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Member Success Case Study

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Applying Machine Learning to Sensing and Signal-Processing Technology

If you've ever driven down a narrow mountain road late at night, you're probably familiar with the white-knuckle experience of taking sharp curves, wondering if you'll see a pair of headlights coming toward you just around the corner. In situations like this, our senses are quite limited. But what if your car could extend your sensing capabilities, telling you what lies ahead?

In densely populated countries with narrow roads, collision accidents are more common. As more people use autonomous-vehicle technology, though, traffic fatalities have dropped dramatically in recent years. In Japan, for example, the National Police Agency reported that the number of deaths from traffic-related incidents fell to a record low in 2019, the lowest number since 1948.

Autonomous vehicles are equipped with sensors, such as radar, that help them navigate their environment. As such, the development and production of smarter sensors that can detect and measure target objects quickly and accurately in real time is becoming increasingly important when improving infrastructure such as transportation. Improving upon advanced sensing and signal-processing technologies with machine learning can greatly improve accurate navigation.

CSAIL Alliance member OMRON Corporation is a global leader in automation, with the mission to "improve lives and contribute to a better society." They do this by increasing productivity in manufacturing and creating new opportunities for people and machines to interact. They achieve automation in manufacturing by evolving sensors and controllers that can think for themselves, creating integrated, intelligent, and interactive machines and systems, with one chief area being the development of sensing technology. In a factory setting, for instance, an industrial robot can help automate sensors, like directing an object on the assembly line. OMRON combines optical control and signal-processing technologies to capture and process valuable information about target objects, painting a full picture of the scene.

"Here in CSAIL, there are so many very detailed researchers and machine-learning specialists. So, the advice we can receive is very high-level every time."

Masayuki Koizumi, visiting researcher from OMRON

Through a collaboration with MIT CSAIL, Masayuki Koizumi, a visiting researcher from OMRON, is working to pair this sensing technology with artificial intelligence. He collaborates with the Networks at MIT research group within CSAIL, led by principal investigator Professor Dina Katabi.

"[Prof. Katabi's group] has radar, electromagnetic-wave technology, and machine-learning technology, and already they have surprising results for sensing through walls," said Koizumi, referring to a project in which wireless sensing capabilities can detect a target object through a barrier.

"We first saw a demonstration on YouTube, and we were very surprised," he said. "We wanted to help improve it and apply this technology to our own work." And so, a collaboration was born. The research team aims to find the target in the non-line-of-sight through wireless signals.

At OMRON, Koizumi previously led the Forpheus project, the "world's first AI-equipped table tennis tutor," and is interested in the computation behind machine learning and artificial intelligence. "Normally, you wouldn't be able to see through a wall, but the combined radar technology and machine-learning pairing made this possible." He said that in a traffic scenario, for example, "if we can find the target in the blind spot, we can prevent collisions."

He further explained, "To detect the target around corners, we utilize multiple reflection of wireless signals. But it is basically very difficult to detect the target from the signals reflected several times, because the signals are reflected in a complex branch in various directions and the intensity is very weak."

That's where machine learning comes in. "If we use machine learning," said Koizumi, "the many times of reflection are calculated, and the signal can be directed more effectively to find the target." He added that Prof. Katabi's research group is directly contributing to the machine-learning part of this work.

"I think that the machine-learning technology can be used for improving any kind of sensing technology. I can apply it to so many other kinds of sensing technologies, which I think will have a huge impact in my company."

Masayuki Koizumi, visiting researcher from OMRON

Due to these promising results, Koizumi sees the potential of improving both the sensing and machine-learning capabilities for a variety of applications, leading to more complicated tasks. "This will be very helpful for Japanese industries," he said. "OMRON uses so many kinds of sensors, such as magnetic wave sensors, and we have so many sensor products and robots, including those for health care, blood pressure measurement, and so on. Or for example, my company is trying to develop industry robots that can sense and grab objects correctly. This machine-learning research will help improve such sensing systems."