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A terradynamics of legged locomotion on granular media CHEN LI, UC Berkeley, TINGNAN ZHANG, DANIEL GOLDMAN, Georgia Tech — The theories of aero and hydrodynamics form the bases for prediction of animal movement and device design in air and water, and allow computation of lift, drag, and thrust forces on wings and fins. While models of terrestrial legged locomotion have focused on interactions with solid ground, many legged animals (and increasingly robots) move on substrates such as sand, gravel, soil, mud, snow, grass, and leaf litter that flow in response to intrusion. However, locomotor-ground interaction models on such flowable ground are often unavailable. Here we develop a resistive force model that predicts forces on arbitrary-shaped legs and bodies moving freely in granular media in the vertical plane. Our resistive force measurements reveal a complex but generic dependence of stresses on an intruder on its depth, orientation, and movement direction in granular media of different particle size, density, friction, and compaction. Our resistive force model and a multi-body simulation predict a small legged robot's locomotion on granular media using various leg shapes and stride frequencies, and give insight into the effects of leg morphology and kinematics on movement on granular media. Our study is an initial but important step in creation of "terradynamics" of locomotion on flowable ground.

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