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ANNUAL REVIEW

ELECTRICAL & COMPUTER ENGINEERING

VCU College of Engineering

OPENCYBERCITY TESTBED

PROVIDES PLATFORM FOR RESEARCH INTO DIGITALLY-CONNECTED SMART CITIES

The OpenCyberCity is a 1:12 scale model of a smart city where students can learn about and experiment with the various systems found in real-life smart cities.

The Commonwealth Cyber Initiative (CCI) has funded three new VCU testbeds aimed at analyzing the security of smart city operations, medical devices and NextG applications.

Developed under the leadership of **Erdem Topsakal, Ph.D.**, director of the CCI Central Virginia regional node, senior associate dean of the VCU College of Engineering and professor of electrical and computer engineering, the new initiative includes the OpenCyberCity Testbed, which provides a realistic, small-scale cityscape in which to run experiments related to smart cities and autonomous vehicles.

A 1:12 scale model, the OpenCyberCity is a smart city testbed where students can learn about several aspects of modern smart cities. The testbed consists of data collection and processing units, database management, distributed performance management algorithms, and real-time data visualization, said **Sherif Abdelwahed, Ph.D.**, project director and VCU electrical and computer engineering professor.

"The testbed provides a near real-life platform to allow students to learn about the unique features of smart cities and explore the supporting technologies," Abdelwahed said. Six graduate students are working on OpenCyberCity-related projects.

The smart city testbed's Intelligent Transportation System includes autonomous cars and intelligent infrastructure.

OpenCyberCity is one of three new testbeds that complement VCU's Dreams to Reality Incubator, which recently launched two new companies that also received early-stage funding from CCI.

Symple Solutions, Inc. is innovating the next generation of safe and secure instrumentation and control systems for critical infrastructures, including nuclear power, autonomous systems and more.

Another startup, VirtualPLC, is designed to mimic programmable logic controllers used in industry settings to collect threat intelligence on physical processes in the U.S. critical infrastructures.

OPTICAL RESEARCH ILLUMINATES A POSSIBLE FUTURE FOR COMPUTING TECHNOLOGY

Nathaniel Kinsey, Ph.D., Engineering Foundation Professor in the Department of Electrical and Computer Engineering (ECE), is leading a group to bring new relevance to a decades-old computing concept called a perceptron. Emulating biological neuron functions of the messenger cells within the body's central nervous system, perceptrons are an algorithmic model for classifying binary input.

When combined within a neural network, perceptrons become a powerful component for machine learning. However, instead of using traditional digital processing, Kinsey seeks to create this system using light with funding from the Air Force Office of Scientific Research. This "nonlinear optical perceptron" is an ambitious undertaking that blends advanced optics, machine learning and nanotechnology.

The United States Department of Defense sees optical computing as the next step in military imaging. Kinsey's work, while challenging, has the potential to yield an enormous payoff. Nonlinear optical computing could also be applied to a number of non-military applications. For example, optical computing could make better light detection and ranging equipment (better known as LIDAR) in driverless cars.

The concept of optical computing is not new, but interest (and funding) in theory and development waned in the 1980s and 1990s when silicon chip processing proved to be more cost effective. Recent years have seen many advancements in computing, but the more recent slowdown in scaling of silicon-based technologies has opened the door to new data processing technologies.

Kinsey and other researchers working in the field are in the early stages of scientific exploration into these optical computing devices. Consumer applications are still decades away, but with silicon-based systems reaching the limit of their potential, the future for this light-based technology is bright.

ENGINEERING STUDENT GAINS REAL-WORLD EXPERIENCE THROUGH SMART SCHOLARSHIP

Sekai Clayton is a recent graduate who completed a Science, Mathematics and Research for Transformation (SMART) Scholar summer internship with the U.S. Department of Defense in Northern Virginia.

"Electrical engineering at VCU prepared me to go into the government sector with the ability to positively impact the work being done on base," said Clayton.

Clayton's research involved developing communication solutions for a fleet of classified emergency radio response team vehicles. He aided in the device configuration of truck-mounted radios, antennas and arrays. Clayton also assembled test beds for networked solutions, like a virtual radio environment that mimicked a disaster zone where getting a good signal would be difficult.

VCU was not top of mind when Clayton considered colleges until he visited the campus to look at the senior design projects during the College of Engineering's Capstone Design Expo.

"I must have gotten lost for an hour, and then it started to rain. Long story short, my socks squished on the car ride home. Even still I had fun. I felt like I was home," Clayton said. "When I walked down West Main Street that day, I felt it was a place I could grow and become a better version of myself. That's why I decided to come to VCU."

During his own Capstone Design Expo experience, Clayton recalls many unexpected challenges. "There were a lot of issues at the front end, but in the best way. I gained a lot of real world engineering experience in my last year that gave me the confidence to step into any lab and get the job done."

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