PHYS 4803 FINAL PROJECT:
AN INVESTIGATION INTO COCKROACH MUSCULAR CONTROL OVER ANGLED TERRAINS

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WHY COCKROACHES?

- Cheaper than mice
- Invertebrate vs vertebrate research permits
- Model organisms for neurobiology
INTERDISCIPLINARY RESEARCH

Robotics
- kinematics

BIOLOGY
- cockroach physiology

CS:
- models

PHYSICS
- kinematics
APPLICATIONS OF RESEARCH

• interpolation to mammalian neurobiology
• Improve robotics
PREVIOUS RESEARCH-Sponberg

• investigated horizontal motion on flat versus rough terrain

• found no significant changes in
  • # of spikes
  • spike intervals
• To expand previous research in cockroach running experiments into an analysis of running versus climbing
GOALS

• To classify EMG patterns for the flexor and the extensor muscles by activity
METHODS: THE TERRAINS

• 0° to compare with Sponberg’s data and generate control data
• 45° to examine incline motion
• 90° to investigate changes in horizontal vs vertical control systems
METHODS: COCKROACHES

• *Blaberus discoidalis*
• .008” (Heavy) and .005” (Light) wire
• Extensor and Flexor muscles
WIRING THE COCKROACHES

1) Cool to unconsciousness
2) Pin to plate
3) Insert wires
4) Secure wires
5) Release into arena
TECHNOLOGY

• Electronic Circuit
• Backyard Brains Phone App
• High Speed Camera
DATA ANALYSIS
VIDEOS - 45 Degrees
VIDEOS - Vertical
DATA QUALITY CONTROL

• Noise
• Continuous vs “Stop & Go” motion
• Heavy vs Light wire gauge usage
Figure 2A, Sponberg and Full (2008)

Horizonal Run
RESULTS--Horizontal Control

A

Proportion of occurrences

Flat Terrain

Rough Terrain

Horizontal Running

Occurrences

Number of Spikes

1 2 3 4
RESULTS

![Bar chart showing the proportion of steps for different number of spikes and orientations: horizontal, 45 degrees, and vertical. The chart illustrates the trend across the number of spikes with the highest proportion at 2 spikes, followed by 3 and 4, for each orientation type.](image-url)
CONCLUSIONS

• A marked difference can be seen between horizontal running and vertical climbing
  • More single spikes in horizontal running
  • More triple and quadruple spikes in vertical climbing

• Seems to be gradual progression rather than “switch flipped”
  • 45° seems to be roughly between horizontal and vertical in terms of action potential spikes
POINTS FOR IMPROVEMENT

• Modify electronic circuit:
  • Decrease noise
  • Increase reliability
  • Implement LED circuit

• Standardize methodology
  • E.g., consistent refrigeration time

• Improve existing arenas
FUTURE STEPS

• Investigate flexor muscles

• Expand the project to include a larger variety of terrains
  • Gaussian distribution to set up control data
  • More angles
  • Quarter pipe
  • Granular terrain
  • “Obstacle courses”

• Integrate force pads in same experimental setup
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1. Animal Warefare Act (1966)
5. Unpublished Goldman Research
QUESTIONS?