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Induced vibrations increase performance of a winged self-righting robot RATAN OTHAYOTH, QIHAN XUAN, CHEN LI, Johns Hopkins University — When upside down, cockroaches can open their wings to dynamically self-right. In this process, an animal often has to perform multiple unsuccessful maneuvers to eventually right, and often flails its legs. Here, we developed a cockroach-inspired winged self-righting robot capable of controlled body vibrations to test the hypothesis that vibrations assist self-righting transitions. Robot body vibrations were induced by an oscillating mass (10% of body mass) and varied by changing oscillation frequency. We discovered that, as the robot's body vibrations increased, righting probability increased, and righting time decreased ($P < 0.0001$, ANOVA), confirming our hypothesis. To begin to understand the underlying physics, we developed a locomotion energy landscape model. Our model revealed that the kinetic energy fluctuations due to vibrations were comparable to the potential energy barriers required to transition from a metastable overturned orientation to an upright orientation. Our study supports the plausibility of locomotion energy landscapes for understanding locomotor transitions, but highlights the need for further stochastic modeling to capture the uncertain nature of when righting maneuvers result in successful righting.

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