Engineers to Develop Robot Swarms from MARS

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Engineers at the University of Pennsylvania have received a $5 million grant from the Department of Defense to develop large-scale "swarms" of robots that could work together to thoroughly search large areas from the ground and sky.
The Scalable Swarms of Autonomous Robots and Sensors or the Swarms Project, as it is known takes organizational cues from the natural world where tens or even hundreds of small, independent robots work together to accomplish specific tasks, such as finding a bomb in a crowded city.

Penn's General Robotics, Automation, Sensing and Perception Laboratory will receive the five-year grant from the federal government under the Defense Department's Multidisciplinary University Research Initiative program. The Swarms project is based upon the success of the GRASP Lab's smaller-scale Multiple Autonomous Robotics project, which managed the movement and behavior of about a dozen robots.

"Our objective here is to develop the software framework and tools for a new generation of autonomous robots, ultimately to the point where an operator can supervise an immense swarm of small robots through unfamiliar terrain," said Vijay Kumar, director of the GRASP Lab at Penn's School of Engineering and Applied Science and principal investigator of the Swarms Project. "There is an obvious military application, to be sure, but the same principles apply whether you are looking for an terrorist in an urban environment or localizing the source of a chemical spill in a city."

While MARS demonstrated the feasibility of such a program, the Swarms Project will take the complexity involved to a new level. To get a better grasp of swarming behavior, Kumar and his colleagues are looking to the natural world for inspiration.

In biology, swarming behaviors arise whenever there are large numbers of individuals that lack either the communication or computational capabilities required for centralized control. The Swarms Project brings together a cross-disciplinary team of researchers with expertise in artificial intelligence, control theory, robotics, systems engineering and biology. They will take cues from the sort of group behaviors that appear in beehives, ant colonies, wolf packs, bird flocks and fish schools. But the GRASP researchers are also working with molecular and cell biologists interested in the complicated signaling processes and group behaviors that go on inside and among cells.

"There are a number of interesting behaviors seen in the natural world that we'd like to incorporate, at least analogously," Kumar said. "We might want to see the stalking behavior of a wolf pack, the searching behavior of ants or honeybees or the quorum-sensing behavior of bacteria.

"In fact, much like ants or bees, these robots will be rather dumb individually, but collectively they'll be capable of performing very complicated tasks."

While the GRASP engineers are not attempting to recreate biology, they are striving to understand what general principals in biological behavior that might be useful in getting robots to think as a group. Eventually, Kumar and his colleagues will demonstrate their biologically-inspired algorithms on practical vehicle platforms, such as the robot blimps, unmanned aerial vehicles and the small "clodbuster" four-wheeled robots already in use at GRASP.

"The MARS project was really about getting robots to interact in a physical space, to see their world and react to the obstacles around them," Kumar said. "With the Swarms Project, we are going beyond the orbit of MARS in that we are getting robots to talk amongst themselves about their image of the world around them."

Footage of robots in recent MARS program tests can be seen at www.cis.upenn.edu/mars/site/multimedia.htm

Source: University of Pennsylvania