Can a robot learn to navigate like a cockroach?

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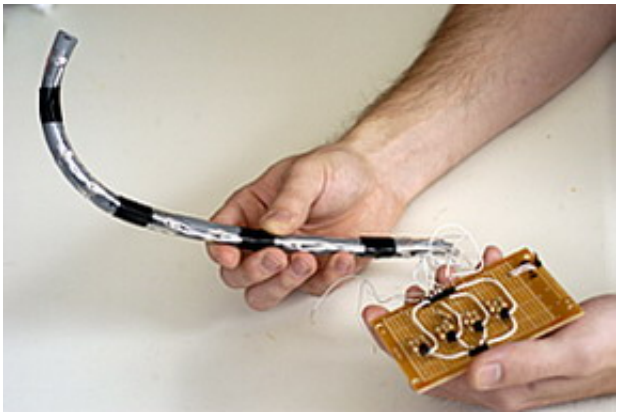

Can a robot learn to navigate like a cockroach? To help researchers find out if a mechanical device can mimic the pesky insect's behavior, a Johns Hopkins engineering student has built a flexible, sensor-laden antenna. Like a cockroach's own wriggly appendage, the artificial antenna sends signals to a wheeled robot's electronic brain, enabling the machine to scurry along walls, turn corners and avoid obstacles.

Undergraduate Owen Loh developed this advanced cockroach-inspired robot antenna, equipped with six strain gages sensors that change resistance as they are bent. Photo by Will Kirk

The work is important because most robotic vehicles that are sent into

dangerous locations rely on artificial vision or sonar systems to find a safe path. But robotic eyes don't operate well in low light, and sonar systems can be confused by polished surfaces. As an alternative, Noah J. Cowan, an assistant professor of mechanical engineering at Johns Hopkins, is turning to the sense of touch, drawing inspiration from bugs that move quite skillfully through dark rooms with varied surfaces.

The key, Cowan said, is the cockroach's antennae, which touch adjacent walls and alert the insect to obstacles. As a postdoctoral fellow at the University of California, Berkeley, Cowan collaborated with researchers at Stanford University to build a crude antenna to show that a moving machine could use the same technique. After joining the faculty at Johns Hopkins, he assigned undergraduate Owen Y. Loh to build a more complex antenna to permit more advanced experiments with a cockroach-inspired robot.

In the fall of 2003, Loh began studying cockroach biology and working up designs for a robot antenna based on the insect model. "I liked the idea of combining biology and robotics," he said.

As a junior mechanical engineering major in the spring of 2004, Loh received a Provost's Undergraduate Research Award from the university, allowing him to continue this work in Cowan's lab during the summer. At summer's end, when the lab team quickly needed an antenna for critical robotic experiments, Loh assembled a simple but effective prototype in less than a week.

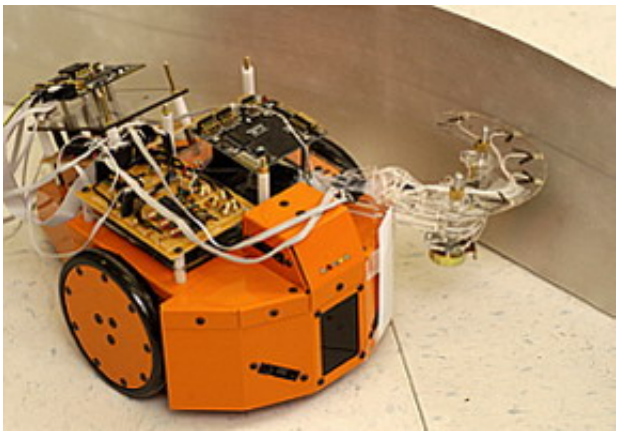

Image: Johns Hopkins researchers have adapted a commercial robot for their experiments with cockroach-inspired technology. Here, the robot uses an earlier version of the antenna to "feel" its way along a wall. Photo by Will Kirk

These experiments resulted in a peer-reviewed paper that has been accepted for presentation in April at the International Conference on Robotics and Automation in Barcelona, Spain. Loh, who is listed as second author on the paper, plans to attend with Cowan and other members of the lab team.

In recent months, Loh has fabricated a more advanced version of the antenna. This model is made of cast urethane, a flexible rubber-like substance, encased in a clear plastic sheath. Embedded in the urethane are six strain gages, sensors that change resistance as they are bent. "We've calibrated the antenna so that certain voltages correspond to certain bending angles that occur as the antenna touches the wall or some other object," Loh said.

This data is fed to the robotic's controller, enabling it to sense its position

in relation to the wall and to maneuver around obstacles. When the antenna signals that the robot is veering too close to the wall, the controller steers it away.

The newer version of the antenna is being tested by Brett L. Kutscher, a former Provost's Undergraduate Research Award recipient who recently finished his master's degree thesis in Cowan's lab. Cowan believes the cockroach-inspired antennae being developed by his team could eventually provide a new generation of robots with an enhanced ability to move safely through dark and hazardous locations, such as smoke-filled rooms strewn with debris.

He said Loh, now 21, from Okemos, Mich., provided crucial assistance. "Owen brought a set of skills to that lab that none of us had," Cowan said. "I'm more of an abstract and theoretical researcher. Owen is very good at making things with his hands."

On March 10, Steven Knapp, university provost and senior vice president for academic affairs, hosted the 12th annual Provost's Undergraduate Research Awards ceremony, which honored the 45 winners who conducted their projects in the summer and fall of 2004. Since 1993, about 40 students each year have received PURA grants of up to $3,000 to conduct original research, some results of which have been published in professional journals. The awards, funded through a donation from the Hodson Trust, are an important part of the university's commitment to research opportunities for undergraduates.

The Johns Hopkins University is recognized as the country's first graduate research university, and has been in recent years the leader among the nation's research universities in winning federal research and development grants. The opportunity to be involved in important research is one of the distinguishing characteristics of an undergraduate education at Johns Hopkins.

The Provost's Undergraduate Research Awards program provides one of these research opportunities, open to students in each of the university's four schools with full-time undergraduates: the Krieger School of Arts and Sciences, the Whiting School of Engineering, the Peabody Conservatory and the School of Nursing.

Source: Johns Hopkins University

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