UNLV | ELECTRICAL & COMPUTER ENGINEERING

MESSAGE FROM DEPARTMENT CHAIR

I welcome you again to the Spring 2018 newsletter of the Department of Electrical and Computer Engineering at UNLV.

Faculty research highlights of this newsletter include Professor Robert Schill's patented solution to quickly and safely detecting sensitive detonation devices, and Professor Biswajit Das' group in their quest to develop a water-free cleaning technology for large-scale photovoltaic (PV) generation.

Our department has enjoyed steady growth of our student population with more than 600 undergraduate students enrolled in our computer engineering and electrical engineering programs. These students are also making their mark in the classroom and through experiential learning opportunities. A pedestrian lighting system, smart ballet shoes, a remote-controlled device that can detect IEDs, and a location-sharing app designed to encourage human interaction were among 10 fascinating Senior Design projects that were on display in last December's Senior Design Competition.

The Internet of Things (IoT) will connect 50 million devices by 2020, and it is anticipated to be the next wave of Internet technologies that will fundamentally change the way we live and work. To expose the senior students and graduate students to these exciting technologies built around IoT, Dr. Grzegorz Chmaj developed a new course with a clear focus on IoT technologies and its applications. The course was delivered in the fall 2017 semester by Dr. Chamj and it was very well received.

As part of a campus-wide effort to grow and expand both our undergraduate and graduate programs, UNLV signed a couple of joint education agreements with Shanghai Maritime University (SMU) in 2017. To promote these joint programs, a UNLV Winter Experience Camp was organized for 25 SMU students who spent three weeks in the ECE department for various academic and non-academic activities in early 2018.

(Yingtao Jiang, Professor and Chair)

Research Highlights:

Using Nanotechnology, Not Water, to Clean Solar Panels

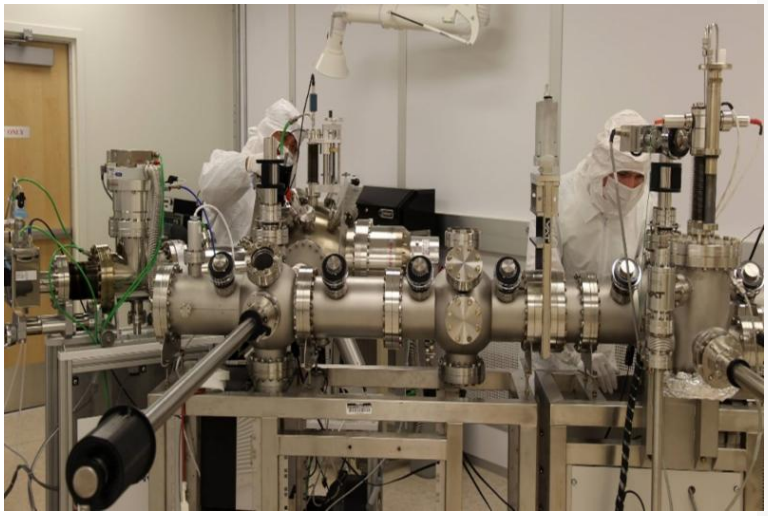
ECE professor Biswajit Das and his team develop a water-free cleaning technology that will be cost-effective for large-scale photovoltaic (PV) generation. (Original story by Jane Palmer from UNLV Nexus with modification)

Although solar panels might appear bright and shiny in desert environments, where they are most frequently installed, layers of dust and other particles can quickly coat their surface. These coatings can affect the panels' ability to absorb sunlight and drastically reduce the conversion of the Sun's rays into energy, making it necessary to periodically wash the panels with water. But often, in areas like Nevada, water resources are scarce.

Consequently, scientists have turned their attention toward developing technologies for waterless cleaning. NASA has already been using such techniques to wash panels in the lunar and Mars missions but their developed methodologies prove too expensive for widespread public application. ECE faculty, Dr. Biswajit Das and his team, supported by NSF Nexus, are aiming to develop a water-free cleaning technology that will be cost-effective for large-scale photovoltaic (PV) generation, whereby they look to nanotechnology, rather than water, to clean the panels.

"Our mission is to develop a waterless, or at least a less-water cleaning technique to address the effect of dust on solar panels," Das says.

"Once developed, this method will significantly reduce water use for the future PV generation."



Nanoparticle Synthesis - Nano Deposition System at UNLV. (Biswajit Das and Sanjana Das Photo)

A Microscopic, and Dry, Solution

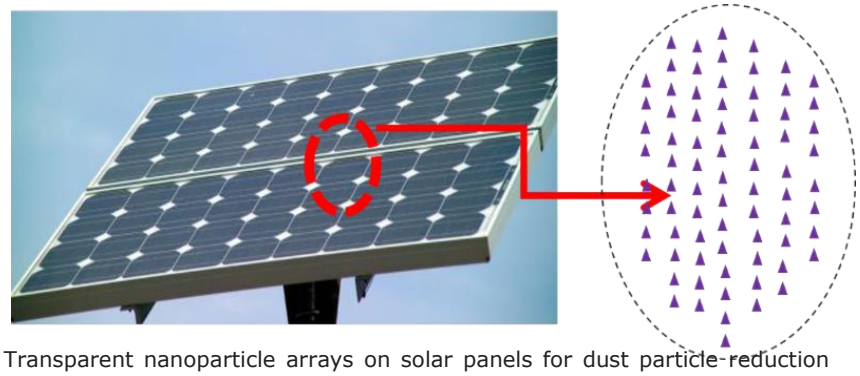
The Das team project relies on tiny particles, known as nanoparticles to do the cleaning work for them. Their idea is to coat the solar panels with arrays of transparent but electrically conducting nanoparticles. These particles provide an electrical field that can modify the electrical properties of the dust particles. Once these dust particles are charged, an electrical field can be used to attract them and sweep them away from the panels without the use of water.

Ivanpah Solar Electric Generating System – a concentrated plant in Mohave Desert. (Biswajit Das and Sanjana Das Photo)

While the concept may appear simple, several factors determine whether the technology will ultimately be viable. The first consideration is that the nanoparticles themselves be transparent. "If we are coating the solar panel, we don't want to block the light, so that is one of the first things we have to address," Das says. Already in the UNLV Department of Electrical and Computer Engineering scientists have a system in place to create any type of nanoparticle at any density, but this technology is currently tailored for the purposes of constructing devices and integrated circuits, not requiring the creation of large areas of nanoparticles. "It's really high cost, so this cannot be useful for large-scale photovoltaic applications," Das says.

At present, however, the scientists are using this methodology to see if their water-less cleaning concept will work. "And then we will move on and develop a low-cost technology for the new solution."

Using the tools already available, the scientists have synthesized nanoparticles of indium tin oxide and zinc oxide. Both these compounds are efficient conductors of electricity but are also transparent, a rare property. The team is also working on developing a low-cost technique, because the existing technique used for project demonstration would be highly expensive. "They wouldn't cover much of a surface area and the PV panels are, of course, huge," Das says. "And we would need to create a technology that is much, much less expensive."



Transparent nanoparticle arrays on solar panels for dust particle-reduction and removal (Biswajit Das and Sanina Das Photo)

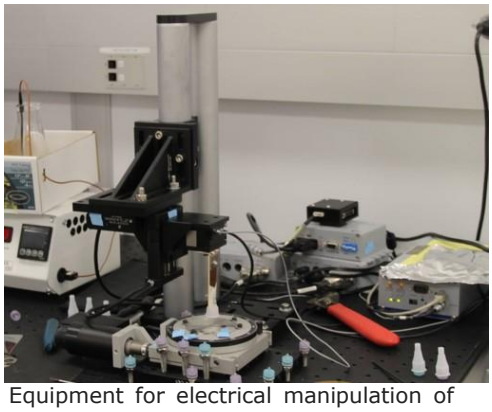
Fine Tuning the Process

The scientists have performed multiple experiments to fine-tune the process of creating the nanoparticles that will be best suited for this application. The scientists' synthesis process produces charged nanoparticles. Using in-house equipment, the scientists have demonstrated that the charged nanoparticles can be moved around using an electric field. "We were very encouraged to see that once the particles are charged, they can be efficiently manipulated using electric field," Das says.

The Das team is currently working on developing a low-cost technique for creating the transparent nanoparticles. Once the nanoparticles are created, one of the key goals of the project is to determine how to charge the dust particles and how to measure that charge. "Unless we can measure it we can't know if we are charging it properly," Das says.

Once the scientists have perfected this process they plan to build a large area of nanoparticles, which will be specifically charged. Dust particles would then accumulate on this area and be charged by the nanoparticles. "Our hope is that the focused electric field could actually charge the dust particles sufficiently so that we can move them," Das says.

The scientists continue to work on the many challenging aspects of the project: creating the nanoparticles, charging and measuring the dust particles, and transferring the dust with an electric field. "We are very encouraged by the achievements we have made so far, and hopeful that will be able to develop a low cost technology for charging and electrically manipulating dust particles," Das says. "We believe that this will be a big step towards sustainable generation of solar energy."

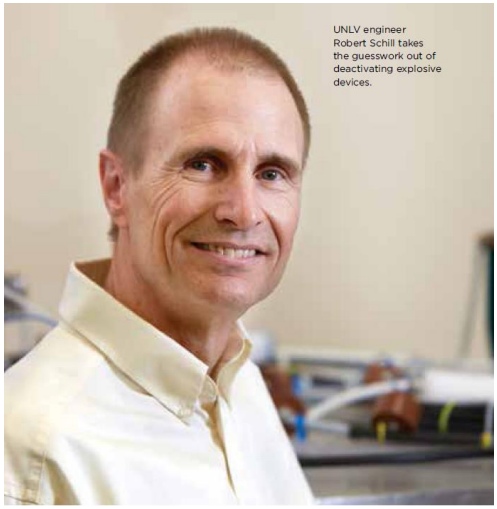


Equipment for electrical manipulation of charged nanoparticles. (Biswajit Das and Sanina Das Photo)

New Patent Covers 'Explosive' Subject

ECE professor Robert Schill has a patented solution to detect explosives.
Originally ran in UNLV Innovation Magazine

Given how commonplace the use of explosive devices has become in fields such as construction, mining, demolition, and more, the need for an effective method to deactivate such devices—particularly in a safe and controlled fashion—becomes clear.


UNLV engineer Robert Schill takes the guesswork out of deactivating explosive devices.

Robert Schill—director of the Center for Energy Materials Interaction Technology Initiative of Nevada (EMITION), professor of electrical and computer engineering, and an expert in areas including electromagnetics and plasma physics—has been working on this problem and was awarded a patent for his solution to it.

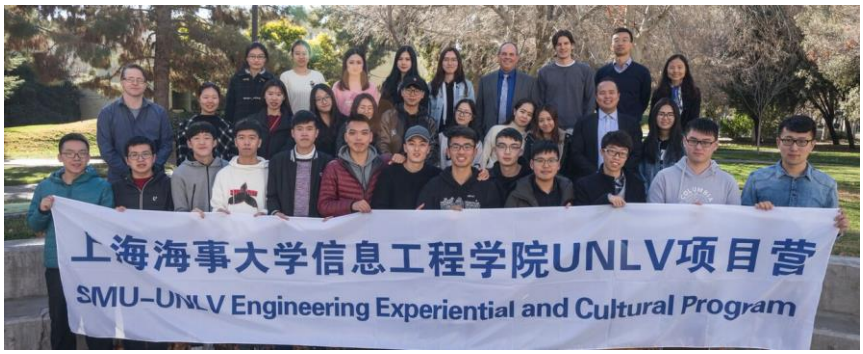
Many of today's explosive devices are triggered electrically or electronically and can be difficult to transport or manipulate. Schill's patent, "Diminishing Detonator Effectiveness Through Electromagnetic Effects" (#9,448,042), covers the apparatuses and methods for deactivating or hindering the performance of these sensitive detonation devices, thereby reducing intentional and accidental triggerings of detonators. His solution takes the guesswork out of disabling explosive devices that can employ any number of activation methods, such as movement or timing, by attacking the heart of the problem— the detonator element itself—and reducing its functionality.

"When we talk about explosives, we're talking about potentially life-or-death situations," said Zach Miles, UNLV's associate vice president of economic development. "Explosives safety is mission critical, and Schill's patented work is a compelling addition to UNLV's portfolio."

INTERNATIONL COLLABORATION

In 2017, UNLV signed the 3+1+1 (combined undergraduate and masters) and joint masters program agreements with Shanghai Maritime University (SMU). To promote these programs, a three-week UNLV Winter Experience Camp was organized by the UNLV College of Engineering. From January 23 to February 9, 2018, the college and the ECE department hosted a group of 25 SMU undergraduate students majoring in Communication Engineering, Electronic Information Engineering, Network Engineering, and Computer Science & Technology. At UNLV, they attended seven short-term ECE Learning Workshops offered by our faculty, in addition to workshops that prepared them to take the Michigan Test (English proficiency test). According to our faculty, these students were very attentive in the ECE learning workshops. Organized by Dr. Mei Yang, the students also visited several of our state-of-the-art research laboratories including Energy Material Interaction Technology Initiative of Nevada, Nevada Nanotechnology Center, Network and System Integration Laboratory, Real-Time Intelligent Systems Laboratory, as well as College of Engineering's Robotics Laboratory. The visiting students were very impressed by the demonstrations and presentations throughout their lab tours. Several students brought up a lot of questions and interacted well with our graduate students. One SMU student desired to continue working in one of our labs.

One pizza party was organized to provide the opportunity for the students to network with our graduate students and faculty on January 26. They also had the chance to attend a basketball game on January 31, played by the host UNLV team against San Jose State. Though it was so short, only three weeks long, the students had acquired in-depth knowledge of the teaching and research opportunities within the department. Several of them expressed deep interest in the 3+1+1 programs. We are expecting to see their applications soon.



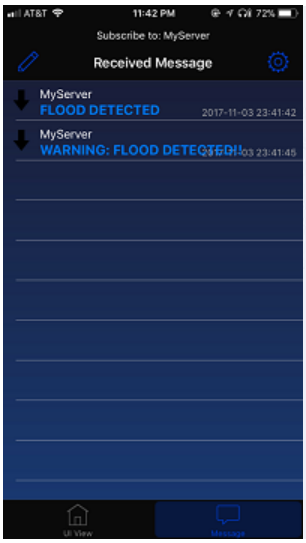
Special thanks to Drs. Muthukumar, Chamaj, Regentova, Saberinia, and Latifi for their effort in preparing the learning workshops, Drs. Schill, Das, Morris, Yang, and Oh for providing lab tours, and our graduate students Jian Ni, Zhao Fu, Yang Jiao, Binayak Tiwari for their assistance in lab tours. Thanks to Jennifer and Cameron for their help.

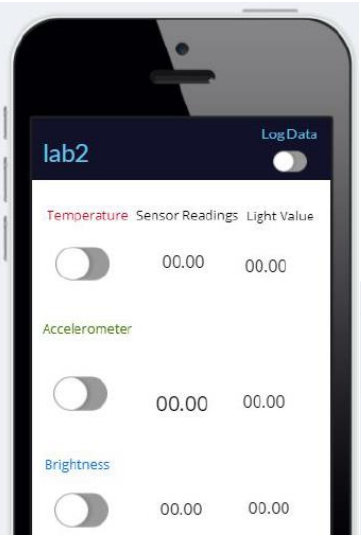
A NEW ENGINEERING COURSE ON INTERNET OF THINGS (IOT)

In Fall 2017, Dr. Grzegorz Chmaj in the Electrical and Computer Engineering Department offered for the first time a new course on the Internet of Things (IoT). Titled as CPE417 Internet of Things Systems (co-listed as ECG617), this course covered various important topics on emerging technology of IoT, including the architecture of IoT Systems, principles of design and accompanying technologies that are present in the IoT and crucial to its operation. The IoT technolgoy dynamically changes both the software and hardware areas. Thus the course includes the overview of the state-of-the-art sensors and nodes, along with their characteristics and examples of use. Many elements operate based on Real Time Operating Systems (RTOS). RTOS characteristics together with non-RTOS operating systems are an interesting topic discussed in the CPE417 class, including the power efficiency of the various solutions. Another key area for IoT is the connectivity - elements of IoT constantly exchange information between local and remote elements. The number of technologies involved in this matter is now huge and still growing. Main topics about the communication in IoT are: IoT-Internet communication, IoT-specific networking protocols, RFID, NFC, WSN and MQTT. Along with the operating systems and connectivity - the security topics applicable to IoT are presented. The course covers the most important ones as well as the latest solutions taking over the IoT world. Many variations of IoT systems are discussed: Internet of Robotic Things, Industrial IoT, Consumer IoT, Internet of Everything and others. By its nature, IoT is related to multiple areas of Electrical Engineering, Computer Engineering and Computer Science. The roles of these areas in IoT are discussed, including Machine Learning, Big Data, M2M, and Blockchain. The CPE417 course also includes few non-technical topics such as Regulations in IoT, Ethics, relation to business and the future of Internet of Things.

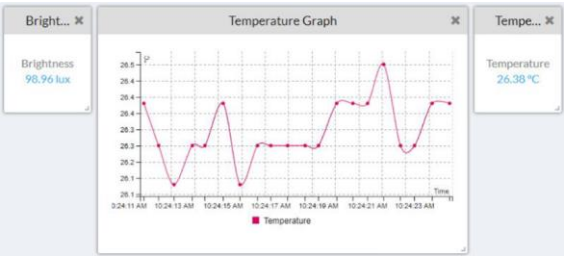
The class includes multiple projects: building small IoT system with local sensors, communicating between multiple hardware elements, interfacing with the remote cloud and building the smartphone-based interface for IoT.

Interfacing to the class project:



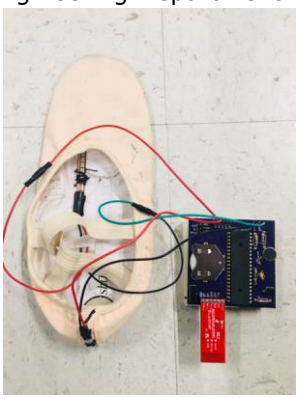


Cloud view

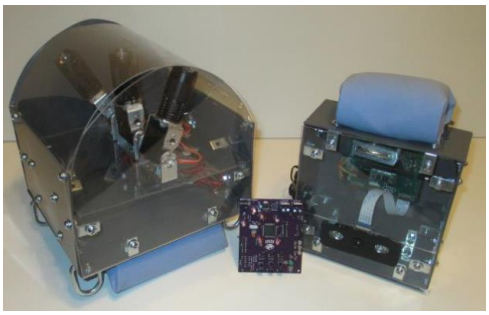


SENIOR DESIGN COMPETITION: FALL 2017

The 2017 Fall semester Senior Design Competition of the Electrical and Computer Engineering Department was held on Dec. 6, 2017, featuring 10 projects drawn from the areas of CPE, EE and multidisciplinary areas. Projects combine engineering design and applications in real life. Some of outstanding projects are described in the following paragraphs.

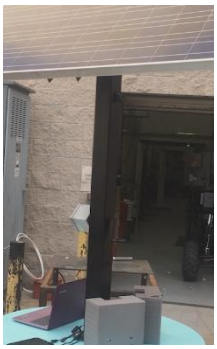


The Smart Ballet Shoe (picture right) is for dancers who need the extra practice to grasp the ballet techniques. It is designed as a footwear that replaces the conventional ballet shoe. The product provides the type of feedback that one would receive from a dance instructor. The components consist of a cloth ballet shoe for housing that fits snug and comfortable to the foot; a flex sensor to measure foot flexibility; a pressure sensor to measure the impact of the wearer's landing and to trigger a stopwatch to time their balance; and a vibration motor to notify the wearer when they are executing a technique incorrectly. A printed circuit board, which is stored in a leg band, is designed, and programmed to retrieve data from the shoe and send it to a computer via Bluetooth.



The Pedestrian Lighting Guidance System (picture left) is designed to aid pedestrians in crossing the street during the nighttime. The device consists of a camera, Raspberry Pi, microcontroller, temperature sensor, photoresistors, servos, and LED lights. Sensors are used to detect the pedestrian. The servos position the LED lights and illuminate the pedestrian to ensure proper lighting from one side of the crosswalk to the other.

ATMOS (picture right) is a simple and cost-effective indoor air monitoring system. It is designed to measure temperature, humidity, and carbon monoxide (CO), particulate matter (PM 2.5 and 10.0) and volatile organic compounds (VOC) levels in the home. This system provides instant notification if any harmful values are detected, and monitors the history of gathered data on a corresponding iOS and Android application.



SOLARjuice is an interdisciplinary project (EE+ME). By combining a photovoltaic system onto a patio style umbrella, and utilizing a dynamic canopy mount, SOLARjuice has provided a means of charging electronics while being able to enjoy the outdoors and promoting sustainable practices. SOLARjuice is a completely off-grid and self-reliant system equipped with a Wi-Fi amplifier, to ensure a strong Wi-Fi connection and a battery to provide a constant source of power. Through implementing a manual, one axis tracking system, SOLARjuice has the capability to sufficiently supply enough charge for 2 AC (alternating current) and 4 DC (direct current) outlets; which allow for up to 6 devices to be charged simultaneously.

JUNIOR DESIGN COPETITION: FALL 2017

In the fall 2017 semester, the ECE Department held the 5th edition of the Junior Design Competition. Students enrolled in CPE100L, CPE200L, CPE300L, EE221L, EE320L or EE370L, and not enrolled in Senior Design were eligible to participate with their lab projects. Teams of two-to-three students presented hardware or software projects to judges and the audience.

The winning team (Flachsenhar, Barker, Heng from CPE100L) presented the project of *Casino Craps* game based on the DE2 FPGA board. The project had great implementation and user interface. The 2nd prize was awarded to project *Morse Code Translator and Display* presented by Harvey and Cabahit, also from the CPE100L class. The programmed board could translate the Morse code to alphanumeric characters in real time. Project *Decimal to Binary Addition Learning Game* presented by a CPE200L team (Buckley, Hierholzer) received 3rd prize. Thegame required players to convert the number and enter the correct combination – to advance the player towards the winning point. Two honorary mentions were awarded: Honorable Mention for Sequential Design for *Digital Alarm Clock* project and Honorable Mention for Analog Design for the project *Visualizing Sound and Electricity*.

FACULTY ACHIEVEMENTS

- ✓ Professor Shahram Latifi delivered a keynote lecture titled "The Rise of Machine Learning" at the International Conference on IT Convergence and Security (ICITCS 2017) at the Seoul, S. Korea on September 26, 2017.
- ✓ Professor Shahram Latifi organized the Cyber Infrastructure Day Event at Las Vegas on May 2, 2017. This event is sponsored by the NSF EPSCoR program and was held as a part of the NEXUS educational outreach activities.
- ✓ Professor R. Jacob Baker was granted four new patents in 2017. His inventions touched upon regulated voltage reference, digital filter, optical interconnect, and analog to digital converter.
- ✓ Professors Yingtao Jiang and Mei Yang and their collaborators coauthored a research paper on new 3D Network-on-Chip (NoC) architecture that genuinely supports runtime thermal-aware task management. The paper appeared in volume 66, issue 10, of IEEE Transactions on Computers published in October 2017.