Thermotaxis by Virtual Reality in Time Domain

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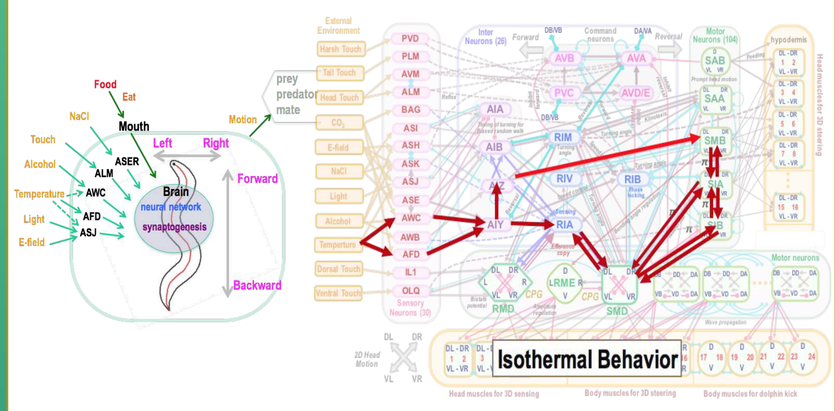
ABSTRACT

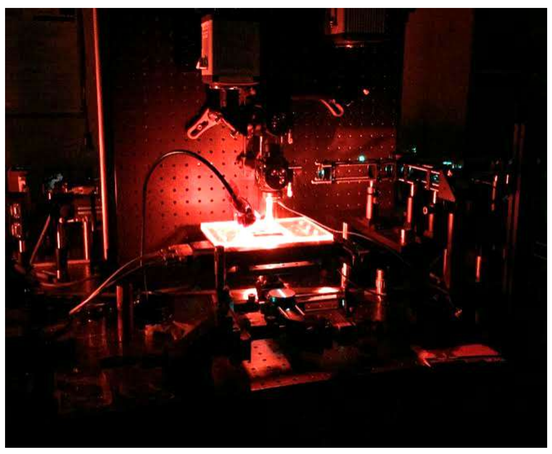
- Caenorhabditis elegans' temperature responses, such as isothermal and negative thermotaxis behaviors, have previously been observed through establishment of a temperature gradient across an aluminum plate.
- Stephens et al. were the first researchers to publish results of thermotaxis responses to an infrared beam, demonstrating the infrared beam's ability to steer C. elegans when shined in a phase dependent manner. However, the use of an infrared beam to create a virtual temperature gradient has yet to be explored.
- The experiment at hand attempts to elaborate on the use of the infrared beam to evoke isothermal behavior by creating a dual-temperature stimulus. To obtain the two temperatures, an infrared beam is shined with alternating intensities in accordance to a time domain variable during free motion.
- During trials the C. elegans continue along a straight path due to their perception that the temperature is hotter on one side and colder on the other.
- The experiment also uses line confocal microscopy to observe the correlation of isothermal behavior with the activation of the AFD thermoreceptor and its postsynaptic AIY interneuron. The sum of these results demonstrates that infrared beams are able to alter the nematodes temperature in a manner that creates a virtual reality causing isothermal neuronal responses and behavior.

INTRODUCTION

- Caenorhabditis elegans' temperature responses have been observed through establishment of a temperature gradient across an aluminum plate.
- When placed on an temperature gradient, the worms were found to track an isotherm within 2 degrees Celsius of their previous cultivation temperature.
- Infrared beam has been shown to steer C. elegans when shined in a phase dependent manner. Nematodes sense a temperature increase on the side of the body where the infrared beam is shined, causing the worm to move away from the beam.
- Use of an infrared beam to create a virtual temperature gradient has yet to be explored. This experiment proposes to evoke isothermal behavior by creating a dual-temperature stimulus.

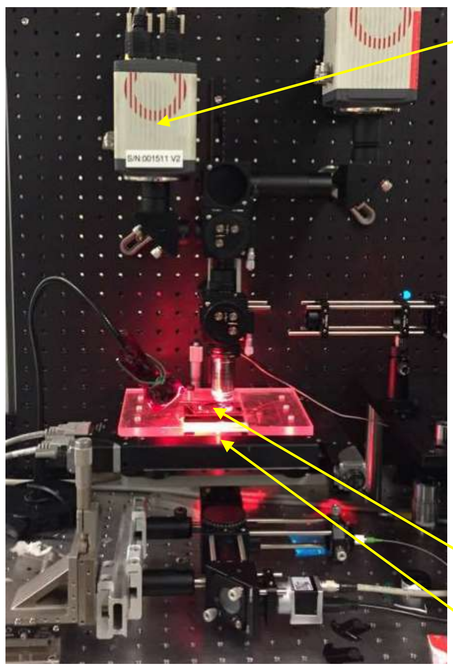


WORM TRACKING WITH INFRARED BEAM



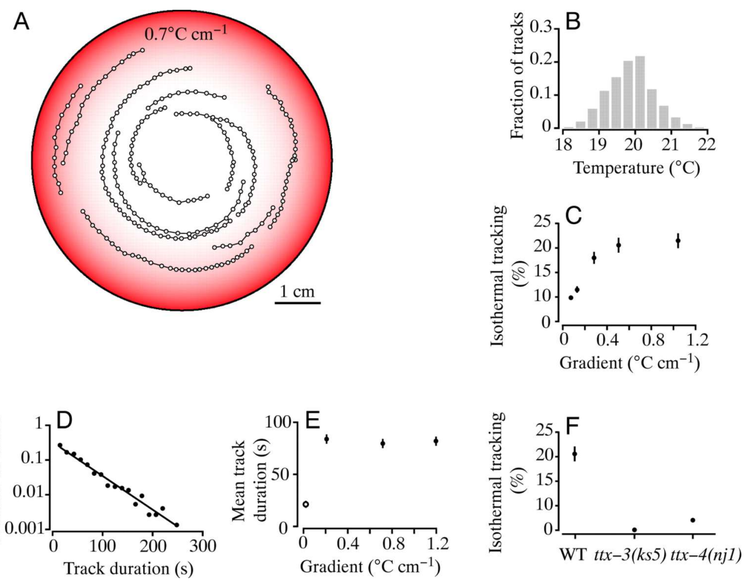
- The C. elegans are placed in gelatin under the field of view of the microscope.
- The stage cameras are directly above and below the worm under observation. The camera focuses on the head of the C. elegans in order to capture the activation of different neurons
- IR beam is shined directly on top of the worm in accordance to the time domain variable.

MATERIALS & METHODS



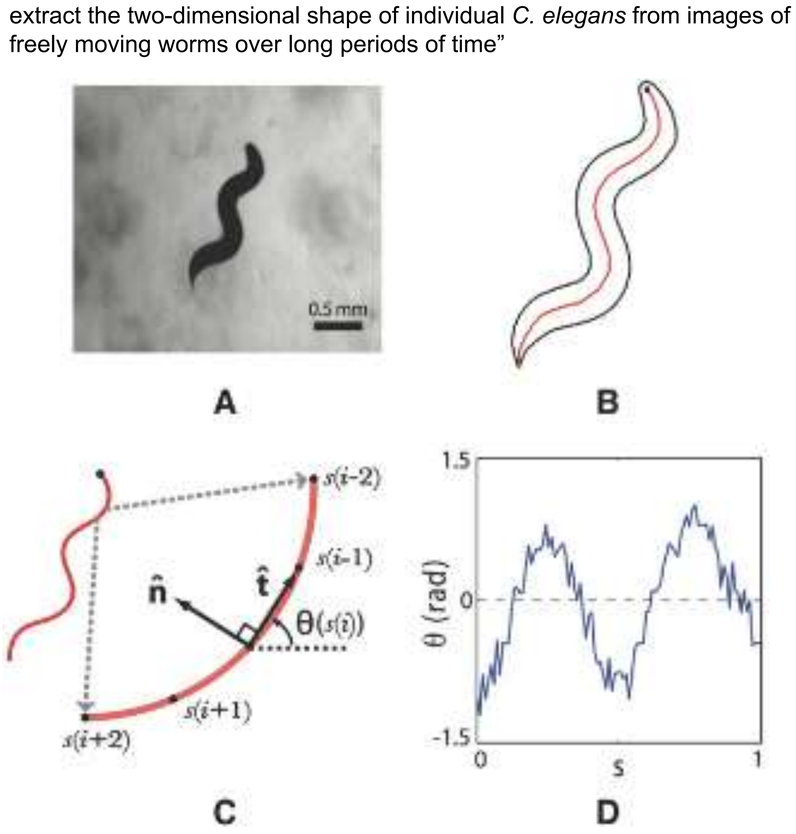
- Infrared beam shined with alternating intensities in accordance to a time domain variable during free motion
- Using line confocal microscopy, we observe the correlation of isothermal behavior with the activation of the AFD thermoreceptor and its postsynaptic AIY interneuron

RESULTS

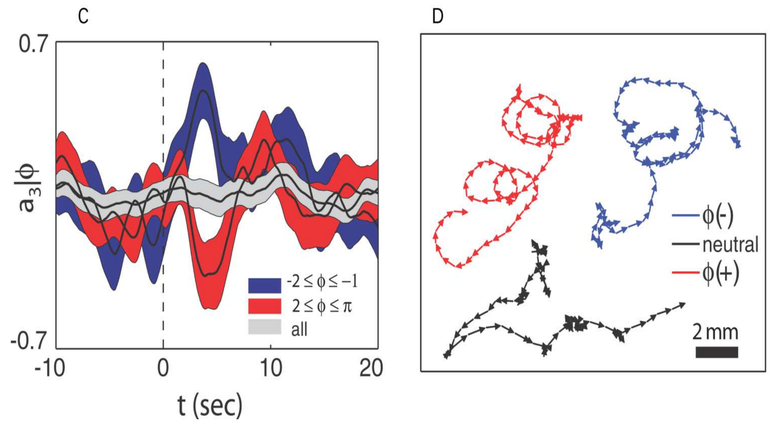


Top: Isothermal tracking on a temperature gradient

Bottom: "Tracking microscopy with high spatial and temporal resolution to extract the two-dimensional shape of individual *C. elegans* from images of freely moving worms over long periods of time"

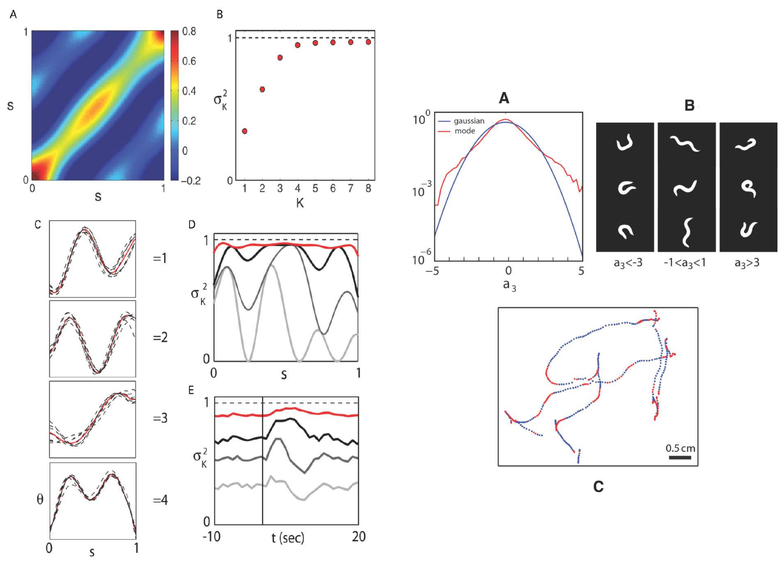


RESULTS



Above: Previous research shows infrared beams have the ability to steer worms when beam is shined in a phase dependent manner.

Below: These graphs describe the sinusoidal movements of the C. elegans which demonstrates the isothermal behavior (response to the difference in temperature) and how it maintains its free motion.



CONCLUSION

This experiment, while still underway, is aiming to demonstrate that a virtual reality can be created by shining infrared beams of alternating intensities on C. elegans in a phase dependent manner, which simulates the perception that one side is hotter, and one side is colder. Regular isothermal tracking on a gradient consists of the worm perceiving a temperature change as it moves its head left to right. A virtual reality through an IR beam causes the worm to move in a relatively straight line, which is analogous to the isothermal tracking of the worm.

REFERENCES

- Luo, Linjiao, Damon A. Clark, David Biron, and Aravinthan D.T. Samuel. "Ensorimotor Control during Isothermal Tracking in Caenorhabditis Elegans."
- Stephens, Greg J., Bethany Johnson-Kerner, Wliliam Bialek, and William S. Ryu. "Dimensionality and Dynamics in the Behavior of C. Elegans." (2008)

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