Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Body shape helps legged robots climb and turn in complex 3-D terrains YUANFENG HAN, ZHELIANG WANG, CHEN LI, Johns Hopkins University — Analogous to streamlined shapes that reduce drag in fluids, insects' ellipsoid-like rounded body shapes were recently discovered to be "terradynamically streamlined" and enhance locomotion in cluttered terrain by facilitating body rolling. Here, we hypothesize that there exist more terradynamic shapes that facilitate other modes of locomotion like climbing and turning in complex 3-D terrains by facilitating body pitching and yawing. To test our hypothesis, we modified the body shape of a legged robot by adding an elliptical and a rectangular shell and tested how it negotiated with circular and square vertical pillars. With a rectangular shell the robot always pitched against square pillars in an attempt to climb, whereas with an elliptical shell it always yawed and turned away from circular pillars given a small initial lateral displacement. Square / circular pillars facilitated pitching / yawing, respectively. To begin to reveal the contact physics, we developed a locomotion energy landscape model. Our model revealed that potential energy barriers to transition from pitching to yawing are high for angular locomotor and obstacle shapes (rectangular / square) but vanish for rounded shapes (elliptical / circular). Our study supports the plausibility of locomotion energy landscapes for understanding the rich locomotor transitions in complex 3-D terrains.

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Date submitted: 10 Nov 2016 Electronic form version 1.4