**The University of Vermont**
**College of Engineering and Mathematical Sciences**

# Bongard Receives 2010 NSF CAREER Award

Dr. Joshua Bongard has been named the recipient of a National Science Foundation CAREER Award by Division of Information & Intelligent Systems. This prestigious award, in the amount of approximately $310,000, supports the early career-development activities of those teacher-scholars who most effectively integrate research and education within the context of the mission of their organization.

“We are proud of the research being accomplished on AI and complex systems by Dr. Bongard,” says Bernard “Chip” Cole, Interim Dean, UVM College of Engineering and Mathematical Sciences. “This recognition reflects the high quality of innovative research done within our College.”

Bongard’s research has received national and international recognition. He received the prestigious and highly competitive New Faculty Fellowship from Microsoft Research in 2007 for his robotics research with self-healing robots. Only five such awards are given nation-wide. He also received recognition from MIT as one of the world’s top innovators under 35 as well as participation in a National Academy of Engineering symposium to discuss 21$^{st}$ century frontiers in research.

“This research is an alternative approach to robotics and biology,” says Bongard. “The research will allow undergraduate, graduate as well as high school students to design novel virtual environments in which robots must evolve.”

**ABSTRACT**

To date, relatively little success has been achieved in realizing machines that continually perform simple yet adaptive behaviors in unstructured environments (compared to a structured environment such as a factory). The prevailing approach to create such machines is to copy physiological and neurological systems observed in animals, and build them into robots. This raises the issue however of what from among the infinitude of existing biological structures should be copied. Research under this award is pursuing an alternative approach: rather than copy existing biological systems, evolutionary dynamics are copied and connected in a virtual space. The resulting evolutionary algorithm optimizes virtual robots' neurological structures that control behavior and their body plans. Importantly, evolution in these studies is task and behavior specific.

The research is intended to make important contributions to robotics and biology. For roboticists, this work will enable computers to automatically design the body plans and neural controllers for robots that are more adaptive and robust than robots designed manually. Automatically-designed virtual robots can then be built as physical devices and deployed into real-world environments, including those that are dangerous to humans. For biologists, our studies will provide insight into why and how particular structures evolved in nature. For example, if legged robots originally evolved for locomotion are then selected to locomote and grasp objects, computational evolution may re-purpose the robot's front legs into arms and grippers; or, it may add manipulatory appendages onto the existing body plan. Either outcome would be of great interest to evolutionary biologists.

Finally, experiments are being housed in online tools that will allow graduate, undergraduate and K-12 students to run evolutionary simulations passively on their own machines, as well as actively participate in the process: they may design novel virtual environments in which the robots must evolve. This active participation is intended to motivate students to understand the physics, biology, engineering and computational processes underlying evolution.

For more on this NSF Award visit:
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0953837

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