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Obstacle traversal and self-righting of bio-inspired robots reveal the physics of multi-modal locomotion CHEN LI, RONALD FEARING, ROBERT FULL, University of California, Berkeley — Most animals move in nature in a variety of locomotor modes. For example, to traverse obstacles like dense vegetation, cockroaches can climb over, push across, reorient their bodies to maneuver through slits, or even transition among these modes forming diverse locomotor pathways; if flipped over, they can also self-right using wings or legs to generate body pitch or roll. By contrast, most locomotion studies have focused on a single mode such as running, walking, or jumping, and robots are still far from capable of life-like, robust, multi-modal locomotion in the real world. Here, we present two recent studies using bio-inspired robots, together with new locomotion energy landscapes derived from locomotor-environment interaction physics, to begin to understand the physics of multi-modal locomotion. (1) Our experiment of a cockroach-inspired legged robot traversing grass-like beam obstacles reveals that, with a terradynamically "streamlined" rounded body like that of the insect, robot traversal becomes more probable by accessing locomotor pathways that overcome lower potential energy barriers. (2) Our experiment of a cockroach-inspired self-righting robot further suggests that body vibrations are crucial for exploring locomotion energy landscapes and reaching lower barrier pathways. Finally, we posit that our new framework of locomotion energy landscapes holds promise to better understand and predict multi-modal biological and robotic movement.

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