Head and leg adjustments help insects and legged robots traverse cluttered, large obstacles

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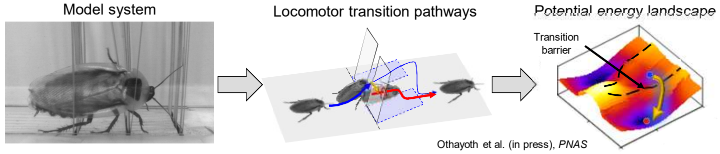
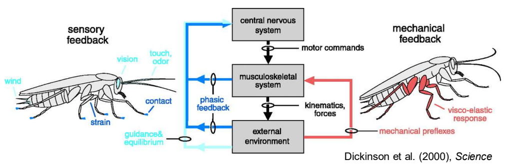
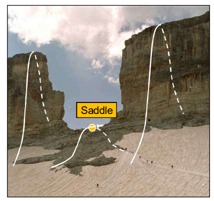
1. Background & Motivation

Physical interaction (energy landscape) plays a major role during obstacle traversal



Animals integrate active sensory feedback and passive mechanical feedback to control locomotion



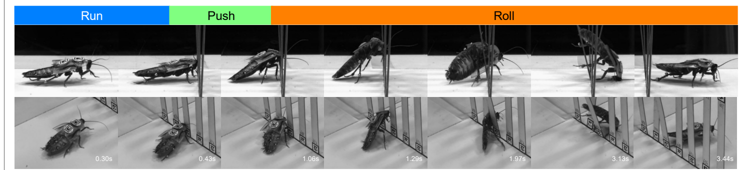


Hypothesis: Cockroaches actively adjust body and appendages to overcome barrier and make transition

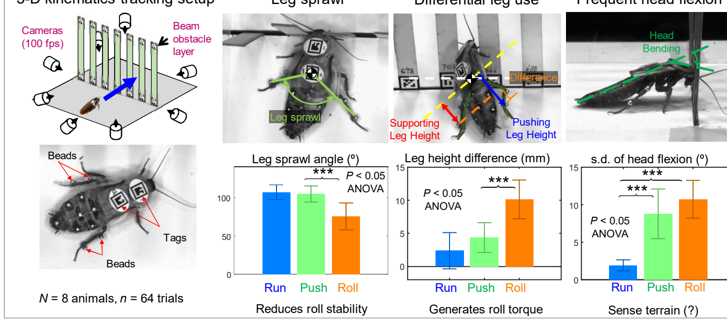
Awareness of landscape helps find a lower barrier

2. Experimental Observations

Beam obstacle traversal can be divided into three phases

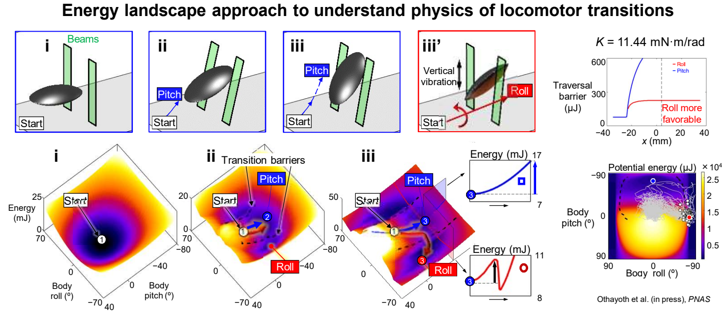


Cockroaches actively adjust their head and legs to make locomotor transition

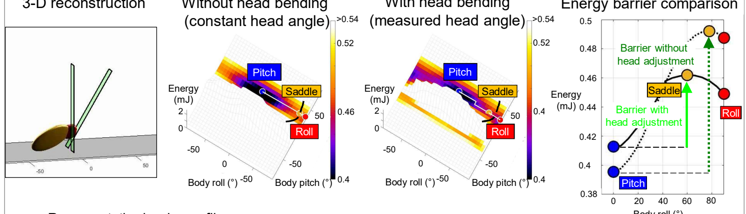


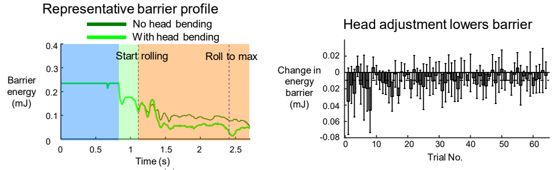
3. Energy Landscape Modeling

Energy landscape approach to understand physics of locomotor transitions



Proper head adjustment reduces energy barrier on landscape



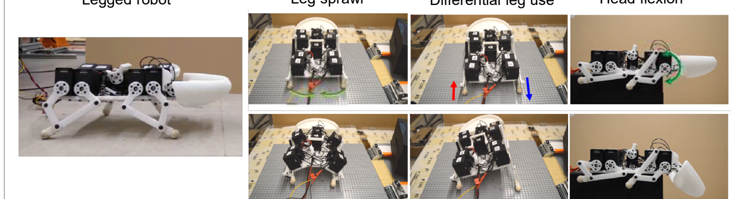


Barrier is smaller with head bending than without (mean change < 0)

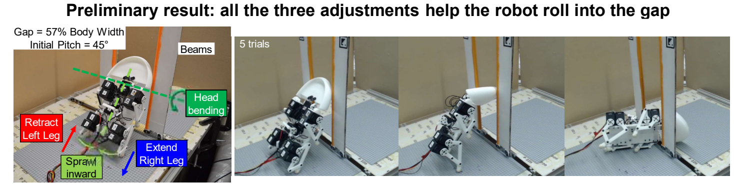
($P < 0.05$, ANOVA)

4. Robophysical Model & Future Work

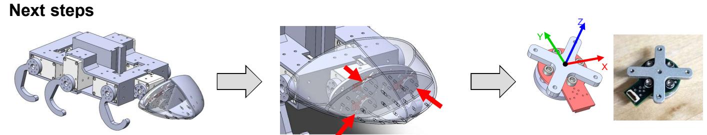
Legged robot to systematically control and vary active adjustment of head and legs



Preliminary result: all the three adjustments help the robot roll into the gap



Next steps



Robot with force sensors

Embedded sensors at the neck

Low cost 3-axis force sensor (designed by J. Krakauer's group)

Force measurements to understand:

- Relationship between contact forces and potential energy landscape (slope?)
- Transitions on landscape emerging from local force sensing

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