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Viterbi RoboDucks Ship Out in Redondo Beach

Joint effort with College probes the mystery of algal blooms

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Yacht-owners, kayakers, harbor patrolmen and sea lions are seeing a new vessel on the waters of Redondo Beach's King Harbor
these days — a craft that someday save the lives of some of the lions.

Just under seven feet long and two feet wide, a low fiberglass hull mounting a pair of forward-looking lenses and a USC banner is making its way through the waves, readying itself for an intensive biological research role this summer hoping to solve the mystery of algal blooms, including the 'red tide' algae infestations that leave deadly tolls of sea life.

RobodDuck1 (soon to be joined by sister RoboDuck2) is a robotic vessel created by a team headed by the Viterbi School's Gaurav Sukhatme, an Associate Professor of Computer Science and director of the USC Robotic Embedded Systems Laboratory. The two RoboDucks will cruise the harbor intensively, stopping frequently to lower a sound into the waters that will assess a series of variables at various depths.

The roving Roboducks will be totally autonomous, going about their business without human controllers, navigating by GPS from sample point to sample point.

Team Roboduck: from left, CS grad students Amit Dhariwal, Jnaneshwar "JD" Das, Arvind Pereira, and professor Gaurav Sukhatme.

Supplementing the ducks' data will be other readings recorded by a network of stationary instruments suspended from buoys and piers. Crucially, the robots will have the ability to work with pre-selected sample points or to create new ones on-the-fly using data measured by the stationary network.

Sukhatme is working with biology Professor David Caron of the USC College and Wrigley Institute, who is one of the world's leading experts on algal blooms, as part of the **Networked Aquatic Microbial Observing System (NAMOS)**. NAMOS and the ducks are designed, he said, to provide an early

RoboDuck meets one of the locals. Click on the sea lion to see a RoboDuck photo album.

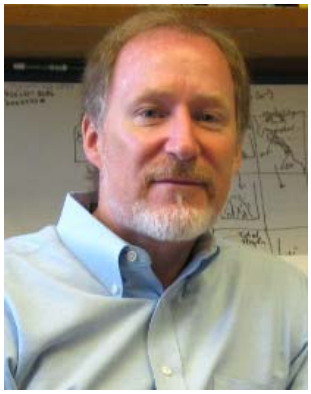
warning system for these sudden and now utterly unpredictable events.

"It's very difficult to be on the scene when the bloom is emerging," Caron said. "What you want is to be there all your equipment studying what is happening as it begins."

But with limited budget and boats, that is impossible, he says: by the time the bloom is detected, it's too late to do more than monitor the end stages.

Caron hopes the robots can change this, working in the limited confines of the Harbor they will be on call continually. Their onboard sensors can monitor water temperature, salinity, dissolved oxygen, turbidity and also algal density, by measuring the concentration of chlorophyll in the water.

If and when their instruments detect an upsurge in algae, Caron and his entire team can immediately come on the scene with "a full-court press."



Caron

The hope is to find out what triggers such blooms which can have catastrophic consequences for sea mammals. As *The New York Times* reported in a June 5 story, "Southern California marine mammal hospitals have been overwhelmed by sea lions sick from the acid, which appeared in record levels off the coast of Los Angeles in April. Domoic acid poisoning has killed hundreds of the animals across Southern California this spring and thousands since a major outbreak in 2002, and has also afflicted animals in Monterey Bay, south of San Francisco."

The new ducks are second generation. The first, RoboDuck0, was a foot-long miniature custom design that served to work out some early issues. RoboDuck1 is based on a commercial vehicle called the Q-Boat, built by the Ocean Science groups of Oceanside California.

The off-the-shelf Q-Boats have remote controls, like those used for model cars. Sukhatme's team, consisting of three CS grad students Amit Dhariwal (PhD student in Computer Science), Jnaneshwar "JD" Das (MS student in Computer Science) and Arvind Pereira (PhD student in Computer Science), made wide-ranging modifications to permit completely autonomous operation. Other Viterbi team members working on the project include technician Carl Oberg and computer science graduate student Bin Zhang.

Dhariwal worked to give the robot sonar-based mapping and exploration capabilities, ranging the bottom. Das specialized in the system design for the boat instrument controls, while Pereira created the GPS-based navigation system. In recent weeks, the system has been given a series of shakedown cruises and is on schedule to go into full operation by July.

"Networked robots such the roboducks are at the cutting edge of research in autonomous robotics." said Sukhatme. "On this project we're building on several years of expertise we've developed in our lab mainly working with more conventional ground-based robots. We're already working on extending the autonomous navigation, mapping and exploration algorithms we develop on this project to underwater robots. "

Sukhatme and Caron emphasized that the King Harbor project has received vital support from Redondo Beach city officials and from the coast guard and harbor patrol. "They couldn't be more supportive," said Sukhatme. "Whenever we need something, they've gone out of their way to help."

The National Science Foundation has funded the project, as part of the Center for Embedded Networked Sensing (CENS) a science and technology center.

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