Robot gliders roam seas

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In February 2013, two gliders (one pictured here underwater) were launched into the ocean: one between USC Dornsife's Wrigley Marine Science Center on Catalina Island and Port Furman and the other just off the coast of Huntington Beach. Credit: USC Viterbi

(Phys.org) —Once the robotic gliders scour the ocean searching for potential harm to sea life, the data is sent to David Caron, professor of biological sciences in USC Dornsife, and other marine biologists. They use the information to spot dangers such as toxic algal blooms.

It was an unforgettable spring morning in 2011 when residents of King Harbor in Redondo Beach, Calif., awoke to find millions of dead anchovies, sardines and mackerel packed into the marina. The stench was strong enough to make even the most seasoned sailor sick.

The incident in King Harbor is unfortunately not the first occurrence of severe losses of marine life, and as a response, Ph.D. students at the USC Viterbi School of Engineering's Robotic Embedded Systems Laboratory are programming underwater robotic gliders that roam the seas, gathering vital information to help scientists predict severe losses of marine life.

"Robots and other kinds of sensors can help us understand these kinds of phenomenon," said Arvind Pereira, a fifth-year Ph.D. candidate studying computer science. "We are determined to dive deep into the ocean and discover what really happens to a given population."

Pereira is the lead student researcher on the glider expedition, a project overseen by professor Gaurav Sukhatme, chair of the Department of Computer Science. Pereira and his fellow students use funds from the National Oceanic Atmospheric Administration, National Science Foundation, U.S. Environmental Protection Agency, NASA and the Office of Naval Research to purchase gliders from a manufacturer. Each glider costs about $120,000.

In February, Pereira's team launched two gliders into the ocean: one between USC Dornsife's Wrigley Marine Science Center on Catalina Island and Port Furman and the other just off the coast of Huntington Beach.

The battery-powered gliders spend their days on patrol, gathering information about the ocean's oxygen level, temperature, salinity and other characteristics. At night, the gliders travel to the ocean surface and transmit the data to various base stations on the shore.

Once the underwater robotics team receives the data, it is sent to marine biologists such as David Caron, professor of biological sciences in USC Dornsife, who uses the information to detect potentially dangerous developments in the ocean.

Marine biologist David Caron examines data picked up by underwater robotic gliders: “Gliders help us wire the ocean, and with this constant surveillance, we are on the verge of being able to predict and mitigate [harmful] events." Credit: Max S. Gerber

"In the case with King Harbor, too many fish entered the marina, and there wasn't enough oxygen to survive," Caron said. "Gliders help us wire the ocean, and with this constant surveillance, we are on the verge of being able to predict and mitigate these events."

This was not the first time King Harbor experienced a massive marine massacre. In 2003 and 2005, "red tide," or toxic algal bloom, poisoned millions of fish that later clogged the harbor.

"Red tide comes about due to the rapid reproduction of microscopic plankton that eventually releases powerful neurotoxins that can infect the brains of shellfish, marine mammals and humans if we end up in that food chain," Caron said. "It actually fires the nerves and will literally burn out synapse connections in the brain, which causes various symptoms ranging from nausea all the way to convulsions and death if you take enough of it in."

The first recorded case of red tide occurred in 1793 when Captain George Vancouver died from eating mussels infected with red tide toxins off the coast of British Columbia. In fact, some scientists believe red tide dates back to biblical times, where it transformed the Egyptian Nile into the "River of Blood" during the days of the ancient Hebrews.

The causes of red tide have sparked a heated debate in the scientific community. Agricultural runoff, sewage and climate change are the main suspects, but the information collected by underwater robots can help scientists nail the true culprit. The glider team has applied innovative modifications to facilitate the transfer of this vital information.

Previously, it took gliders several hours to send data after reaching the surface. However, the group recently developed an onboard computer that programs gliders to send only the most important information. As a result, the robot no longer wastes time sending researchers everything it collects. This is important because it can reduce what used to be a two-hour process to only 20 minutes, according to Pereira.

"The faster the gliders can transmit the data, the sooner we can receive it and the sooner we can help biologists detect dangerous changes in the ocean," Pereira said.

However, because the gliders are located sporadically in the ocean, the team faces the challenge of ensuring the safety of the gliders. After all, if a ship propeller damages a glider, it is very unlikely the glider could still roam the ocean and efficiently gather information. Though researchers can assign a glider certain routes outside crowded shipping lanes, powerful ocean currents might push a robot off course into harm's way.

"The gliders are especially impacted by the currents because they are not propeller-driven," said Stephanie Kemna, a first-year Ph.D. candidate studying computer science and maritime robotics. "To solve this, we use an ocean model that predicts the currents and allows us to direct the glider west if the current pushes east," she said.

Compensating for currents helps the team have a better idea of where the glider is located. The glider's Global Positioning System (GPS) tracking device only works once the glider emerges to the surface. As a result, currents can steer gliders miles away from intended destinations without anyone finding out until the glider resurfaces hours later.

Fortunately the team does not have the same worries about keeping the glider safe from marine life. Very rarely will a shark, seal or whale attack a glider. However, just in case, the glider is composed of fortified aluminum that can withstand a shark bite.

Earlier this month, Pereira and the underwater robotics group returned to the USC Wrigley Marine Science Center to retrieve the gliders and make any necessary modifications. Geoff Hollinger, the postdoctoral researcher overseeing the glider project, said the practical value of the gliders is what makes the project so significant.

"Computer science can be abstract, but I get really passionate about looking at real-world problems that have real-world impact," he said. "Those are the problems that we look at when we're working with the gliders."