**Insect Designs for Improved Robot Mobility**

**By**

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**DATE:** Friday 17 May 2001  
**TIME:** 3.00 pm - 3.45 pm  
**VENUE:** Maxwell Auditorium, Singapore Science Centre

**SYNOPSIS:**

The biorobotics group at CWRU follows a strategy of close interaction between engineers and neurobiologists to create improved robot designs and gain insights into neural control of legged locomotion. A series of legged vehicles has been developed. The first 2 robots were not based upon a particular insect. Robot I walked with insect gaits using network controllers. Robot II walked on irregular terrain using a distributed controller with localized reflexes. The third in this series, Robot III, is more powerful and benefits from the joint and leg designs of cockroach, but is scaled 17 times larger. A small hybrid wheel-leg autonomous robot has also been developed with inspiration from cricket.

The implementation of cockroach-like mechanics into Robot III resulted in animal-like posture and leg movements. The efforts to control the complex mechanics of this robot have led to hypotheses and insights into the neural basis of insect locomotion. High-speed video records of cockroaches performing locomotory tasks were used to determine the essential joint designs and motions for each leg. Leg movements were recorded during walking on a treadmill, turning and climbing over relatively high barriers. These data were incorporated into a dynamic simulation that predicted appropriate values for design. Actuators were sized according to the predicted joint torques. The entire structure of the robot was designed according to the predicted loads.

Robot IV is currently being constructed and it will be dynamically similar to cockroach. It shares the leg kinematics and size of Robot III, but its actuators give its joints some important muscle-like properties such as tunable passive stiffness. This passive joint stiffness will provide the robot with energy efficiency.

We have constructed a hybrid wheel-leg microrobot with rear legs inspired by those of cricket and two front wheels. The robot has its power system and locomotion controller on board. Others in our group have developed microvalves using a MEMS fabrication process to distribute compressed air to the robot’s actuators.

The escape response circuit in cockroach has been mapped and modeled and adapted for use as a crash avoidance system for cars. We have shown it to be effective in simulation and in a model car equipped with sonar sensors.

**ABOUT THE SPEAKERS:**

**Roger D. Quinn** is a professor on the faculty of the Mechanical and Aerospace Engineering Department at Case Western Reserve University in Cleveland, Ohio. He joined the department in 1986 as the General Motors Assistant Professor. He received the B.S. (1980) and M.S. (1984) degrees in Mechanical Engineering from the University of Akron and the Ph.D. degree in Engineering Science and Mechanics from Virginia Polytechnic and State University, Blacksburg, in 1985. He has directed the Biorobotics Laboratory at CWRU since its inception in 1990. 3 insect inspired robots and 1 worm inspired robot have been developed. The second legged robot, RII, received an award at the 1995 IEEE ICRA. The third legged robot, RIII, is based upon cockroach and was a finalist for the 1998 Discover Magazine’s Technology Awards. Robot IV, now under development, will be even more similar to cockroach and will use muscle-like actuators. He is also directing the development of a small autonomous robot that will walk and jump based upon crickets. He was also team leader for the Agile Manufacturing Project in the Center for Automation and Intelligent Systems Research at CWRU from 1994-98. His research is devoted to biorobotics and robotics for manufacturing.

**Roy E. Ritzmann** is a professor in the Department of Biology at Case Western Reserve University in Cleveland, Ohio, which he joined in 1977. Roy received his B.A. in Zoology from the University of Iowa, Iowa City, Iowa in 1969 and later attained his Ph.D. in Biology from the University of Virginia, Charlottesville, Virginia in 1974. He worked as a postdoctoral research assistant in the Neurophysiology Department of Cornell University, Ithaca, New York in the Laboratory of J.M. Camhi between 1974 and 1977 prior to joining CWRU. He is an elected Fellow of the AAAS, of which he is a member since 1989. He is also a member of the Society of Neurosciences, International Society of Neuroethology and the Neural Control of Locomotion. His major research interest is in the area of behavioral neurobiology.

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