, playing the guitar, food, and cooking.

IoT in action in the University's solar vehicle project:

Closer home, you will see a demonstration of how such connectivity is impacting the University's Solar Vehicle Project as it prepares for the world solar car race in Australia in fall 2015. PTC, one of the several generous sponsors for the project has among other things, donated the use of its Creo Parametric for designing the vehicle. It has also donated the use of ThingWorx, PTC's software platform for running IoT applications, for the team to collect and transmit crucial contextual data from sensors located on the team's support vehicles that lead and follow it on the race route. For the fall 2015 race in Australia, the solar vehicle team will have GPS and weather support, courtesy of ThingWorx. The use of ThingWorx during the testing phase will also contribute to improving the vehicle, making it a leaner and perhaps meaner machine.

New faculty announcements



Sarah Swisher joins as an assistant professor in fall 2015. She is currently a Ph.D. candidate in Electrical Engineering at the University of California, Berkeley, where she earned her master's degree. She received her undergraduate degree from the University of Nebraska in Lincoln. As part of her graduate research, she designed and built a flexible electronic device that uses impedance spectroscopy to provide early detection of pressure sores in patients.

Before embarking on her graduate level studies, Sarah worked for Garmin International, Inc. as a design engineer for GPS based bicycle computers. Sarah's expertise lies in materials for biocompatible and bioresorbable electronic materials.

Mehmet Akcakaya joins in fall 2015 as an Assistant Professor. He received his graduate degrees from Harvard University and his undergraduate degree from McGill University in Montreal. He has previously worked as a postdoctoral research fellow, and is currently an instructor in medicine at the Beth Israel Deaconess Medical Center at Harvard Medical School.

Mehmet's expertise is in biomedical imaging with a particular emphasis in magnetic resonance imaging. He expects to work closely with the researchers at the University's Center for Magnetic Resonance Research (CMRR).



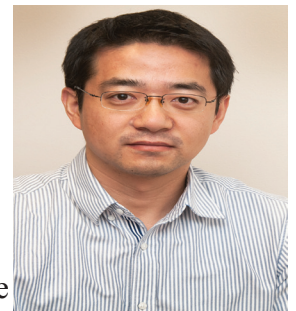
David Orser joined the Department of Electrical and Computer Engineering as a Lab Coordinator. He earned his Bachelor of Science in Electrical Engineering from Minnesota State University, and his master's and doctoral degrees from the University of Minnesota. He has extensive experience teaching coursework here and at Minnesota State University, and working in industry.



Faculty promotions

Chris Kim (left) has been promoted from associate professor to professor in spring 2015. His area of expertise lies in digital and mixed-signal circuit design.

Mo Li (right) has been promoted from assistant professor to associate professor in spring 2015. His areas of research area include nanophotonics, nanotechnology, and photonic crystal structures.



New staff announcements

Frances Wood joined the staff in spring 2015 as an academic advisor. She has previously worked as a career and higher education advisor at Westminster Kingsway College in London, UK following a career change from working in research science. She has a postgraduate diploma in career guidance from Nottingham Trent University, UK, and a master's degree in chemistry from the University of Bath, UK.

John Van Proyen joined the IT team in spring 2015 as an end user support staff. He has previously worked with various IT teams at the University, and at the University of Illinois Urbana-Champaign (in the College of Engineering), from where he also graduated with a BA in Economics in 2012.

News briefs

ECE faculty receive three NSF Early Career Development awards

Congratulations to Prof. Arya Mazumdar (far left), Prof. Sairaj Dhople (center), and Prof. Jeong-Hyun Cho (near left) for being awarded the Faculty Early Career Development Award from the National Science Foundation. NSF grants this select award to junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of the University of Minnesota.



Prof. Jarvis Haupt receives Young Faculty Award from DARPA

Congratulations to Prof. Jarvis Haupt for being awarded the highly competitive Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA) providing rising research stars in junior faculty positions with funding, mentoring, and industry and DoD contacts to develop their research ideas.



Prof. Randall Victora (far left) will assume his position as new head of the ECE department on July 1, 2015. Prof. David Lilja who has led the department for ten years will step down on June 20, 2015.



Prof. Murti Salapaka (center) will lead the ECE graduate program as the new Director of Graduate Studies. His research focuses on control and dynamical systems and their application to nano and bio interrogation. He earned his graduate degrees from the University of California, Santa Barbara, and holds the Vincentine Hermes-Luh Chair in Electrical and Computer Engineering.

Prof. Rhonda Franklin (above right) will take over the role of Director of Undergraduate Studies for a year starting fall 2015, while Prof. James Leger is away on a sabbatical in Australia.

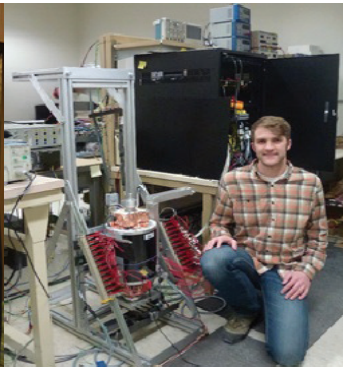
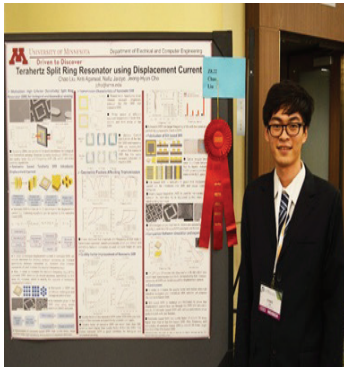
Boeing Scholarships for Katherine Wilson and Adeola Isola

Katherine Wilson's interests in space and public health were cultivated through opportunities with the National Aeronautics and Space Administration, Centers for Disease Control and Prevention, Minnesota Department of Health, and Dr. Douglas Fantz's lab (Agnes Scott College). After earning a bachelor's degree from Agnes Scott College, she came to the University of Minnesota to pursue her interest in electrical engineering and human spaceflight. Through coursework, participation in the University's CanSat team, and other science outreach opportunities, Katherine is gaining experience with design reviews, troubleshooting, working with team members

to integrate systems across multiple disciplines, and mentoring future students in STEM. She plans to apply her B.E.E. degree to advance space technology. With the help of the Boeing scholarship, Katherine hopes to make the most of the opportunities at the University.



Adeola Isola moved to Minnesota from Lagos, Nigeria four years ago. She started her journey towards an engineering degree at the Anoka Ramsey Community College, and having earned her associate's degree there, transferred to the University of Minnesota to earn a bachelor's degree in electrical engineering. She says, "Having electricity is a privilege back home [in Nigeria], so this has been one of my greatest motivations. I want to find the most efficient and best way to help the power systems back home." Recently, Adeola was appointed secretary of the Women in Engineering (WIE) student group. She hopes to create a project that WIE could assemble and exhibit in middle and high schools to demonstrate to female students how much women can contribute to engineering, and to encourage them to consider a career in engineering. Her future goal is to find "better ways to get electricity to as [many] people as needed in Nigeria so having electricity can become more of a lifestyle [and] not a privilege."



Chao Liu (far left) was awarded the Best Poster award at the Materials Research Society (MRS) 2015 Spring Meeting. Chao's was one of four posters that had been selected out of 728 posters presented at the meeting. (Prof. Jeong-Hyun Cho, advisor). **Eric Severson** (near left) received the award for best paper of the session at the 2015 IEEE Applied Power Electronics Conference (APEC) in Charlotte, NC. His paper is titled "Practical Implementation of Dual Purpose No Voltage Drives for Bearingless Motors". (Prof. Ned Mohan, advisor)



Varsha Padhee received the 2015 Thomas F. Ellerbe Scholarship. The award recognizes creativity in scientific thinking and research that can have a positive impact on the sustainability of the built environment. The scholarship is funded by the Minnesota Architectural Foundation (Prof. Ned Mohan, advisor). **ECE alumnus Meisam Razaviyayn** (Ph.D. '14) was selected for the 2014 SPS Young Author Best Paper Award for his "On the Degrees of Freedom Achievable Through Interference Alignment in a MIMO Interference Channel". Co-authors were Genady Lyubeznik and ECE Prof. Zhi-Quan Luo who was also Meisam's advisor.

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ECE patents

The following is a list of patents granted to ECE faculty over the last 3 full calendar years and includes the year 2015 to date. The names of fellow inventors have also been included.

Filing - Patent Issued Number	Filing - Innovator - Full Name	Filing - Title
8,090,142	Ahmed H Tewfik Mitchell D Swanson	Embedding Data in and Detecting Embedded Data from Video Objects
8,089,522	Jaehyuk Choi Euisik Yoon	Spatial-temporal Multi-resolution Image Sensor with Adaptive Frame Rates for Tracking Movement in a Region of Interest
8,098,707	Mi K Oh Byung-Hoo Jung	Ultra Wideband Receiver
8,098,637	Ahmed H Tewfik	Using Delay Costs to Load Balance Nodes Across Access Points in Wireless Local Area Networks
8,098,707	Ramesh Harjani	Ultra Wideband Receiver
8,108,759	Jaekyun Moon Jihoon Park	Error Detection and Correction Using Error Pattern Correcting Codes
8,111,770	Jaekyun Moon	High-bandwidth Over-the-Air Signal Processing
8,128,856	Stephen Y Chou	Release Surfaces, Particularly for Use in Nanoimprint Lithography
8,131,007	Bin Zhu Ahmed H Tewfik Mitchell D Swanson	Watermarking Using Multiple Watermarks and Keys, including Keys Dependent on the Host Signal
8,134,864	Xi Chen Randall H Victora	Exchange-assisted Spin Transfer Torque Switching
8,149,961	Ebrahim Saberinia Ahmed H Tewfik	Ranging in Multi-band Communication Systems
8,155,375	Ahmed H Tewfik Bin Zhu Mitchell D Swanson	Video Watermarking Using Temporal Analysis
8,169,179	Krushna K Mohapatra Ned Mohan	Open-ended Control Circuit for Electrical Apparatus
8,366,905	Euisik Yoon Seong-Jin Kim	Apparatus Having Reduced Noise and Method of Using the Apparatus for Detecting Ionic Materials
8,446,743	Gysler F. Castelino Kaushik Basu Nathan D. Weise Ned Mohan Ranjan K. Gupta Krushna K Mohapatra	Soft Switching Power Electronic Transformer

ECE patents

(cont.)

Filing - Patent Issued	Filing - Innovator - Full Name	Filing - Title
8,588,317	Georgios B Giannakis Xiaoli Ma	Estimating Frequency-offsets and Multi-antenna Channels in MIMO OFDM Systems
8,604,572	Md Tofizur Rahman Jian-Ping Wang	Magnetic Tunnel Junction Device
8,619,168	Jaehyuk Choi Euisik Yoon	Image Sensor with High Dynamic Range Imaging and Integrated Motion Detection
8,629,398	Anand S Gawarikar Ryan P Shea Joseph J Talghader	Detection Beyond the Standard Radiation Noise Limit Using Spectrally Selective Absorption
8,634,233	Jian-Ping Wang Shruti R Patil Xiaofeng Yao Jonathan D Harms David J Lilja	Systems and Methods for Direct Communication Between Magnetic Tunnel Junctions
8,704,179	Joseph J Talghader	Detection Beyond the Standard Radiation Noise Limit Using Reduced Emissivity and Optical Cavity Coupling
8,718,185	Xiaoli Ma Georgios B Giannakis	Estimating Frequency-offsets and Multi-antenna Channels in MIMO OFDM Systems
8,728,380	Stephen Y Chou	Lithographic Method for Forming a Pattern
8,774,309	Xiaoli Ma Georgios B Giannakis	Estimating Frequency-offsets and Multi-antenna Channels in MIMO OFDM Systems
8,787,962	Ahmed H Tewfik	Transmit Opportunity Detection
8,802,965	Nathan C Lindquist Sang-Hyun Oh	Plasmonic Nanocavity Devices and Methods for Enhanced Efficiency in Organic Photovoltaic Cells
RE45,230	Yan Xin Zhengdao Wang Georgios B Giannakis	Wireless Communication System Having Linear Encoder
8,948,562	Sang-Hyun Oh Nathan C Lindquist	Replication of Patterned Thin-film Structures for Use in Plasmonics and Metamaterials

PhDs awarded

Doctoral degrees awarded from June 2014 to May 2015

Mohamed Khaled Ibrahim Almekkawy, Optimization of Focused Ultrasound and Image Based Modeling, June 2014. Advisor: Prof. Emad Ebbini

Mahdi Bayat, Non-invasive In Vivo Ultrasound Temperature Estimation, June 2014. Advisor: Prof. Emad Ebbini

Nasim Yahyasoltani, Dynamic Learning and Resource Management under Uncertainties, June 2014. Advisor: Prof. Georgios Giannakis

Yu Chen, High Quality Silicon Photonic Devices Based on Heterogenous Integration Method, Aug. 2014. Advisor: Prof. Mo Li

Chia-Lin Hu, A Low Power Biosensor for Medical Applications, Aug. 2014. Advisor: Prof. Ted Higman

Cheol Hong Min, Detection of Behavioral Markers Using Wearable Wireless Sensors, Aug. 2014. Advisors: Prof. Mostafa Kaveh, and Prof. Lucy Dunne

Sohini Roy Chowdhury, Automated Segmentation and Pathology Detection in Ophthalmic Images, Aug. 2014. Advisors: Prof. Keshab Parhi, and Prof. Dara Koozekanani

Yao Wang, System Study of Two Dimensional Magnetic Recording System, Aug. 2014. Advisor: Prof. Randall Victora

Haibao Zhao, Magnetic Thin Films with High Perpendicular Anisotropy, Aug. 2014. Advisor: Prof. Jianping Wang

Pin-Wei Huang, Micromagnetic Study of Heat Assisted Magnetic Recording, Sept. 2014. Advisor: Prof. Randall Victora

Binh K. Lieu, Dynamics and Control of Newtonian and Viscoelastic Fluids, Sept 2014. Advisor: Prof. Mihailo Jovanovic

Shihai He, Synthesis of Hard Magnetic Nanoparticles for Applications in Permanent Magnets, Dec. 2014. Advisor: Prof. Jianping Wang

Lian Huai, Low Complexity MIMO Detection Algorithms and Implementations, Dec. 2014. Advisor: Prof. Gerald Sobelman

Bongjin Kim, Digital Intensive Circuit Design Techniques for Enhancing Performance, Dec. 2014. Advisor: Prof. Chris Kim

David Orser, Grid Fault Ride-through in Matrix Converters for Adjustable Speed Drives, Dec. 2014. Advisor: Prof. Ned Mohan

Amogh Rajanna, Error Correction and Opportunistic Scheduling Protocols in Random Wireless Networks, Dec. 2014. Advisor: Prof. Mostafa Kaveh

Casey Edward Murray, Reconfigurable Passive RF Circuits Leveraging Integrated Fluidic Structures, Jan. 2015. Advisor: Prof. Rhonda Franklin

Ayan Paul, Circuit Design and Modeling Techniques of On-chip Power, Jan. 2015. Advisor: Prof. Chris Kim

Maziar Sanjabi Boroujeni, Resource Management in Wireless Heterogenous Networks, Jan. 2015. Advisor: Prof. Zhi-Quan Luo

Huan Li, Multifunctional Optomechanical Dynamics in Integrated Silicon Photonics, Feb. 2015. Advisor: Prof. Mo Li

Mona A. Ebrish, Graphene Quantum Capacitance Varactors, Mar. 2015. Advisor: Prof. Steven Koester

Subhrajit Roychowdhury, Breaking Perceived Limits of Performance for Nanoscale Interrogation and Transport Systems, Mar. 2015. Advisor: Prof. Murti Salapaka

PhDs awarded *(cont.)*

Ravishankar Sivalingam, Sparse Models for Positive Definite Matrices, Mar. 2015. Advisor: Prof. Nikolaos Papanikolopoulos

Eliot Lewis Estrine, Development and Characterization of Magnetostrictive GaFe, April 2015. Advisor: Prof. Bethanie Stadler

Balasubramanian Gopalakrishnan, High Performance Adaptive Beamforming for Wireless Networks, May 2015. Advisor: Prof. Nikolaos Sidiropoulos

Gregory Ingersoll, Multiplexed Volume Bragg Gratings in Narrow and Broadband Spectral Systems: Analysis and Application, May 2015. Advisor: Prof. James Leger

Forrest Johnson, Sputtered Metal Oxide Broken Gap Junctions for Tandem Solar Cells, May 2015. Advisor: Prof. Stephen Campbell

Yuanpeng Li, Magnetic Biosensing System, May 2015. Advisor: Prof. Jianping, Wang
Feilong Liu, Model Development for Organic Semiconductor Heterostructure Devices, May 2015. Advisor: Prof. Paul Ruden

Morteza Mardani, Leveraging Sparsity and Low rank for Large Scale Networks and Data, May 2015. Advisor: Prof. Georgios Giannakis

Sravan Kumar Marella, Performance Variations Due to Layout Dependent Stress in VLSI Circuits, May 2015. Advisor: Prof. Sachin Sapatnekar

Akshay Soni, Structured and Sparse Signal Estimation—Fundamental Limits and Error, May 2015. Advisor: Prof. Jarvis Haupt

Ruoyu Sun, Matrix Completion via Nonconvex Factorization: Algorithms and Theory, May 2015. Advisor: Prof. Zhi-Quan Luo

Hung-Wei Tseng, A Combined Statistical and Machine Learning Approach for Single Channel Speech Enhancement, May 2015. Advisor: Prof. Zhi-Quan Luo

Fei Zheng, A Two Dimensional Speckle Tracking Method Based on Zero Phase Crossing with Riesz Transform, May 2015. Advisors: Prof. Emad Ebbini, and Prof. Anand Gopinath

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In Memoriam



Vernon D. Albertson, Professor Emeritus, University of Minnesota, Department of Electrical and Computer Engineering, passed away on June 6, 2015. He served as a faculty member in the department from 1963-1997.

Professor Albertson received his Bachelor of Science degree from North Dakota State University in 1950, his Master of Science degree from the University of Minnesota in 1956, and his doctorate from the University of Wisconsin, Madison in 1962, all in electrical engineering. He worked at the General Electric Co. in Schenectady, NY from 1950-1952, and as a Communications Officer in the United States Air Force from 1952-1954.

In 1981, Professor Albertson set up the University of Minnesota Center for Electric Energy within the Department of Electrical and Computer Engineering with the primary mission to support undergraduate education and graduate research in electric power and energy. He was also responsible for establishing a lasting connection between the University of Minnesota and the Norwegian University of Science and Technology in 1981.

Professor Albertson did pioneering and seminal research in the area of protecting power systems from the effects of geomagnetic storms. In collaboration with the National Oceanic and Atmospheric Administration (NOAA), he had magnetometers installed in northern Minnesota for measuring these currents. Professor Albertson and his students, based on their research, were instrumental in advising about the impact of stray currents in dairy farms. He was very active in IEEE, organizing annual meetings and seminars. He started MIPSYCON (Minnesota Power Systems Conference) fifty years ago, which has now turned into the premier conference in the upper Midwest, attracting attendees from all over the country and Canada. Professor Albertson's contributions to the field of electrical energy and power systems, his friendship, and generosity will be missed.

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