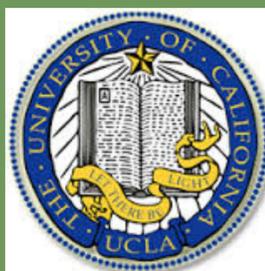


Introduction of Multi- and Single Worm Trackers, and Modifications Made for Behavioral Analyses of *C. elegans*

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Introduction

Worm tracking is important for studies conducted with the nematode worm *Caenorhabditis elegans*.

There are two major classes of worm trackers:

- Online (real time analysis with a moving object)
- Offline (video analysis only)

Because of the difficulty of online worm tracking, analysis conducted in the lab will use two types of offline worm trackers:

- Center of mass (midbody) worm tracker (Goodman)
- Head, midbody, tail worm tracker (Wormlab)

Each type of experiment conducted in lab requires specific analysis, which requires different worm trackers. This poster discusses the application of worm tracking for the following experiments: electrotaxis, phototaxis, touch response, and motion.

Motivation

- Finding the suitable worm tracker for each experiment.
- Outputting data into a visual, comprehensible form that may be used for publication.

An example of visual data:

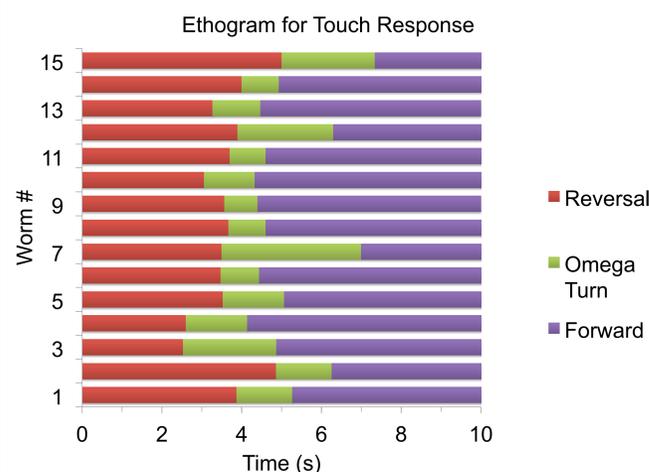


Figure 1: Hand-generated ethogram from the phototaxis experiment

Worm Trackers

Goodman Worm Tracker:

Advantages:

- Free
- Fast
- Easy to use once setting is established

Disadvantages:

- Requires MATLAB
- Can only track center of mass of *C. elegans*

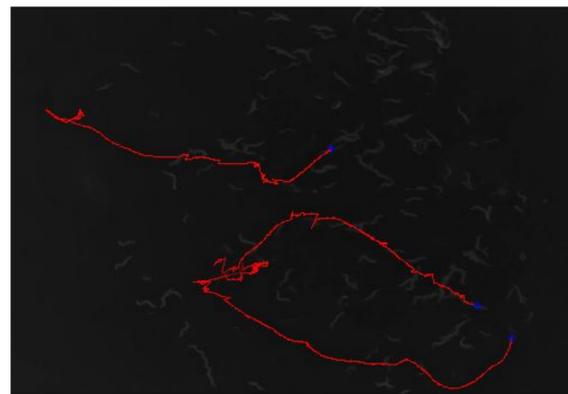


Figure 2: Worm tracking of a trial from the electrotaxis experiment

Wormlab:

Advantages:

- Standalone software
- Can track head, tail, and midbody of *C. elegans*
- More detailed analysis available (as discussed in the Results section)
- Settings are easier to manipulate

Disadvantages:

- Requires a license fee
- Slower processing, more resource consuming, and occasionally crashes



Figure 3: Worm tracking of a trial from Touch Response

Results

Goodman:

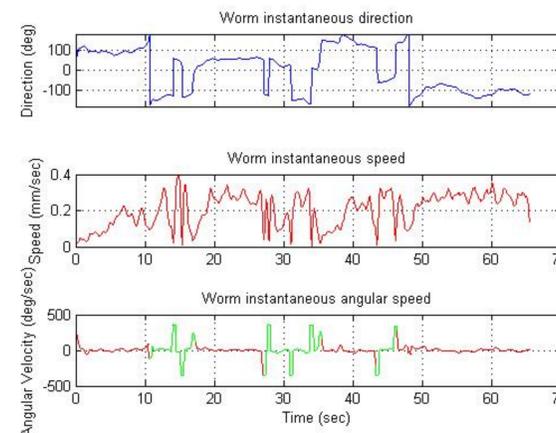


Figure 4: Sample graphical output of a single track from the acceleration experiment

- The Goodman worm tracker is suitable for groups that require mainly the position data, and not necessarily need tracking of the head:
 - Both thermotaxis and electrotaxis experiments require each worm's position, and the angle of worm movement

Wormlab:

- Can automatically calculate useful properties including:
 - Time of forward, reversal, and omega turn
 - Wavelength

- Since multiple tracks are outputted in the same file, analysis can be conducted more easily
- Because phototaxis and touch response require detailed tracking of the movement of head and tail, Wormlab is the chosen worm tracker.

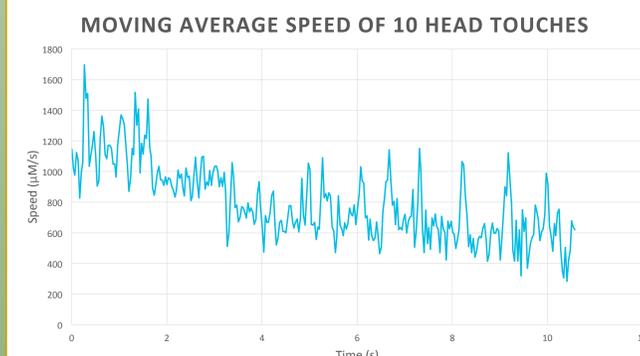


Figure 5: Average speed ($\mu\text{M/s}$) of 10 worms after 10 head stimulation with eyebrow hair

Summary

Experiments suitable for center of mass tracking:

- Thermotaxis
- Electrotaxis

Experiments that requires head, tail, and midbody analysis:

- Phototaxis
- Touch Response

Future Directions

- A pursuit of more efficient data analysis measures for both worm trackers, by utilizing simple scripts that can compile data from multiple excel files into a single unified form.
- Development of 3-D worm tracking stage, accompanied by an online worm tracker that can position the worms into the center of view, while having *C. elegans* in a more natural state of 3-D motion

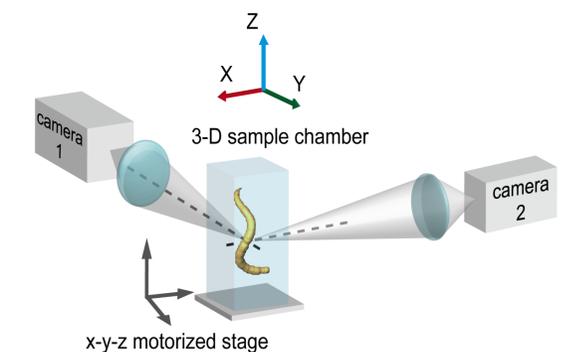


Figure 6: Concept of 3-D Worm Tracking

References

- 1.) Goodman, M.B. Mechanosensation (January 06, 2006), WormBook, ed. The *C. elegans* Research Community, WormBook, doi/10.1895/wormbook.1.62.1
- 2.) Husson, S. J. et al. Keeping track of worm trackers (September 10, 2012), WormBook, ed. The *C. elegans* Research Community, WormBook, doi/10.1895/wormbook.1.156.1, <http://www.wormbook.org>.

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