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UC Berkeley Launches Swarm of 100 Floating Robots

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The next time a levee overflows or an oil pipeline breaks, hundreds of pint-sized robots could be ready to deploy instantly, fan out into the water, and track the contamination in real time through their own communications network.

That's one of the goals behind UC-Berkeley's Floating Sensor Network Project, which sent its first full fleet of 100 miniature robotic watercraft into the Sacramento River last week.

Each of the foot-long robots was equipped with its own GPS-enabled smartphone to transmit data back to servers at the Lawrence Berkeley National Laboratory, which is a partner in the project.

Miniature robot swarms have a number of advantages over in-place monitoring

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stations or manned watercraft. They can deploy more rapidly, they can reach areas that would otherwise be inaccessible - the Berkeley robots are designed to be air dropped - and they can cover more territory.

Robot swarms can also move along with water as it flows, enabling them to track currents, tides and contaminated areas over a wider span with more precision. They're also relatively inexpensive.

The Floating Sensor Network Project is designed specifically to help preserve water quality in Northern California's complex Sacramento-San Joaquin Delta. It could be adapted for use in other estuary systems, lakes or rivers, where stationary monitoring systems provide inadequate coverage.

Eventually, the research team hopes to "put California water online" with a system for visualizing the state's water resources as they evolve over time.

Aside from routine and episodic pollution, the main challenge for the Delta system is the management of salinity churned up by ocean tides. To that end, local water managers have focused on maintaining a freshwater channel that bisects the entire Delta.

The key to the robot swarm's effectiveness will be coordinating the communication between the individual members and a central database, as described in the project's press materials:

> Jointly with the Lawrence Berkeley National Laboratories and the California Department of Water Resources, the team is developing a computational infrastructure which will run online (Web-based), and integrate in real-time the measurements from static sensors (for example, USGS permanently deployed sensing stations), mobile measurements, and any other data feed available to us, to estimate river flow and contaminant propagation in real-time, using online measurements. The results will be available to users in the form of "water maps", that show the motion of water in real-time, and corresponding transported quantities (such as salt).

According to writer Sarah Yang of UC-Berkeley, the Floating Sensor concept builds on previous research into a traffic flow monitoring system.

The inaugural launch was designed to monitor the speed of water currents. Many of the units were a stripped-down version that floats passively in the current, which among robot aficionados might not pass the smell test for true robot-worthiness.

Others in the fleet, though, were equipped with propellers or diving capabilities that would enable them to avoid obstacles autonomously.

Other versions include salinity sensors and depth sensors for mapping subsurface features including the shape of channels.

UC-Berkeley's project joins a growing list of robot swarms in development, many of which involve water monitoring. In 2009, for example, UC-San Diego received a grant from the National Science Foundation to develop small undersea robots capable of deployment in ocean waters, and Arizona State University is also working on bubble-shaped "Sensorbots."

The field has matured to the point where meta-research is also starting to emerge. As noted by the Floating Sensor team, one key issue to resolve is managing the data stream from dozens, hundreds or even thousands of individual units, and coordinating their activities as well.

To tackle that problem, researchers at Carnegie-Mellon University are studying the nervous

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