COLLEGE OF ENGINEERING
MULTIDISCIPLINARY DESIGN PROGRAM
UNIVERSITY OF MICHIGAN

Cockroach Climbing

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BIRDS lab

Introduction

Cockroaches routinely slip while they climb vertically, even though they climb well. The goal of this project is to study the methods that cockroaches use to generate propulsion while overcoming slipping and gravity, with the intention of applying the insights gathered to the design of climbing robots in the future.

Cockroach Experimental Setup & Optimization

Main Challenges for Tracking Feet and Body Angle

- Shadow from the main body obscure legs
- Poor resolution results in data loss
- Legs & body overlap resulted in unclear border
- Compressed vs uncompressed videos

Cockroach Climbing Apparatus



Before

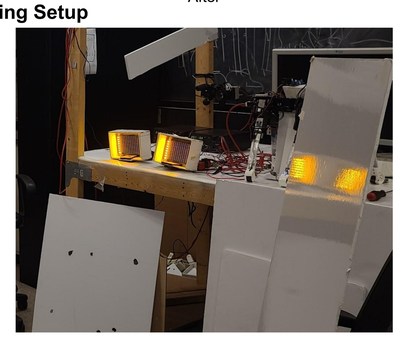


After

Diffused Lighting Setup



Before



After

Leg- Body Overlap & Shadow

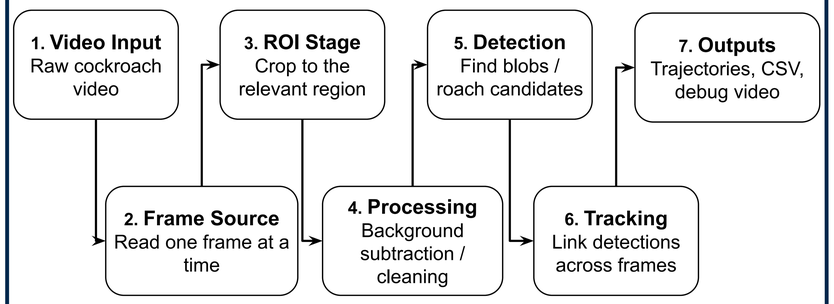


Before



After

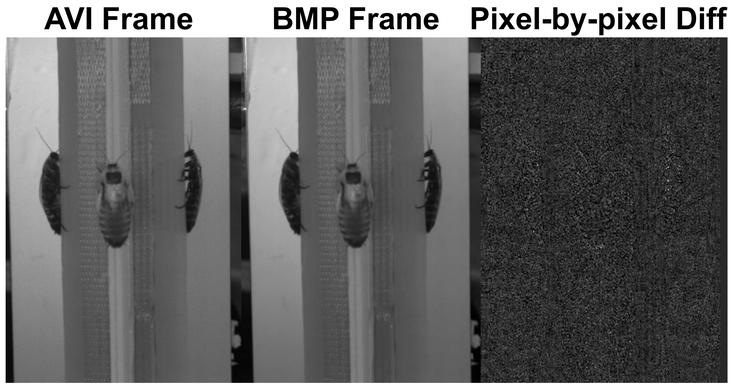
Video Processing Pipeline



Annotation Tool – ImagePager



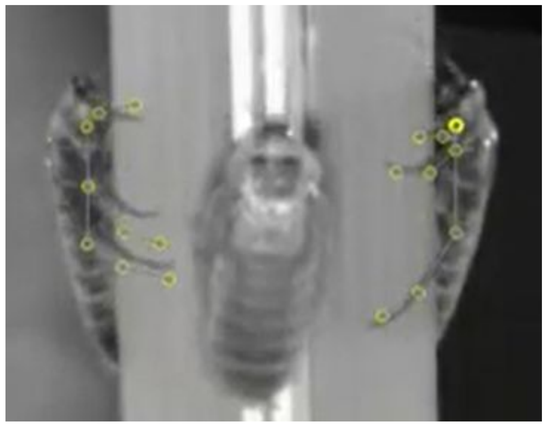
Video Compression Analysis

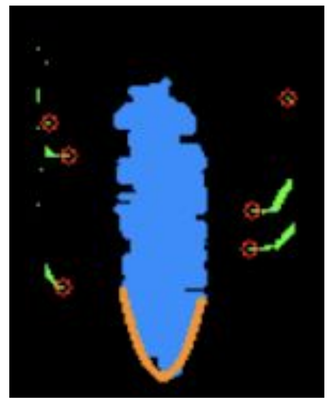


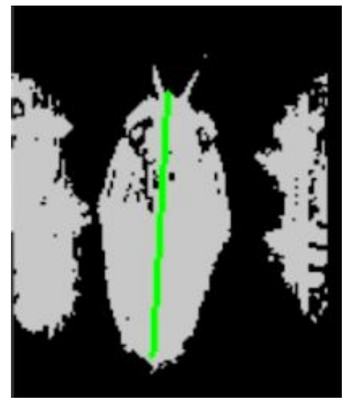
Cockroach tarsi are only a few pixels wide, so compression artifacts can prevent us from tracking their positioin.

Data Analysis - Tracking Code

- Goal: estimate cockroach body pitch relative to vertical
- Initial method: use the convex hull of the body and fit a quadratic curve to its base
- This method was too sensitive to noise and not reliable
- We then designed a lighting-dependent body filter to capture the full body while excluding the legs
- To improve the segmented body region, we applied erosion and dilation
- Finally, we used row-wise symmetry detection and a linear fit to estimate body pitch more robustly







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