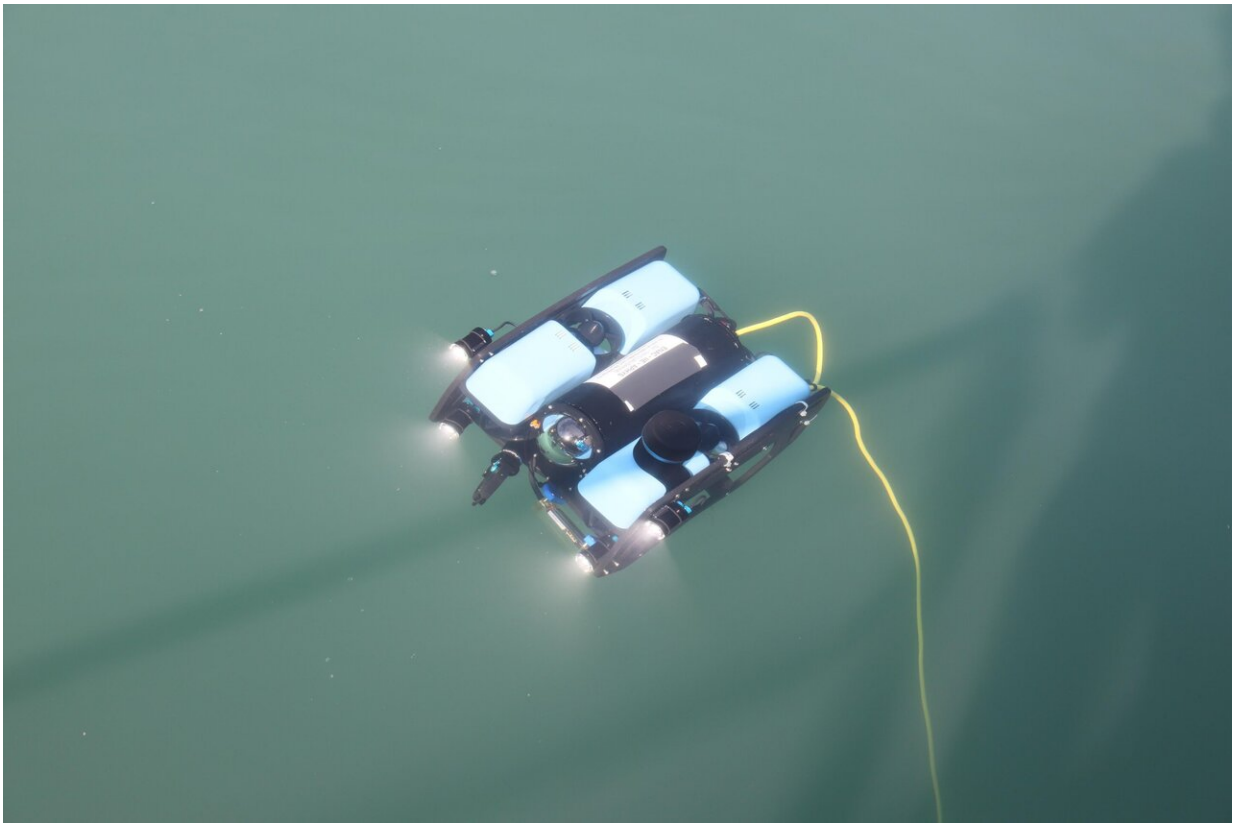
Optical Wi-Fi allows for ultrafast underwater communications

September 22 2020, by Sandy Evangelista



a robot lowers the modem to the bottom of the water. Credit: EPFL Alain Herzog

EPFL spin-off Hydromea has developed a miniature optical modem that can operate down to 6,000 meters below the ocean's surface. It is

sensitive enough to collect data at very high speeds from sources more than 50 meters away.

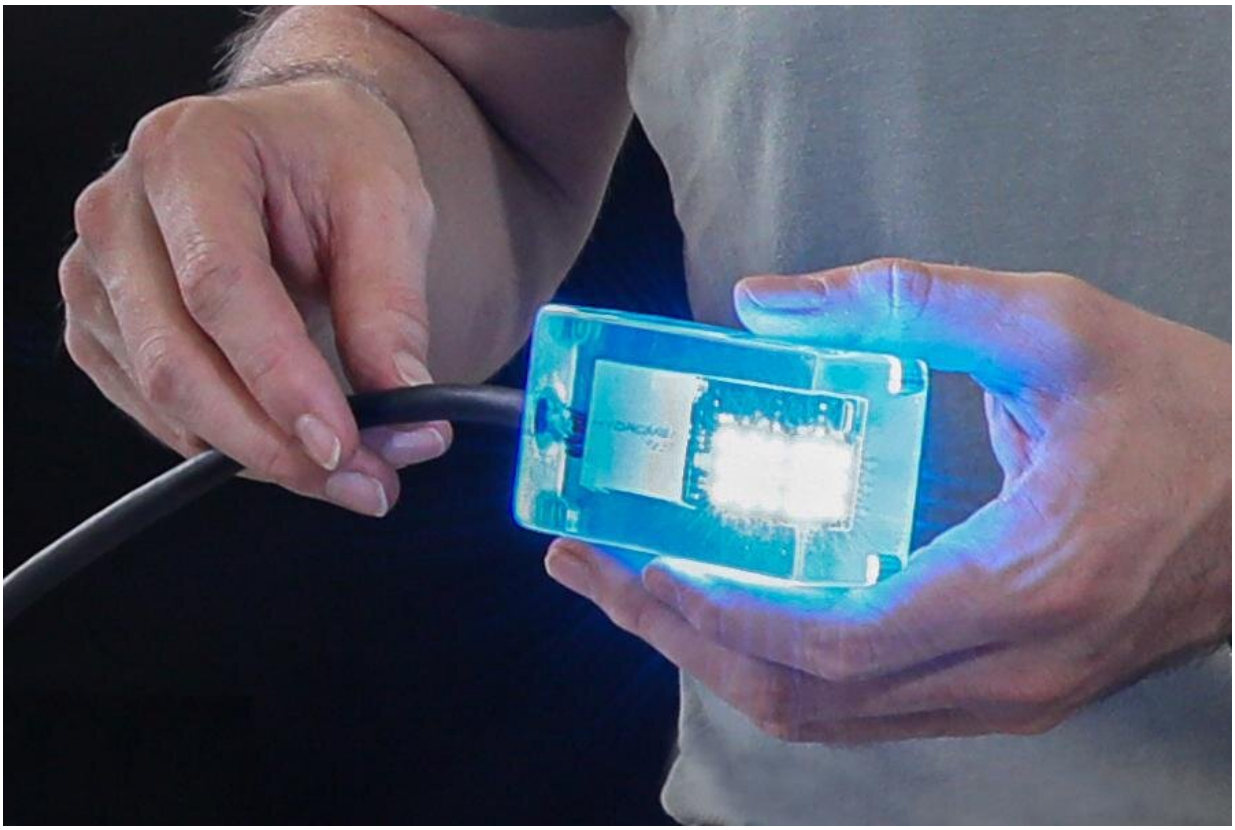
If you want to use a connected device underwater, you don't have many options. Radio waves don't work well—they are easily absorbed by water, meaning they can't go much further than a meter. Many sensors only offer a wired connection, but they are impractical because you have to remove the devices from the water to recover their data. Acoustic communication is often used, but it is very slow and unreliable. These are significant obstacles to effective communications when it comes to underwater construction, inspection, monitoring and repair activities—such as in the offshore energy sector. Limnology research is another field affected by this problem.

However, the engineers at Hydromea have come up with a solution: using light to transmit data below the ocean or lake surface. They have developed an underwater modem called LUMA that communicates through a rapidly blinking blue light. The modem converts data into light pulses that it sends out, or inversely, converts light pulses that it receives into data—all in the blink of an eye. "Our optical modem gives you a fast wireless underwater connection," says Alexander Bahr, Hydromea's COO.

On the same wavelength

"We chose blue light because even though water is generally opaque for electromagnetic waves, there is a small transparency band for blue and green light. That's what lets our system send and receive data over long distances," says Felix Schill, the company's CTO. While water readily absorbs most waves, and especially infrared ones, just blue and green light can travel through it. The red and yellow light waves of the sun are absorbed in just a few meters.

The hardest part about developing LUMA was making sure it could send data over long enough distances and work reliably under all sorts of conditions. "Because light generally diffuses so rapidly underwater, finding a way to send communications over distances of 50 or 100 meters was difficult," says Schill. "It took us a long time to develop a receiver sensitive enough to capture tiny light pulses even from far away."



The LUMA underwater optical modem communicates with blue light. Credit: EPFL Alain Herzog

Plumbing the depths

LUMA is designed to work at depths of up to 6,000 meters. It's a fully contained unit in a plastic casing, which is completely encased in clear plastic so it doesn't collapse under extreme water pressures. The system has already been tested in the Pacific Ocean, at 4,280 meters below sea level, by scientists at the Alfred Wegener Institute for Polar and Marine Research, in Germany. That's the first research institute that Bahr and Schill began working with. "We were later contacted by companies operating offshore that were interested in our technology for laying underwater pipelines or building foundations for offshore wind farms," says Bahr.

LéXPLORE platform off Vidy. Credit: EPFL Alain Herzog

Bahr and Schill started researching underwater Wi-Fi systems when they were both students in Australia back in 2004. They fleshed out the details of their design over the years, and finalized it during their post-doc work at EPFL. Today they still collaborate with the School. For instance, they are helping develop robotics and communications systems for LéXPLORE, a research platform located just off the shores of Lake Geneva, neat Pully Vidy.

There, limnologists are using LUMA to regularly check on the data collected underwater and make sure the measurement instruments are working properly, since the sensors need to remain underwater for months at a time. One modem is installed on the data logger which collects scientific data from the submerged sensors and the other modem is installed on a subsea robot that dives down to where the sensors are located and collects the sensors' data instantly. "The LéXPLORE scientists give us feedback on their specific needs, and this helps us further improve our modem's performance," says Bahr.

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