College students use 'smart' technology in football helmets to detect injuries

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Imagine a football helmet with brain wave probes and a device that measures acceleration forces to detect concussions on the field and directly communicate the information to medical staff.

Or a bike recovery network that uses tracking technology and a network of "smart" bike racks to text the owner and police the moment a bike is stolen, and the moment the thief parks it in another rack with the same technology.

Maybe a wristband that looks like a Fitbit, programmed by a pharmacist through Bluetooth to vibrate and light up to remind people when to take specific medications.

During the past two semesters, teams of students at University of Wisconsin-Madison brainstormed these devices and a couple dozen others in the university's Internet of Things Lab.

"Internet of Things" refers to a new generation of devices that measure, monitor and control the physical world by talking with each other via the Internet. The only human involvement is creating and programming them.

"Imagine everything you touch could have an Internet connection with sensing and data, and it could do more," said Sandra Bradley, the lab's research director for consumer and retail applications. "Your refrigerator keeps things cold. What if it could give you shopping lists or monitor

spoilage of food? This is about things people touch every day, and say, 'What if?'"

A team of students developed a prototype for exactly what she described - a "smart kitchen inventory" using cellphones and Near Field Communication tags that securely store personal data to be communicated between devices.

The lab's goal is to be a hub where the promise of devices for a hyper-connected world can be unlocked with consumer, retail, health care and industrial applications, according to Bradley.

Aside from developing devices in a lab, students get a chance to work in cross-disciplinary teams to solve problems, Bradley said.

It's like a sandbox where students with different but complementary strengths can find each other, brainstorm and develop technology innovations together, said Raj Veeramani, the lab's faculty director.

"We give them 'toys' and pizza," Veeramani told several hundred people gathered for a recent open house to measure industry interest in the devices.

By toys, he means cutting-edge technologies such as Google Glass (an optical head-mounted technology that displays information requested via voice command); RFID (radio-frequency identification); EEG (brain wave) probes; accelerometers (electromechanical devices that measure acceleration forces; think air bag deployment after a car crash); Oculus Rift (virtual reality headset for 3-D gaming); and Bluetooth (wireless communications technology).

The lab isn't part of a class; students do the work on their own time. But faculty and industry provide guidance as needed. Because students are

not paid, prototypes they create are their intellectual property. They can find investors, patent and ultimately sell their creations.

Medcuff, the wristband that a pharmacist could program via Bluetooth to remind people when to take medications, debuted at an open house last spring. Its developers have been talking with potential investors.

Medcuff vibrates and lights up a color associated with a specific pill. It was inspired by a conversation between retailing student Dylan Mack and his mother.

"She was talking about getting reminders for my grandparents to take their pills on time," Mack recalled. "She was constantly calling them to remind them; they didn't have smartphones to set reminders."

During the open house that attracted about 400 people, including faculty, other students and industry professionals, the team that developed the concussion-detecting football helmet won $800 because a group of industry professionals judged it the device with the most potential impact.

A team that used Bluetooth, radio-frequency identification and an object tracker drone to send real-time data also won $800 for most innovative technology.

Several industry representatives milled among exhibits of devices, including Scott Kurilla, marketing director for ITW Welding-Global Industrial Systems in Appleton.

"There's a lot of very interesting technology leaps and the potential is boundless," Kurilla said of what he saw at the open house. "We're looking at the connection of industrial devices like welding equipment through the Internet and transfer of manufacturing product data."

The still-under-development Bike Recovery Network would use a radio-frequency identification tag (RFIT) hidden on a bike and an Internet-connected bike rack, according to team member Akhil Sundararajan, an electrical engineering grad student.

"Most bikes that are stolen aren't recovered, and if you see your stolen bike, you usually can't prove it's yours," Sundararajan said. "We think it could possibly be integrated by the bike manufacturer so it's concealed and foolproof."

He estimated it would cost about $20 per device to manufacture in bulk.

The Bike Recovery Network, which Sundararajan said could be an effective theft deterrent on college campuses, was the brainstorm of undergraduates and graduate students in industrial and systems engineering, philosophy, electrical and computer engineering, computer sciences, and operations and technology management.

Sundararajan said the team plans to meet with Madison police to discuss the device and its potential. They're also talking about expanding the technology to snowboards and skis, with the reader device attached to ski lifts.

The UW Athletic Department donated a Badger football helmet to the students developing the high-tech helmet.

"We're refining the design and hope to get better sensors at some point," said team member Shawn Bartel, who will graduate with a bachelor's degree in mechanical engineering.

The sensors tucked in the helmet padding record four frequency bands of brain waves: delta (to detect any loss of consciousness), beta (to detect abnormalities in cognitive thought, such as slower responses), alpha

(mood/stress) and theta (light sleep, or the border between conscious and subconscious).

The accelerometer device in the helmet measures impact forces of a collision.

John Keehn, another mechanical engineering undergrad who worked on the helmet, played football as a kid and had the idea of quick assessment for possible concussions. The third team member, Sohan Shinde, is a mechanical engineering graduate student.

Bartel is a Packer's fan. He said he's excited about working on technology to better detect concussions so players can be sidelined, rather than continue to play and risk further injury.

He's also a fan of the Internet of Things Lab.

"It's a really cool way for students to engage in projects they have ideas for," Bartel said. "The lab provides equipment and guidance, and you get to work with students you otherwise wouldn't meet."