Roll, Crawl, Walk, Climb, and Jump: Robot Locomotion Inspired by Nature and Beyond

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Abstract
Most mobile robots we see today utilize wheels or treads to move around. But why don't we see such locomotion mechanisms in nature? Or a better question we should ask is: why don't we use locomotion mechanisms used in nature for creating robots? Animals move in various ways; crawling, walking, jumping, and undulating to name a few. What are the mechanisms behind these motions and why do they use them? Inspired by biology, when and how should we apply these concepts to create robots with higher mobility?
In this talk, we present the concept of bioinspiration for robotics. Bioinspiration does not mean simply copying ideas from nature, but rather learning the mechanisms behind it and being inspired by them to create novel concepts and solutions that go even beyond what we see in nature. This talk will present several biologically inspired novel locomotion strategies for mobile robots currently under development at RoMeLa (Robotics & Mechanisms Laboratory) including a unique everting robot inspired by the motility mechanisms of amoebae, a rock climbing robot that uses matching behavior, an actuated spoke wheel system for unstructured environments, a hexapod crawler with dry adhesive feet for zero gravity space applications, a novel three legged robot that walks more like a human, a scaffolding climbing serpentine robot that rolls up to move, and an autonomous bipedal humanoid robot that can even play a game of soccer. The ability of robots created with bioinspiration can go even beyond that of animals in nature.

Short Biographical Sketch
Dennis Hong is an Assistant Professor and the Director of RoMeLa (Robotics & Mechanisms Laboratory) of the Mechanical Engineering Department at Virginia Tech. His research expertise lies in the area of novel robot locomotion mechanisms, design and analysis of mechanical systems, kinematics, and dynamics. He was the inventor of 'whole skin locomotion' for mobile robots inspired by amoeboid motility mechanisms, and pioneered in generating and utilizing everting motion for locomotion in soft body robots. His work on this area was awarded with the prestigious Faculty Early Career Development (CAREER) award from the National Science Foundation (NSF) in 2007, the Best Paper Award at the 13th International Conference on Advanced Robotics in 2007, and the Biomimicry Award / Best Paper Award at the 29th ASME Mechanisms and Robotics Conference in 2005. He also won the Outstanding Assistant Professor award at the College of Engineering in 2007 and the ASPIRES Award in 2004 at Virginia Tech, the ASME Freudenstein / GM Young Investigator Award in 2005, and was selected as a NASA Summer Faculty Fellow at JPL in 2005. Dr. Hong received his B.S. degree in Mechanical Engineering from the University of Wisconsin-Madison (1994), his M.S. and Ph.D. degrees in Mechanical Engineering from Purdue University (1999, 2002). Dr. Hong also has a number of patents for novel robot locomotion mechanisms and devices for medical applications.