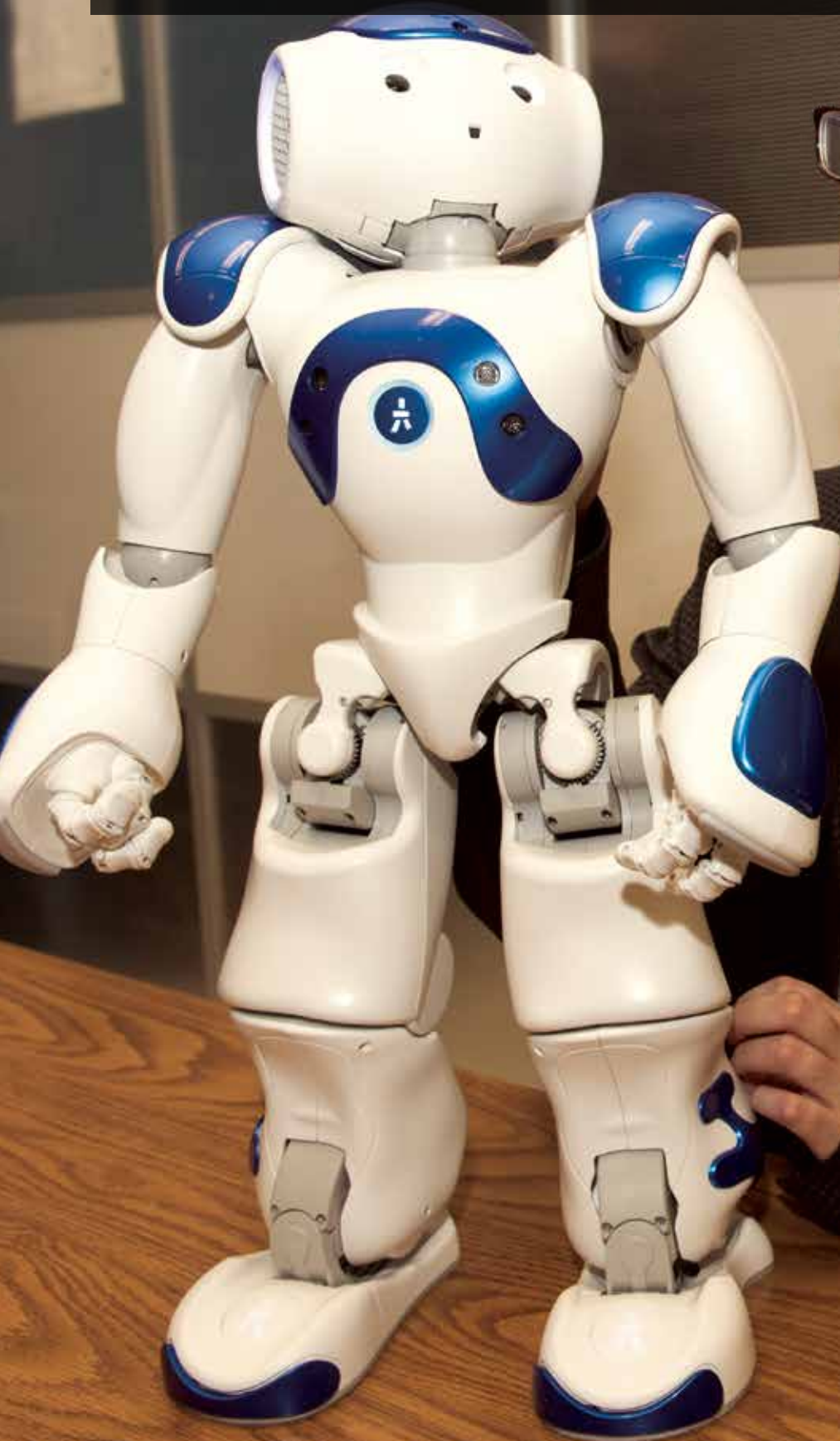


IPFWCONNECT



**SOLVING A
FOUL PROBLEM**

Developing cleaner
water filters

pg. 4

**LEARNING THE LANGUAGE
OF SYSTEM DESIGN**

Center helps enterprises
work smarter

pg. 13

**PREVENTING INVISIBLE
TRAFFIC JAMS**

Keeping mobile phones and
emergency channels open

pg. 16

"As the state's second Metropolitan University, our campus remains committed to and engaged with northeast Indiana."



A Letter from the Dean

This issue of *Connect* reaches you at a momentous time in our university's history. The transition to Purdue University Fort Wayne* is particularly significant to the College of Engineering, Technology, and Computer Science (ETCS). While ETCS graduates receive Purdue degrees currently, the transition provides our degrees with greater distinctiveness. As the state's second Metropolitan University, our campus remains committed to and engaged with northeast Indiana. And as Purdue Fort Wayne, we will continue to provide ample opportunities for partnerships with industry and community-based organizations through internships, service-learning projects, applied research, and much more.

The articles in this issue illustrate the breadth of our faculty's research and expertise and their devotion to addressing needs in Fort Wayne, northeast Indiana, and beyond. Most of the highlighted projects engage local industry. Our regional partners not only support senior capstone design projects, they also provide collaborative opportunities for the faculty through Technical Assistance Program (TAP) and Indiana Next Generation Manufacturing Competitiveness Center (IN-MaC) initiatives. Through such initiatives, we build exemplary Metropolitan University–community partnerships.

What is our path forward? ETCS is poised to become the college of choice in northeast Indiana and beyond—known for its world-class, hands-on, transformative, and entrepreneurial education in engineering, polytechnic, computer science, and leadership.

Respectfully,

Manoochehr Zoghi, Ph.D., MBA, PE, DGE, FASCE
Dean, College of Engineering, Technology, and Computer Science
Professor, Civil Engineering

*Pending Higher Learning Commission approval.

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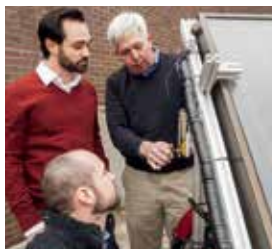
Ordered Groceries Designing and implementing a smart home based on the Internet of Things

By Guoping Wang and Zesheng Chen

"One of the main goals of studying energy systems is to increase system efficiency.

One of the long-term projects being studied in the Modeling and Simulation Lab is heat loss from slab construction homes."

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Solving a Foul Problem

Developing cleaner water filters



According to the U.S. Environmental Protection Agency, the earliest drinking water treatment was recorded around 4000 BCE in Greece and India. Since then, drinking water treatment technology has developed standard processes, including coagulation, flocculation, sedimentation, sand filtration, and disinfection to convert natural fresh water into drinking water (See Figure 1).

Unfortunately, fresh water accounts for just 3% of the global water resources, the rest is salt water. As a result, desalination is necessary when the

available fresh water supply cannot meet personal and economic needs. The first breakthrough in desalination distillation methods was made in 1959 when the first reverse osmosis (RO) thin membrane was created from a cellulose acetate polymer. RO membrane pores are so tiny that only small molecules like water can pass through at a reasonable rate under hydraulic filtration pressure. The RO membrane removes most water contaminants, including dissolved salts, from the water supply.

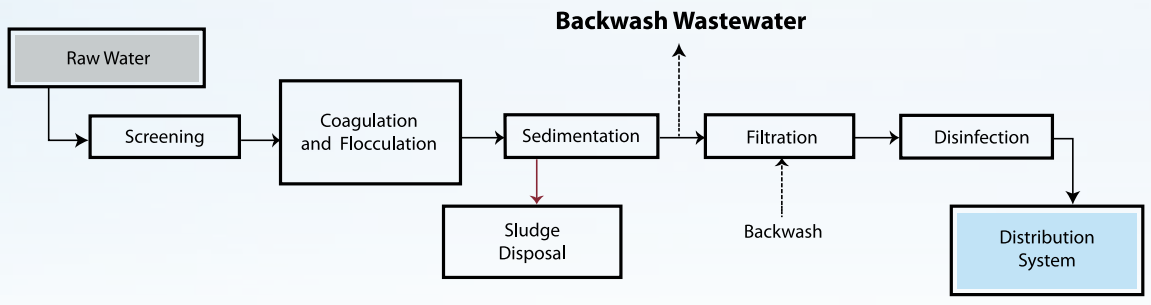
RO membrane development was a milestone in modern water treatment

technology. Today, wider application of membrane technologies is driven by demands for increasingly pure finished water quality, including the removal of pharmaceutical compounds and other contaminants.

Challenges of Membrane Filtration

The process of taking dissolved salts out of water fights against Mother Nature—aka, the second law of thermodynamics. The filtration process costs energy (in the form of heat or hydraulic pressure) to separate water molecules from dissolved salts. Of course, even though water can produce energy through

Figure 1
Conventional drinking water treatment process



hydro-power, producing purer water always requires more power.

A barrier to expanding the use of membrane technologies is membrane fouling. Membrane fouling occurs when water impurities, or foulants, such as organic substances and particulates collect on the membrane surface or clog the pores. As a result, energy use increases as membrane productivity declines over time, which increases the cost of water filtration.

So researchers must develop innovative and effective techniques to reduce membrane fouling. In my lab, I have investigated innovative ways to control membrane fouling using physical, chemical, and biological methods. These methods encompass two approaches: 1) reducing the affinity (connection, attraction) between the foulants and the membranes; and 2) developing dynamic, self-cleaning membranes.

In 2016, I pioneered and eventually received a U.S. patent for my research on using enzymes to keep water filtration membranes clean in advanced water and wastewater treatment and reuse. Microorganisms in water secrete gel-like substances that, over time, can clog water filtration membranes. The patent I received covers a technique of introducing enzymes that degrade the gel-like secretions in water filtration

systems. These enzymes clean the membranes efficiently.

A grant from the National Science Foundation funded another study of dynamic, self-cleaning membranes. In this research, the self-cleaning membrane system under study utilizes smart multi-functional materials that can deliver simultaneous mechanical vibration and chemical oxidation at controlled vibrational frequencies, amplitudes, and durations. The combination removes impurities from the membrane's surface and pores. As a result, the membrane can be kept clean to produce purified water at a high capacity and a low energy cost.

Benefiting Industry, Community

I hope my research and developing expertise on water treatment provide technologies that can benefit local industry and our community. Usable and adoptable technologies that optimize conventional processes, including advanced ones like membrane filtration, will help us produce cleaner water at a lower cost. The benefits include reduced personal (bottled water) and industrial (energy) carbon footprints, greater efficiencies through longer and more efficient membrane use, and cleaner water to use, enjoy, and drink!

~~~~~  
**“Fresh water accounts for just 3% of the global water resources, the rest is salt water.”**  
 ~~~~~



DONG CHEN

Ph.D. in civil (environmental) engineering with a minor in geological science from Ohio State University

Chen is a professor in the Department of Civil and Mechanical Engineering whose research interests include water filtration membrane processes and fouling control, water and wastewater chemistry and treatment processes, nano materials, and corrosion protection. He is a registered and licensed professional engineer in the state of Ohio.



Social Media's Minefield

Organizations need policies and training to avoid liability



Increasingly, organizations are using employees' personal social media as a tool in employment decisions. These decisions range from selecting candidates to disciplining or terminating existing employees.

Organizations want to hire the best candidates, and social media is a common recruitment tool. In fact, 96% of organizations report that they look up applicants' social media profiles as part of the vetting process. From a legal perspective, there are relatively few legal protections for candidates under these circumstances. However, anti-discrimination laws, including Title VII of the 1964 U.S. Civil Rights Act, mandate that information discovered by an employer online may not be used for discriminatory purposes. So, de-selecting a candidate based upon a race, gender, sex, religion, national origin, or other legally protected class characteristics violates the law.

Employers who vet candidates via social media must be trained not to engage in discriminatory practices. Candidates also need to be more aware that their potential employers are looking at social media. Research indicates that job-seekers feel more positively toward organizations who are transparent about their social media use in selection.

STATS ON SOCIAL MEDIA



of organizations have social media policies, though the content and language of these policies varies tremendously.



of organizations report that they have disciplined employees for their personal social media use, and 7% report that they have terminated an employee.



STATS ON SOCIAL MEDIA

90%

of organizations report that they look up applicants' social media profiles as part of the vetting process.

Section

7

of the National Labor Relations Act (NLRA) grants protections that allow employees to communicate about their working terms and conditions on social media.

Social Media Policies and Employee Discipline

Approximately 80% of organizations have social media policies, though the content and language of these policies varies tremendously. Some organizations, for example, encourage employees to post liberally about their work, usually for marketing and other promotional purposes. On the other hand, some organizations have strict social media policies that tell employees to refrain from work-related postings. Often, such organizations tend to have proprietary information they want to protect. Organizations with strict policies, however, must be aware that all-out bans instructing employees to "never post anything work-related" may violate the National Labor Relations Act (NLRA).

Private sector employees have some legal protections under Section 7 of the NLRA. These protections allow employees to communicate about their working terms and conditions on social media. The U.S. Constitution's First Amendment does provide public-sector workers with protections that apply to posting to social media about matters of "public concern." So public-sector workers have free speech protection to communicate via their social media about matters related to political, social, or other concerns.

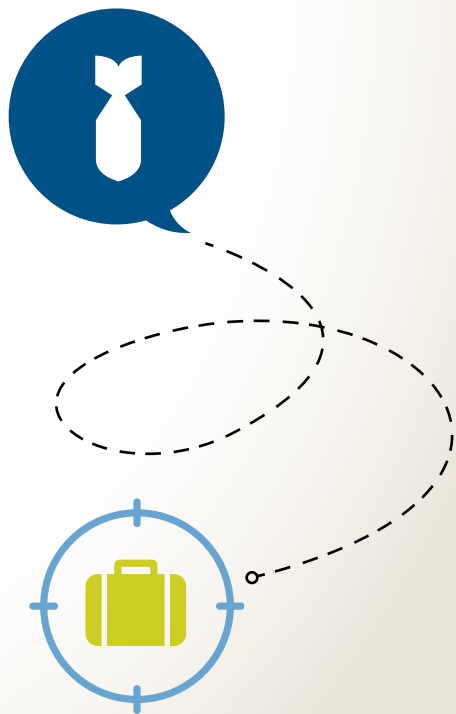
Employees may certainly be disciplined by organizations when their personal social media posts fall outside these parameters. Approximately 20% of organizations report that they have disciplined employees for their personal social media use, and 7% report that they have terminated an employee. These statistics indicate that both employers and employees need to keep current on legal developments involving social media.

Employee Training

Employees who have been disciplined or terminated from employment often report a lack of understanding about their employer's social media policy. This may be because the language of the policy itself is unclear or because workers are not well-trained. A 2016 study we published with our colleague Professor Michelle Drouin (psychology) showed that only 31% of employees reported knowing that their organization had a social media policy. Of this 31%, only half of workers knew what behaviors actually violated their employer's policy.

These statistics point to the need for employers to provide social media policy training to their employees. Social media training should occur through a variety of methods, with employees receiving regular exposure to policy language and meaning. Also, when drafting social media policies, examples of both appropriate and inappropriate online worker behavior should be provided. Lastly, social media policies should be consistently enforced so that employers can protect themselves from liability.

Increasingly, organizations are using employees' personal social media as a tool in employment decisions. These decisions range from selecting candidates to disciplining or terminating existing employees.



Ph.D. in organizational psychology from Michigan State University.

GORDON BRUCE SCHMIDT

Schmidt is an associate professor and chair of the Department of Organizational Leadership. His research focuses on how the Internet is changing the nature of work. He also studies using social media in the classroom and is the co-editor of the book *Social Media in Employee Selection and Recruitment: Theory, Practice, and Current Challenges* (Springer, 2016).



Assistant professor of organizational leadership at IPFW, and an attorney, licensed to practice in the state of Indiana.

KIMBERLY O'CONNOR

O'Connor is the director of graduate studies in the Department of Organizational Leadership. She has published numerous academic articles and book chapters on the topic of social media and the law, and she has presented her work at both national and international conferences.



WRITTEN BY

DON MUELLER, ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING

A BETTER TOMORROW

Lab Helps Test Theories and Predict Outcomes

In the Modeling and Simulation Lab at IPFW, I work with my mechanical engineering faculty colleagues, Zhuming Bi and Bongsu Kang, and our students and other faculty to study a wide-variety of engineering systems. The systems involve complex physical phenomena such as heat transfer, multi-cycle loading, energy conservation, lubrication-wear, and vibration. Our lab supports classroom projects, capstone design, research (undergraduate and graduate), and industry-academic projects. The scope of projects ranges from basic research to applied research to design.

Researchers working in the lab use their engineering knowledge and experience to analyze a physical system, then they apply science to represent the system, use math to describe the system, and computers to simulate the system. During any study, engineering processes and best practices are followed to ensure that our work is correct, understandable, and useful. While analyzing and reporting results, researchers also consider ethical, economic, and sustainability issues.

Today's powerful computers allow engineers to tackle a widening scope of problems, while advances in software have increased the utility of computer use in labs such as ours. However, these advances in computing capabilities necessitate more systematic engineering procedures, better judgment, and more thoughtful analysis—it is too easy just to press a button and get nice, colorful graphs and figures.

A common theme in my own research is mathematical modeling and computer simulation of engineering systems—especially thermal and energy systems. One of the main goals of studying energy systems is to increase system efficiency. When systems are more efficient less fuel is consumed. Not only is the increased efficiency more economical, but it is also more sustainable and better for the environment.

One long-term project being studied in the Modeling and Simulation Lab is heat loss from slab construction homes. While many advances have reduced the heat loss from the above-ground portion of homes, not as much attention has been focused on ground-level heat loss. Also, building codes

require insulation to be placed around the perimeter of the slab and down into the ground to prevent heat loss, but do not specify how. In our lab, we've investigated different configurations of insulation systems to make them more effective at reducing slab, ground-level heat loss by predicting the energy (and economic) savings for the home owner. The goal is to make the nation's energy supplies and the environment more sustainable—reducing home energy loss translates into less energy consumption and less CO₂ release into the atmosphere.

In addition to studies seeking to improve energy conservation, our lab has also worked to improve energy

“It is too easy just to press a button and get nice, colorful graphs and figures.”

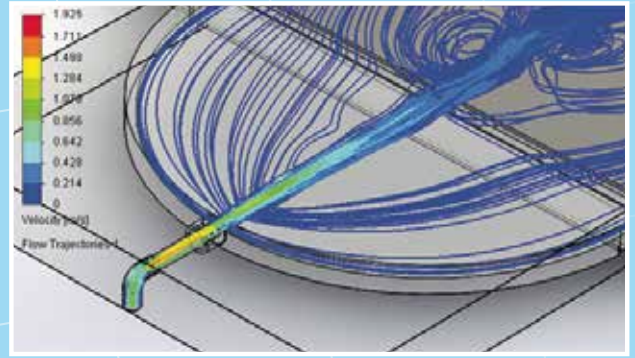
conversion systems, especially those involving renewable or alternative energy sources. I have worked with IPFW alumnus Ahmad Saleh (M.S.E. 2012) and my mechanical engineering colleague, Hosni Abu-Mulaweh, to create a computer model to predict the behavior of solar collectors used to heat water. After testing, our computer model is now being used to predict how a solar collector can best be used to deliver hot water and to store it overnight.

Another alumnus, Sotirios (Akis) Lyrantzis (B.S.M.E. 2016), and I developed a mathematical and

computer model of flow through a boron-hydride fuel cell. By focusing on the fluid dynamics inside the fuel cell, our model helps designers better understand how to construct the passages to reduce pressure drops, allowing for greater flow rates and more cells to be stacked, thus increasing the power output.

Our lab has a direct impact on local industry, especially those without in-house expertise to perform in-depth studies involving complex physics and requiring specialized software packages. With the help of IPFW's Office of Engagement, local companies bring interesting projects to the lab. Our researchers have designed models to predict heat transfer when quenching aluminum automotive parts and to predict wear when a part is exposed to high-cycle loading under different lubrication conditions. These projects help local industry engineers better understand complex phenomena through modeling and simulation, which allows them to design better devices or develop manufacturing processes that add value.

Work in the Modeling and Simulation Lab includes our classrooms. In spring 2016, a new graduate-level course was offered, ME 544 Modeling and Simulation of Mechanical Engineering Systems. Students apply a modeling and simulation life-cycle approach to various engineering systems, including a final project on a topic of their choice. Through this course, IPFW faculty are training future engineers to apply modeling and simulation paradigms to tackle the challenges of tomorrow.



Top Photo
Diagram of flow through a fuel cell.

Middle Photo
Students in the Modeling and Simulation Lab discuss findings.

Bottom Photo
Students and Professor Mueller analyze a PV panel.



B.S., M.S., and Ph.D. in mechanical engineering from the Missouri University of Science and Technology.

DON MUELLER

Mueller is an associate professor of mechanical engineering with research interests in modeling solar collectors and studying building heat loss. He is a licensed professional engineer and a member of the American Society of Mechanical Engineers, the American Institute of Aeronautics and Astronautics, and the American Society of Engineering Education.



Learning the Language of SYSTEM DESIGN

**From HR to
manufacturing,
center helps
enterprises
work smarter**

Collective System Design (CSD) is a system design implementation approach developed in response to problems that many enterprises face when implementing sustainable change. In that a system is more than a collection of parts, a small change might have an unexpected effect on a system. Since enterprise systems include the thoughts and actions of people, change implementation is a complex issue.

CSD begins by understanding customer needs and gaining collective agreement as to system purpose. The process of collective agreement aligns the system's purpose with what it must achieve. For example, alignment from top-level management to associates on a factory floor is guided by a conscious understanding of participants' tone and thinking. System design provides a common language to guide collective understanding of and agreement regarding system requirements and solutions. CSD's common language creates building blocks used to construct sustainable plans that meet the desired enterprise goals.

Engagement: CSD with Application Partners

Today more than ever, businesses are focused on reducing costs and increasing revenue to maximize shareholder value. The IPFW Center of Excellence in Systems Engineering (SE Center) partners with industry throughout the region to apply CSD research and methodology to help them design and implement plans that achieve their defined system requirements.

Stimulating and nurturing economic enterprises, CSD has been used to (re) design manufacturing systems and cell layouts, and new product introduction processes, reduce set-up and changeover times to improve operational efficiency, and overhaul wasteful inventory management and scheduling. Recently, CSD has been used to develop an HR system based on the employee life cycle, with the intent on improving employee retention and productivity.

In our work, we engage with various industry types and sizes, and we approach

Students enhance their learning by applying research to real-world situations and by developing relationships with potential employers.

each project as a collaborative partnership. Engagements are most successful when senior leadership, process owners, and workers are involved. CSD methodology fosters sustainable growth and continuous improvement, which ensures that organizations are able to adapt and grow, which in turn, can increase profitability.

These collaborative partnerships also address the need for economic growth of our metropolitan area while

simultaneously providing new learning and research opportunities for faculty and students. For example, students who participate in engagement activities participate in real-world applications of CSD methodology, thereby improving their critical understanding of system design.

Discovery: CSD in Applied Research

Conducting applied research with CSD addresses and solves practical and real-world problems using systems engineering. The SE Center's research focuses heavily on system design projects that are co-authored with our industry partners. Recent CSD projects analyzed the order-to-delivery path of custom medical device products, manufacturing system redesign for automotive suppliers, problem identification and response in commercial product manufacturing, and system redesign of hospital emergency room and operating room facilities and practices. CSD is also being used to support strategic planning initiated by the IPFW College of ETCS.

Learning: CSD in the Classroom

CSD is integrated into the IPFW master's program in Systems Engineering (SE Program) to help students learn how to design, implement, and lead enterprise change to produce better products and sustainable enterprises. Students apply CSD in systems engineering classes to design systems for a wide array of businesses from manufacturing systems to healthcare. In senior engineering design classes, students first design a product of their choosing, and then use CSD principles to design the enterprise to build, deliver, and support their product, which also fosters an entrepreneurial mindset.

Graduate student theses focus on projects sponsored by a student's employer or in conjunction with work in the SE Center. Students enhance their learning by applying research to real-world situations and by developing relationships with potential employers. Students from companies that fund employees' tuition further benefit when

thesis project work involves their own organization.

Future Research Opportunities and Applications

The SE Center is committed to an integrated engagement, applied research, and learning agenda that builds an interdisciplinary approach to system design, manufacturing improvements, and entrepreneurship. Our goal is to expand industry partnerships and to become a conduit to facilitate learning, research, and engagement.

The CSD framework used in the SE Center defines an approach in which testable research hypotheses are made and tested through applications with industrial, healthcare, and other partners. This collaboration between IPFW and our community partners provides a results-oriented, collaborative approach to learning, discovery, and application that benefits SE faculty, IPFW students, and our community partners



DAVID COCHRAN

Director of IPFW's Center of Excellence for Systems Engineering and an Associate Professor of Systems Engineering.

Cochran is the director of the Center of Excellence for Systems Engineering. He established the Production System Design Laboratory at MIT and is the two-time recipient of the Shingo Prize for Manufacturing Excellence. His research is in the development of Collective System Design of sustainable systems.



JASON BARNES

Associate Director of the Center of Excellence for Systems Engineering

Barnes, who is associate director of the Center of Excellence for Systems Engineering, has worked as a part of industry in northeast Indiana for more than a decade as a systems engineer and an electrical design engineer. His systems engineering emphasis is in modeling and simulation.



JENNIFER OXTOBY HUNTER

Senior research associate in the Center of Excellence for Systems Engineering.

Hunter is a senior research associate in the Center of Excellence for Systems Engineering. Her work has spanned more than 15 years and her interests include enterprise transformation focused on process improvement, six sigma, leadership, and organizational development initiatives.

We live in the era of “Big Data,” in that now nearly everything is being captured and stored as digital data. Organizations are collecting and analyzing massive amounts of data from sources such as operational databases, web logs, social media accounts, mobile phone logs, video/image postings, and government records. The information stream is so large and complex that traditional data processing approaches are inadequate. These inherent challenges stem from big data’s unique characteristics, the 3 Vs: the volume of data, velocity with which it arrives, and variety of forms it takes.

Big data has great potential to convert the raw data captured from our physical world into useful information that may benefit many applications, including business, finance, public health, security and law enforcement, and city planning. For example, on social media such as Facebook and Twitter, nearly a billion comments and tweets are generated every day. This represents data that can be captured and analyzed to better understand target audiences, track purchase intent, and evaluate campaign impact.

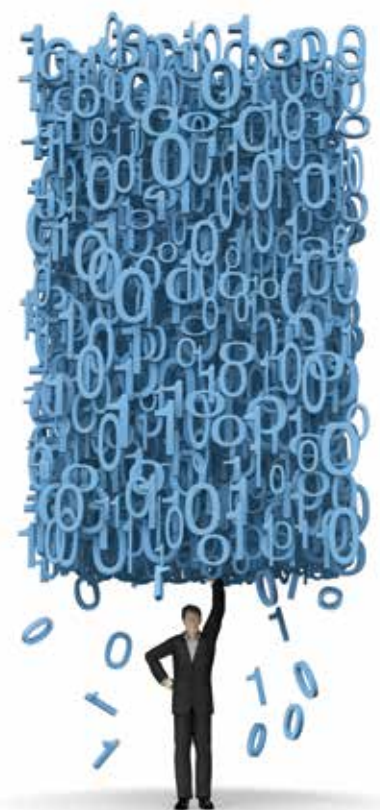
In our community, smart meters continuously stream data about electricity, water, or gas consumption, data that can be shared with customers and used to calculate more transparent pricing plans using almost real-time analytics. Geospatial data collected through various sources such as

sensors, mobile phones, social media, and global positioning satellite (GPS) or Internet of Things (IoT) devices can be used to refine sales and market segmentation, upgrade asset management, augment situational awareness, and enhance transportation and logistics planning.

At IPFW, I have focused my research on big data, computational data analytics, and data management. I include students in research such as spatial and temporal data mining, social media analytics, learning analytics, and analytics of things. Using big data technologies to analyze crime occurrences in the Fort Wayne area, we discovered interesting association patterns between incident points and nearby geospatial features. Students also built a nowcasting model to predict regional flu-like illness rates using real-time geotagged tweets. In research with students, we also have analyzed the course trajectories of successful and unsuccessful students.

A 2011 study by the McKinsey Global Institute predicted that by 2018 the U.S. labor market will face a shortage of 140,000 to 190,000 professionals with big data management and analytical skills. In addition, the report projected a need of 1.5 million additional mid-level managers and analysts who can consume the results of big data analysis effectively. Our graduates will be part of these new areas of expertise in the age of big data.

Big Data, Bigger Insights



JIN SOUNG YOO

Ph.D. in computer science from the University of Minnesota, Twin Cities, 2007.



Yoo, an associate professor of computer science, has been developing and teaching the big data analytics and data science curriculum since 2007. She researches data mining, database, machine learning, and statistical analysis, and she has focused on developing scalable algorithms for data management, data-driven knowledge discovery, and big data analytics.

Preventing Invisible Traffic Jams



Prof's work keeps mobile phones ringing and emergency channels open

Ph.D., Tokyo Institute of Technology

TODOR V.
COOKLEV

Cooklev is director of the Wireless Technology Center and Harris Professor of Wireless Communication and Applied Research. Cooklev is co-founder and CEO of Adaptive RF, the first Purdue University start-up company in Fort Wayne. His research interests include most aspects of modern wireless systems.



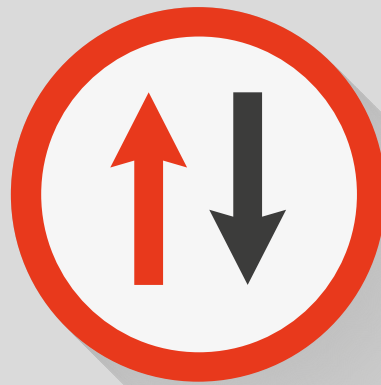
The radio frequency (RF) spectrum has growing economic value to consumers, businesses, and governments worldwide. Consumers demand higher data rates, which in turn require wider bandwidths. One channel of a 1G cellular connection is 30 KHz, while 4G requires up to 20 MHz (20,000 KHz). The bandwidth requirements of Wi-Fi connections have also grown from 20 MHz to 40–80 MHz. Usage patterns are also significant. Modern smartphones have many applications such as Facebook that run in the background and generate cellular

very desirable, its implementation on a large scale is technically very complex. So a technical problem that must be solved is spectrum monitoring. In 2013, President Barack Obama directed the National Telecommunications and Information Administration (NTIA) to design and implement a pilot program to monitor spectrum usage. One purpose of the monitoring is to detect interference. Another purpose is to determine how much of the allocated spectrum is being used and to identify opportunities for spectrum sharing

not contain a few large, expensive monitoring stations. Rather, such a monitoring system should involve a large number of simpler, less expensive spectrum sensors. To make the spectrum monitoring system sustainable and permanent, as well as able to evolve over time, it must be constructed as a system-of-systems in which the entire system has an indefinite lifetime, while the individual elements that comprise it have finite lifetimes. Therefore, government regulatory agencies should be concerned less about specific spectrum monitoring parameters and more about the architecture of this system-of-systems. The reason is that the RF spectrum environment is far too complex. There are numerous wireless systems with different bandwidths, modulation formats, multiple-access techniques, output power levels, and many other considerations.

At IPFW, we have also researched cloud-based RF spectrum monitoring and the influence of “big data.” Studying the creation, storage, and processing of exceptionally large volumes of data is vital because the amount of data produced by spectrum monitoring is much larger than other big data applications. Furthermore, an improved data architecture allows more complex services to be offered such as RF data analytics. RF data analytics will uncover what is buried in the data by mining massive datasets at different resolution levels. In this way monitoring can identify opportunities for spectrum sharing.

The spectrum environment of the future will be increasingly complex and will require permanent spectrum monitoring. At IPFW, we plan to continue our research in spectrum monitoring and other spectrum-related issues.



traffic constantly. Video is increasingly used, and as a result, there is a growing demand for space on the RF spectrum.

Spectrum Not Used Efficiently

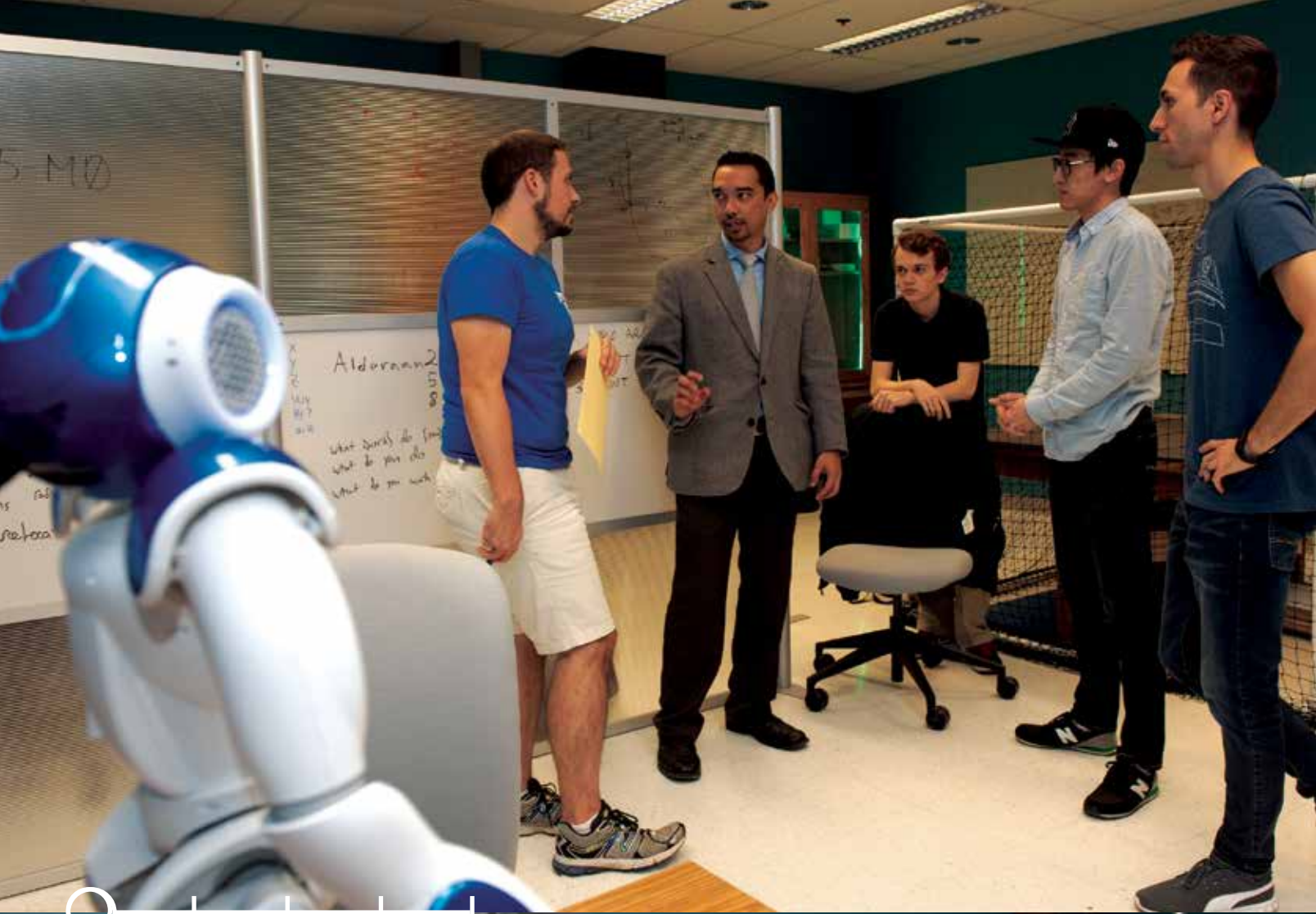
At the same time, spectrum surveys consistently show that the currently licensed spectrum is not used efficiently. Consequently, requests for additional bandwidth increasingly involve sharing rather than exclusive allocation. The concept of spectrum sharing is simple: If one system does not require bandwidth at specific times, that bandwidth can be used by secondary systems during those times, provided that the secondary systems do not cause unacceptable interference. While spectrum sharing is

among government and civilian users.

The NTIA also asked the public to comment on the proper parameters of such a system. The companies that responded touted the characteristics of their proprietary technologies. However, there is no interoperability among these different devices—they cannot work in tandem or together—and interoperability is not even an objective.

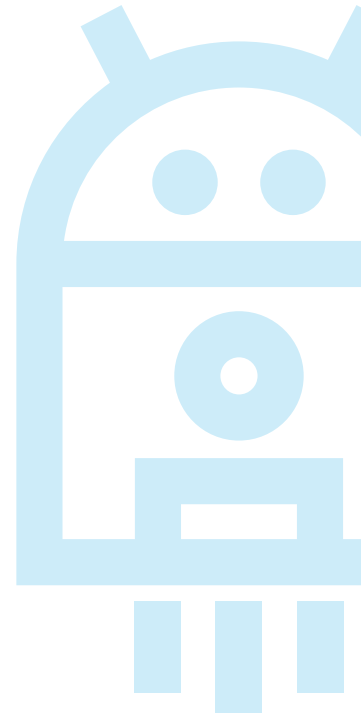
Researching RF Spectrum and Monitoring Systems on Campus

At IPFW’s Wireless Technology Center, we have been doing research on RF spectrum issues and monitoring systems. Our research suggests that an effective monitoring system should





FROM ROOMBA TO R2-D2 RESEARCH MAKES ROBOTS SMARTER



Can we predict what the future of artificial intelligence and computing will look like? In an IPFW Department of Computer Science research lab in the Engineering Technology building, teams of undergraduate and graduate student researchers are working hard to shape that future, with IPFW at its forefront.

In the Analogical Constructivism and Reasoning Lab (ACoRL), one of our first research projects began as a simple re-purposing of an iRobot Roomba® vacuum cleaning robot. With the addition of low-cost equipment, such as an Xbox 360 Kinect® for 3D vision and a touchscreen tablet for speech and other communication, the machine is now a “turtle-bot,” a partially autonomous robot that can be used in many creative ways—a telepresence avatar that allows people to attend meetings remotely, a way for nurses to check in with multiple patients easily, or even a robotic security guard.

It is hard to underestimate how much our students benefit from the opportunity to work on research projects. As the founding director of ACoRL, I see each day how a good university education involves much

more than just classes and homework. Research trains students to conceive, develop, and complete things that nobody's ever done before. It gives students the opportunity to think about the kinds of problems that aren't answered in the back of their textbook. In fact, for most research problems, the answers don't exist *yet*.

Although the computer science department faculty and staff manage the lab, we regularly contribute to cross-disciplinary projects. A collaboration between faculty in three IPFW departments—computer science; electrical and computer engineering; and civil and mechanical engineering—involves robots that can reconfigure themselves in multiple combinations. These robots can potentially transform to solve problems that designers could not anticipate. Uses for such reconfigurable robots? Consider the robots sent to do work on Mars. It would be costly to design and transport robots for every possible physical task and problem that the project may confront. Instead, it may be better to deploy a relatively small set of robots that can change their configuration—transform—to meet the needs of multiple tasks.



"... it may be better to deploy a relatively small set of robots that can change their configuration—transform—to meet the needs of multiple tasks."

And these projects stimulate more research questions: How can those robots communicate with and be controlled by a human who might be millions of miles away? If the human sends a command for the robots to form a particular configuration, how do the robots move on their own, find each other, and orient themselves properly? Some of these questions are being addressed by a computer science senior student design team working in my lab, whose work is the subject of a recently submitted National Science Foundation grant application.

In addition to collaborating with other departments, the lab allows faculty and students to engage with regional industry. Partnering with Beomjin Kim and the IPFW Information Analytics and Visualization (IAV) Center, a group of our students recently began a project funded by Targamite, LLC, a Fort-Wayne-based robotics company. The project involves

equipping Targamite's signature product, the Targabot,[®] with artificial intelligence so that it can more effectively be used in law enforcement and military personnel training. This project involves developing a 3D first-person shooting simulation that can be deployed using one-wall projection systems like those in the IAV center, from which our researchers can use AI algorithms to study effective movement patterns.

We are incredibly optimistic about our lab's future. The computer science department is beginning new projects involving the ET143 lab, including some involving the Internet of Things (see article on pages 22–23) virtual and augmented reality, and of course, continuing existing robotics projects. There are always interesting opportunities available for interested students and potential industry collaborators.



Ph.D. from Rensselaer Polytechnic Institute in 2015, specializing in artificial intelligence and the study of computational models of human-level reasoning

JOHN LICATO

Licato is a former assistant professor in IPFW's Department of Computer Science and the founding director of the Analogical Constructivism Reasoning Lab (ACoRL). In 2015 Licato became the first IPFW faculty member to receive the Air Force Office of Scientific Research's Young Investigator's Program award. Licato is now an assistant professor at the University of South Florida.



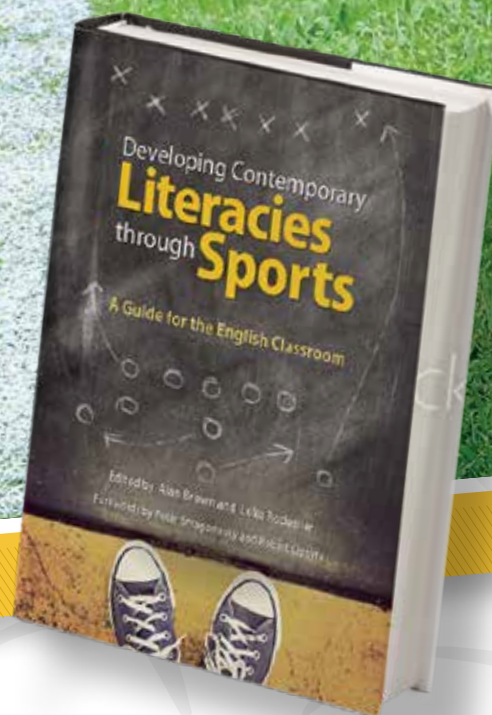
Building Smarts with Sports

When students don't connect with traditional studies of literature, sports-based texts may provide an opportunity to engage students.



**LUKE
RODESILER**

*IPFW assistant professor
of secondary education*



**Check out the
companion website
ncte.org/books/sportslit**

Find sports-themed lesson plans and classroom activities that resonate with students.

When Luke Rodesiler met Alan Brown, Wake Forest University assistant professor of English education, they discovered they shared interests in sports and its role in culture and society.

Rodesiler and Brown's research created many impactful ways for teachers to engage students through sports-related curriculum. To share these techniques with middle and

high school teachers, they co-wrote *Developing Contemporary Literacies through Sports: A Guide for the English Classroom*.

Rodesiler believes that sports and sports culture provide numerous pathways for in-depth conversations about tough subjects, such as power, privilege and marginalization, and the representation of women in sports culture.

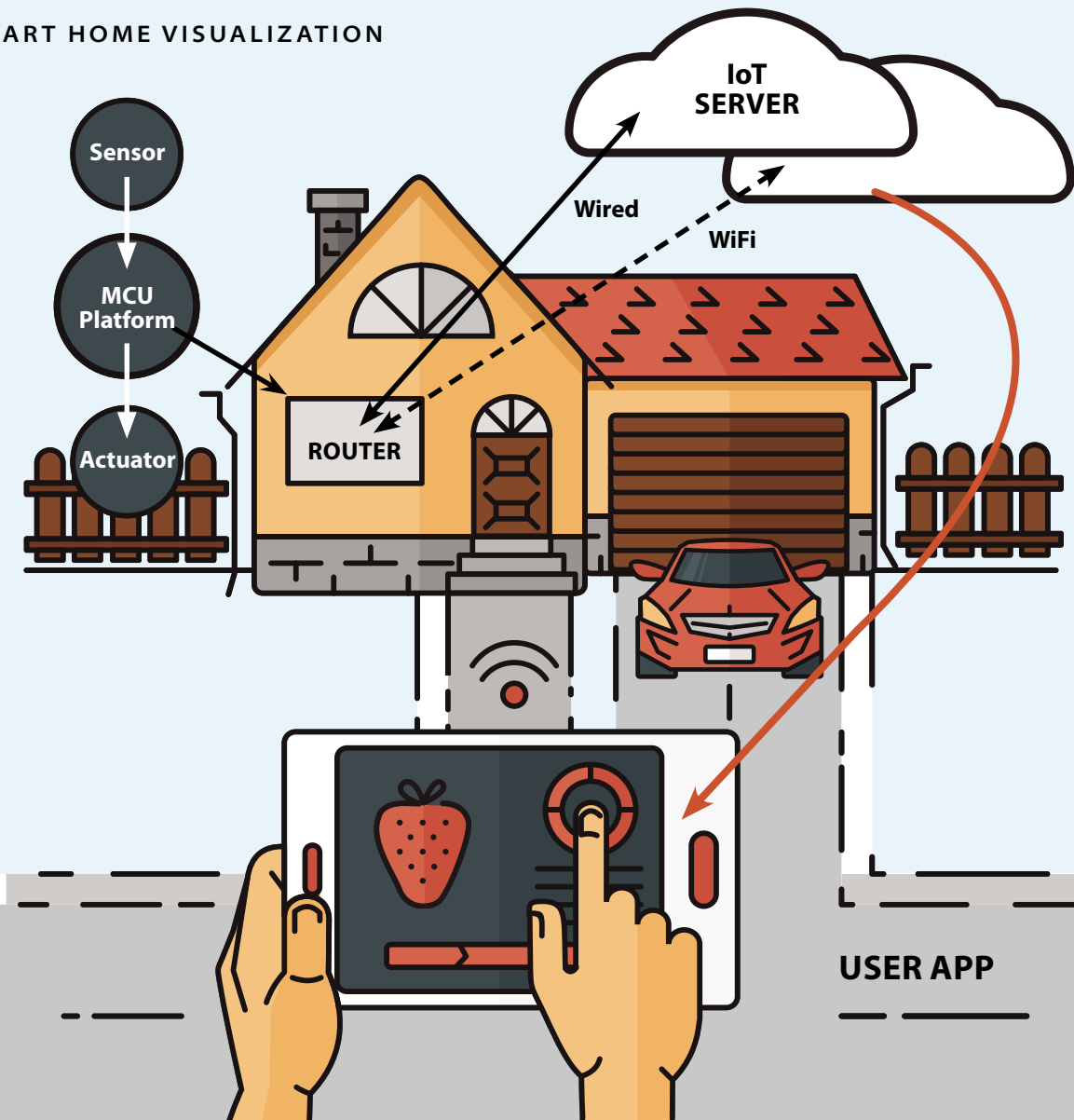
Your House Just Ordered Groceries

Designing and implementing a smart home based on the Internet of Things

Internet of Things (IoT). Have you heard of this? No, it is not a second Internet. In 2014, the Institute for Electrical and Electronics Engineers (IEEE) published a special report entitled “Internet of Things” in which the phrase was defined as “a network of items—each embedded with sensors—which are connected to the Internet.” Experts have predicted that there will be between 30 to 50 billion IoT objects connected to the Internet by 2020.

The IoT’s value lies in the data that interconnected items share. IoT data, for

IoT SMART HOME VISUALIZATION



instance, may lead to improved highways, more efficient hospitals, and more economical shipping practices. This has added a term to the lexicon: “business intelligence.” For example, a smart home filled with IoT-connected products may make lives easier, more convenient, and more comfortable. Imagine that you are driving home on a hot summer day; you can simply use your smart phone to turn down the thermostat before you are home. IoT smart city applications conveniently help organizations manage traffic, water distribution, waste, security, and other civil concerns. The expanding IoT also has benefited fields such as healthcare, construction, retail, energy, manufacturing, mobility, logistics, and others.

At IPFW, we are working with students from the Departments of Electrical and Computer Engineering and of Computer Science to research, design, and construct an IoT-focused smart home. Incorporating IoT applications in our smart home presents challenges such as the IoT system availability, big-data processing inefficiencies, and security (hacking) vulnerability. Alongside these project challenges, we want to design a low-cost, efficient, robust, and secure smart home. IoT smart home visualization is shown on page 22.

IoT Smart Home Visualization

Here are some ways our team has addressed design and implementation challenges:

- Using readily available off-the-shelf, inexpensive components, such as Raspberry Pi and Arduino Yun. For our smart home’s IoT server (often a significant cost), we are testing open-source solutions. Finally, since the open-source solution may not have all the features that we need, we are

programming our IoT server to support features such as big-data processing and security.

- Due to technological limitations, audio and video data may not be supported. We are researching both hardware- and software-level solutions that support large data transmission using new compression algorithms.
- Current IoT systems are not robust and lack sufficient back-up protocols, so our team used open-source tools to create a backup device that activates when a failure is detected.
- IoT security is a challenge. To secure our smart home’s IoT system, we are researching ways to encrypt the data transmitted between devices, providing each message has a digital signature, so that the system is less vulnerable to attack.

This project provides broader impacts beyond the proposed research and educational activities. First, the IoT platform will be available to the IoT technical community in Fort Wayne and beyond. The completed IoT project can serve as a model for discussions about IoT needs and possibilities with local industry and professionals. This project also can be used in our K–12 outreach activities to show local students what they can do if they study in our departments. Third, expanding our understanding of IoT will help researchers design better protocols and security mechanisms for next-generation complex networks. Finally, our research from this smart home project can be utilized in smart city, smart office, smart health, and other projects to make IoT development cheaper, more efficient, more robust, and more secure.



GUOPING WANG

Ph.D. in computer engineering from the University of Oklahoma

An associate professor of computer engineering in the Department of Electrical and Computer Engineering, Wang teaches courses in electronic circuits, embedded system, real-time operating systems, and computer architecture. His research areas include IoT application, embedded systems, and Field Programmable Gate Array (FPGA) for Digital Signal Processing (DSP) applications.

ZESHENG CHEN

Ph.D. in electrical and computer engineering from Georgia Institute of Technology

Chen is an assistant professor of computer science in the Department of Computer Science and teaches courses in computer architecture, programming languages, software engineering, software project management, and web application development. His research areas include the Internet of Things (IoT), social networks, mobile sensor networks, cognitive radio networks, and network security.



Experts have predicted that there will be between 30 to 50 billion IoT objects connected to the Internet by 2020.



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