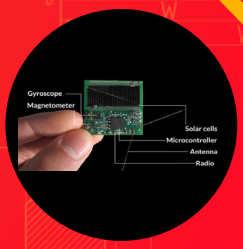
KEYSIGHT TECHNOLOGIES

IoT INNOVATION CHALLENGE



2019 SMART WATER FINALIST

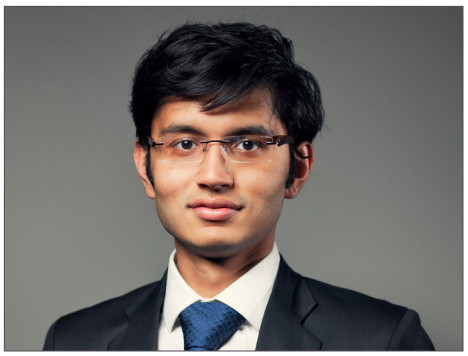
Immersible IoT Sensors for Cloud-based Water Quality Monitoring

Stanford University graduate students develop a simple IoT platform to swiftly detect chemical spills in water

Water is being used more and more for agriculture, but each year, there are thousands of chemical and oil spills around the nation. When a chemical spill takes place, it can be a huge setback—and by the time it's detected, it's almost always too late to minimize the damage.

A team of three graduate students from Stanford University hope to change this. The team developed a platform called Immersible Internet-of-Things (IoT) Sensors for Cloud-based Water Quality Monitoring that allows users to customize the number and types of sensors to continually monitor water conditions and detect spills quickly. They've coupled this with a novel sensor for ammonia, a contaminant that can be found in agricultural runoff and other waste stream water. The team believes their ammonia sensor is more precise than commercially available sensors, requires much less power and can survive in harsher conditions.

The platform, which was awarded as the United States/Canada finalist for the Keysight IoT Innovation Challenge's Smart Water track, leverages the team's prior success in developing micro-satellites for low-earth orbit, has proven reliability and runs on very, very low power. It can be powered by batteries and solar power, such as power-harvesting technologies, and can deploy for long periods of time.



Anand Lalwani

Max Holliday

The innovation was inspired when Anand Lalwani, a 23-year-old from India who is pursuing a Ph.D. in electrical engineering, and Max Holliday, a 27-year-old from New Mexico who is a Ph.D. student studying materials science and engineering, were working on another Keysight IoT Innovation Challenge entry about retrofitting gas meters in Spain for the Smart Land challenge.

"We were working to automate gas meters and realized we can add sensors as well and tackle bigger projects," Lalwani said. The platform also leverages the students' prior successes developing micro-satellites for low-earth orbit. They also enlisted the help of their third team member, Valmik Lakhlani, who is pursuing a master's degree in chemical engineering.

Stanford's Professor Senesky, Professor Tarpeh and Professor Manchester all contributed to the students' sensor network plan. That's not to say the design didn't come with some big challenges that the students had to work to overcome.

The team developed a simple IoT platform that allows users to customize the number and types of sensors to continually monitor water conditions and detect spills quickly.

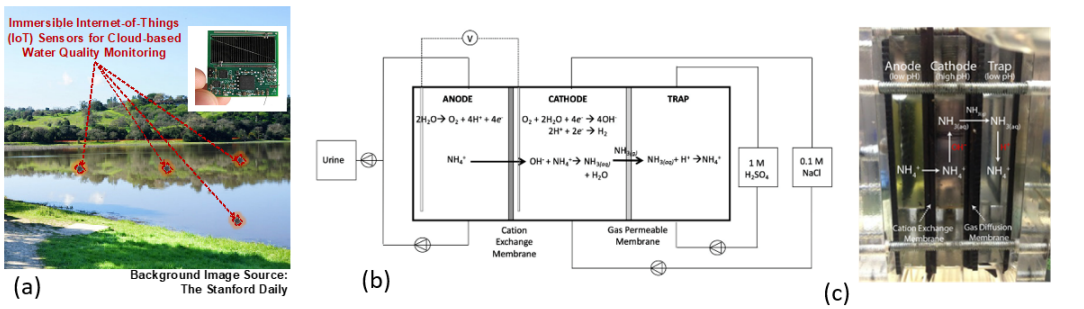


Figure 1. *(a) proposed sensors deployed in lake (b) Nitrogen-selective electrochemical stripping approach. (c) Image of cation exchange and gas diffusion membranes*

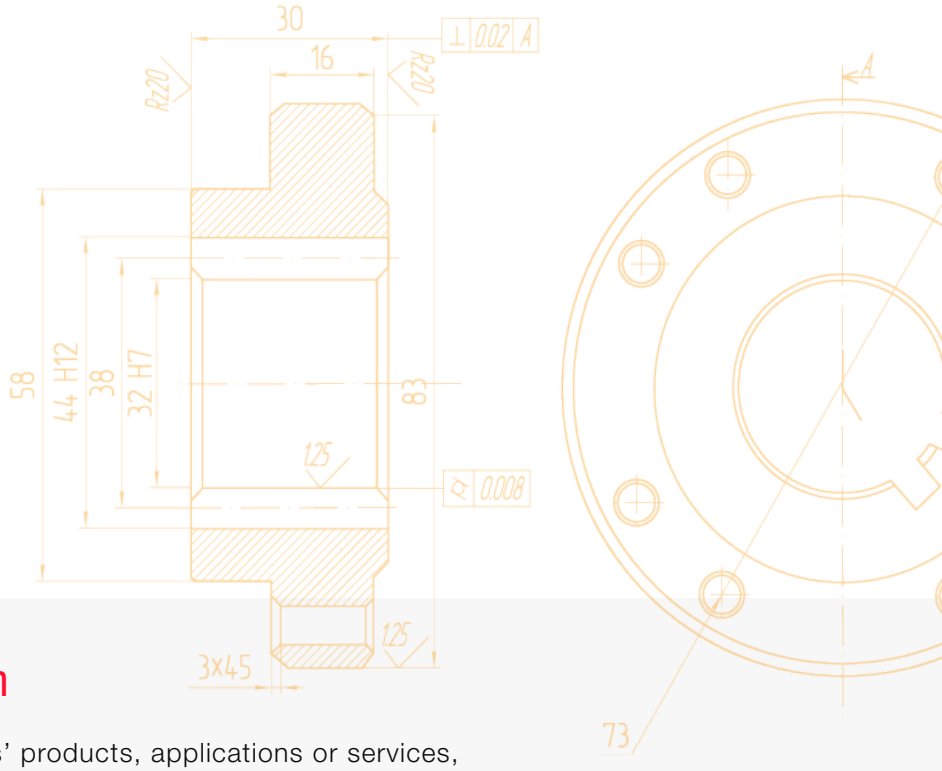
"It's one thing to build an IoT widget that works on your bench, it's a whole other challenge to build something at scale and deploy it in 'harsh' conditions like the Mississippi River or even the ocean," Holliday said. "We're leveraging our research backgrounds in developing micro-satellites for low-earth orbit as the foundation for building high-reliability electronic systems."

The team also faced the challenge of collecting meaningful data. They tackled this with their novel ammonia sensing solution, but it was difficult to find the balance between the scale of the ammonia sensor from Professor Tarpeh's lab for a smaller application, without sacrificing any of its capabilities.

Now that they've got these nuances under control, the team believes the best way to move forward would be to mass produce their platform. "This could involve contracting with the United States Environmental Protection Agency or local government bodies," Lalwani said. "We'd like to monitor and measure water in different parts of the country and get actionable data and report that back to them."

The team believes this project marks just the beginning of a longer journey to tackle other humanitarian issues in the future through engineering. "Broadly speaking, we hope over the next five years we can continue to identify and solve tangible environmental and humanitarian issues through spanning multiple disciplines," Holliday said.

For others interested in participating in the Keysight IoT Innovation Challenge in the future, Holliday encouraged students to tap into what they are passionate about. "Pick a project you're passionate about and run with it," he said. "It's important to have a driver—like passion—for projects such as these despite it not being anyone's 'day job.'"



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