

The Design and Application of a Three-Dimensional Flying Prey Simulator

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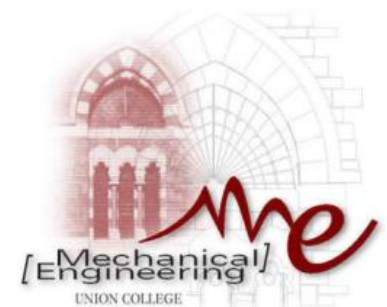
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Outline

- Biology background
- Motivation
- Design
- Construction
- Testing

Objective

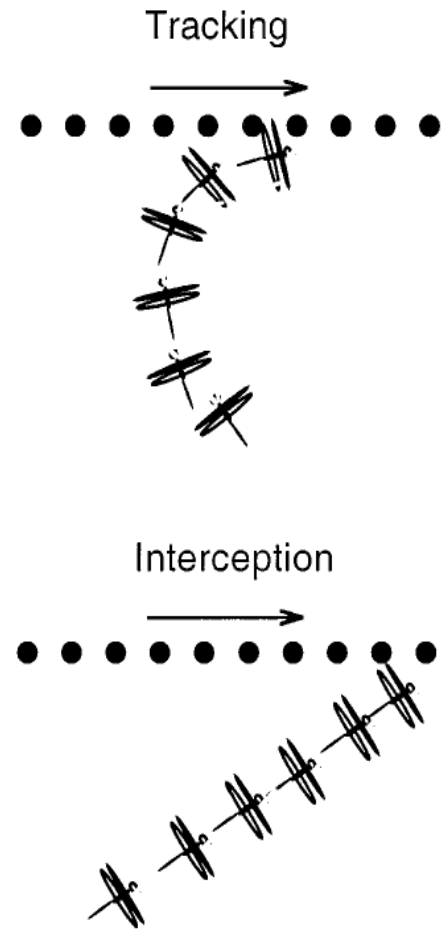
- Investigate the neuronal control of flying prey interception in dragonflies



- Will be used to determine how dragonfly neurons encode information about object movement in three dimensions

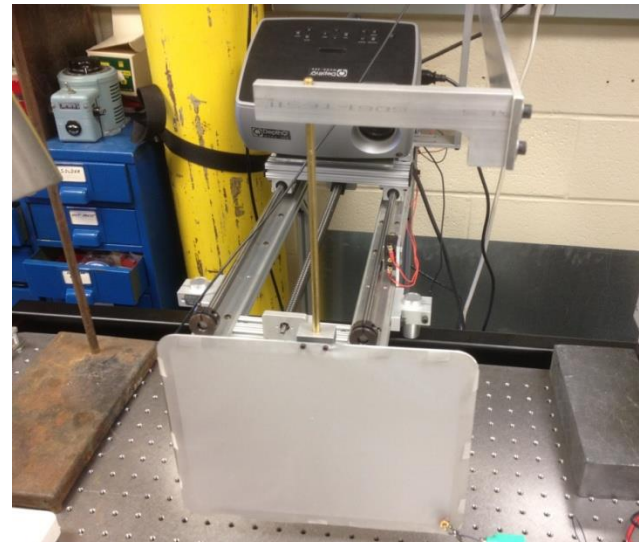
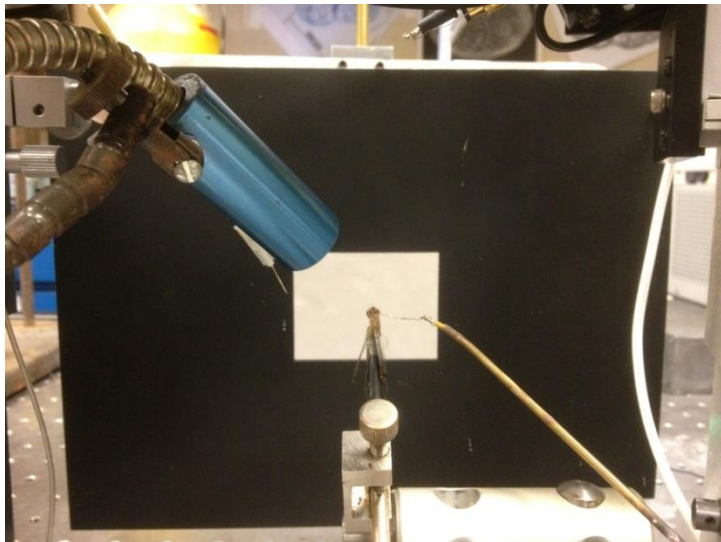
Introduction

- Highly efficient aerial predators
- Requires rapid visual processing and information transmission
- Evolution of large neurons in the control pathway
- Target-selective descending neurons (TSDNs)



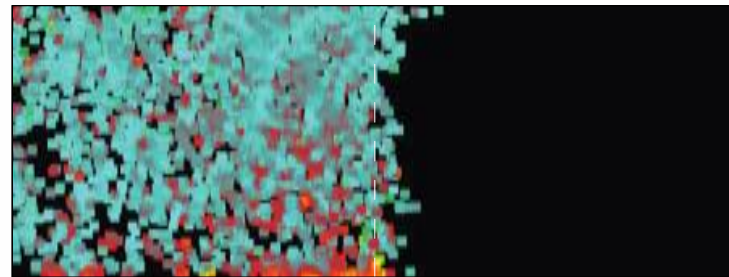
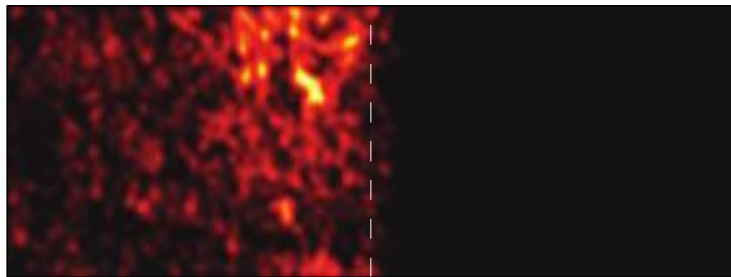
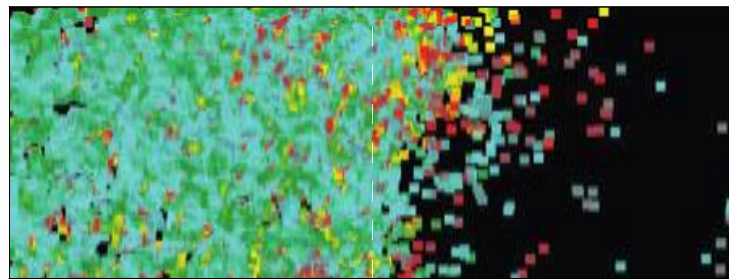
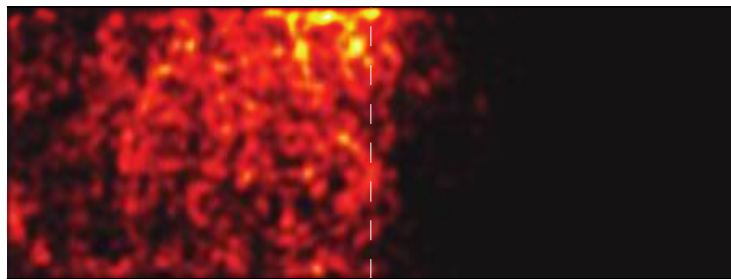
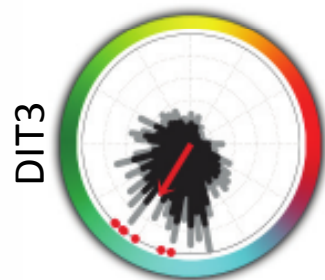
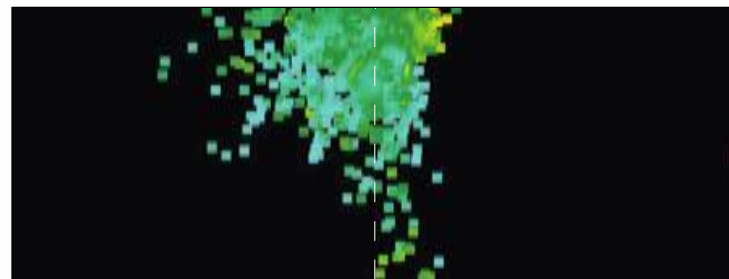
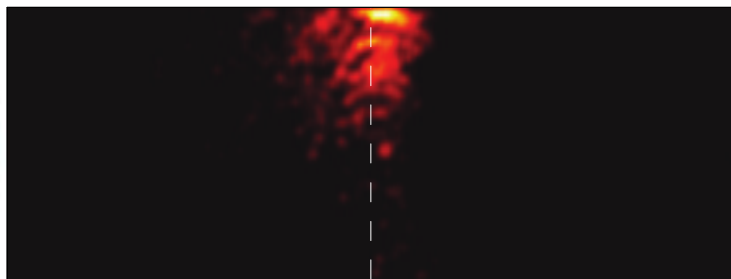
Motivation

- Previously the dragonfly visual neurons have been mostly restricted to two dimensions
 - X direction (right-left) and Y direction (up-down)
- Flying insect prey pursued by dragonflies move in three dimensions and little is known about how the visual neurons encode the third (depth dimension)

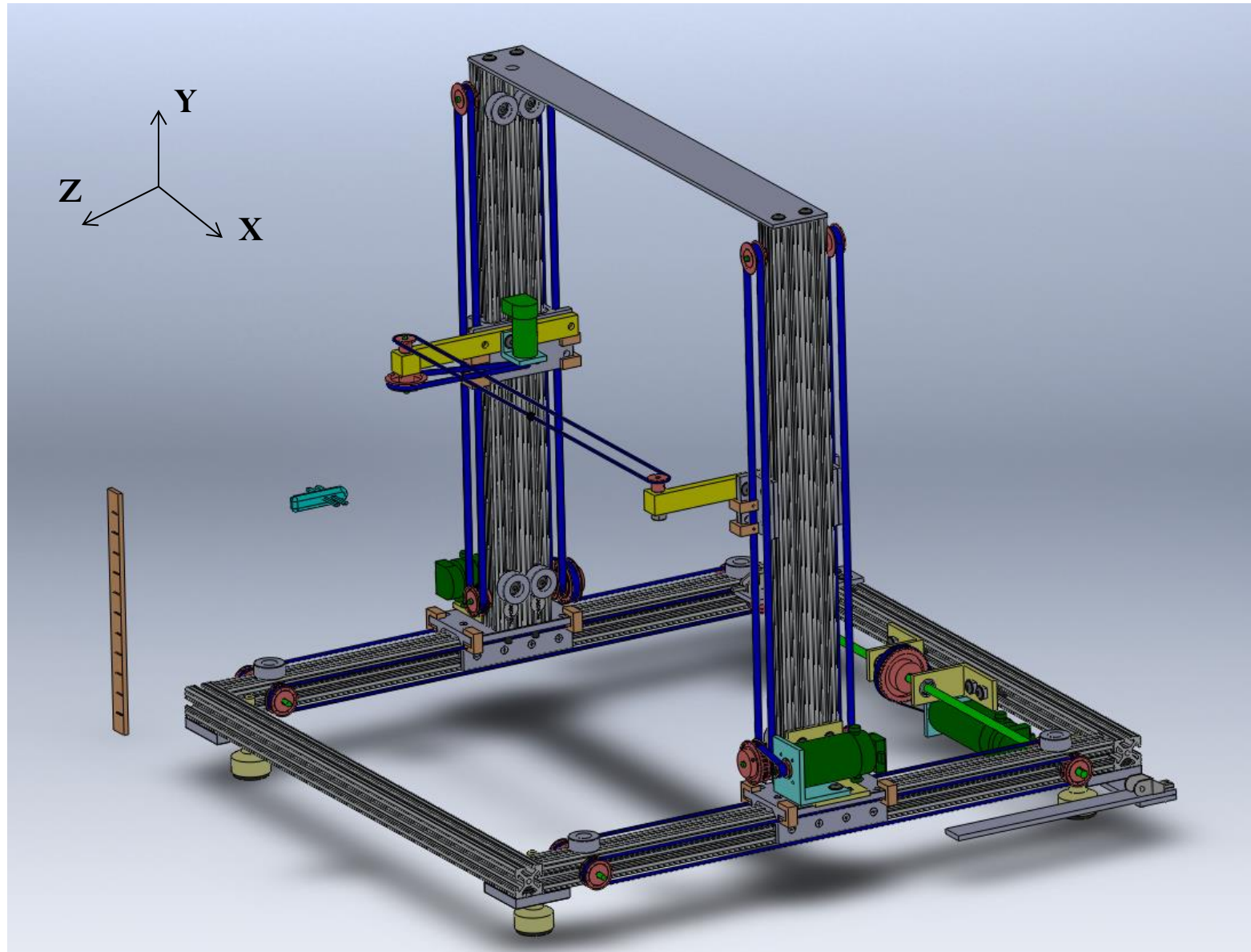


Previous Results

A Contralateral TSDNs



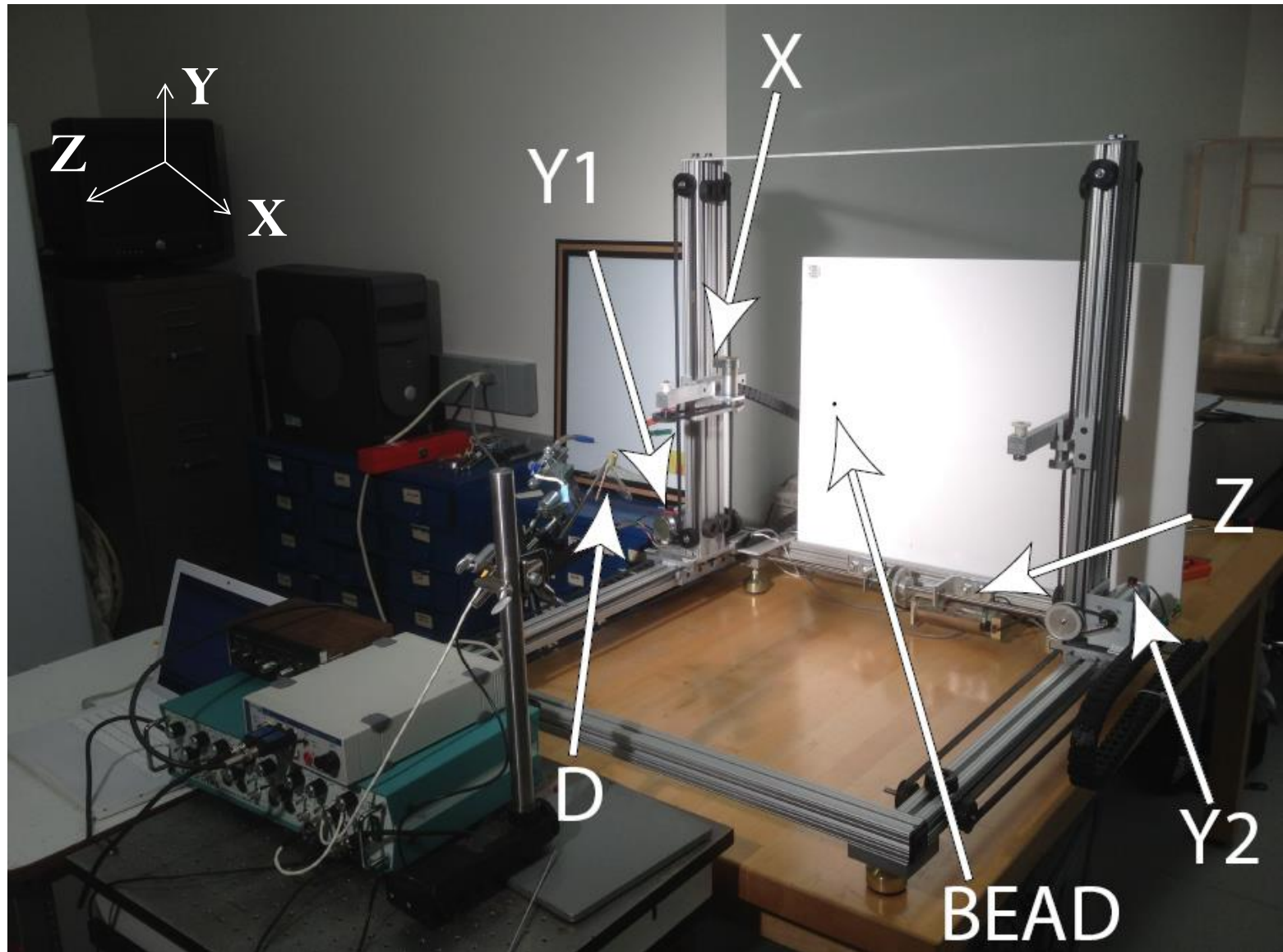
Design Requirements

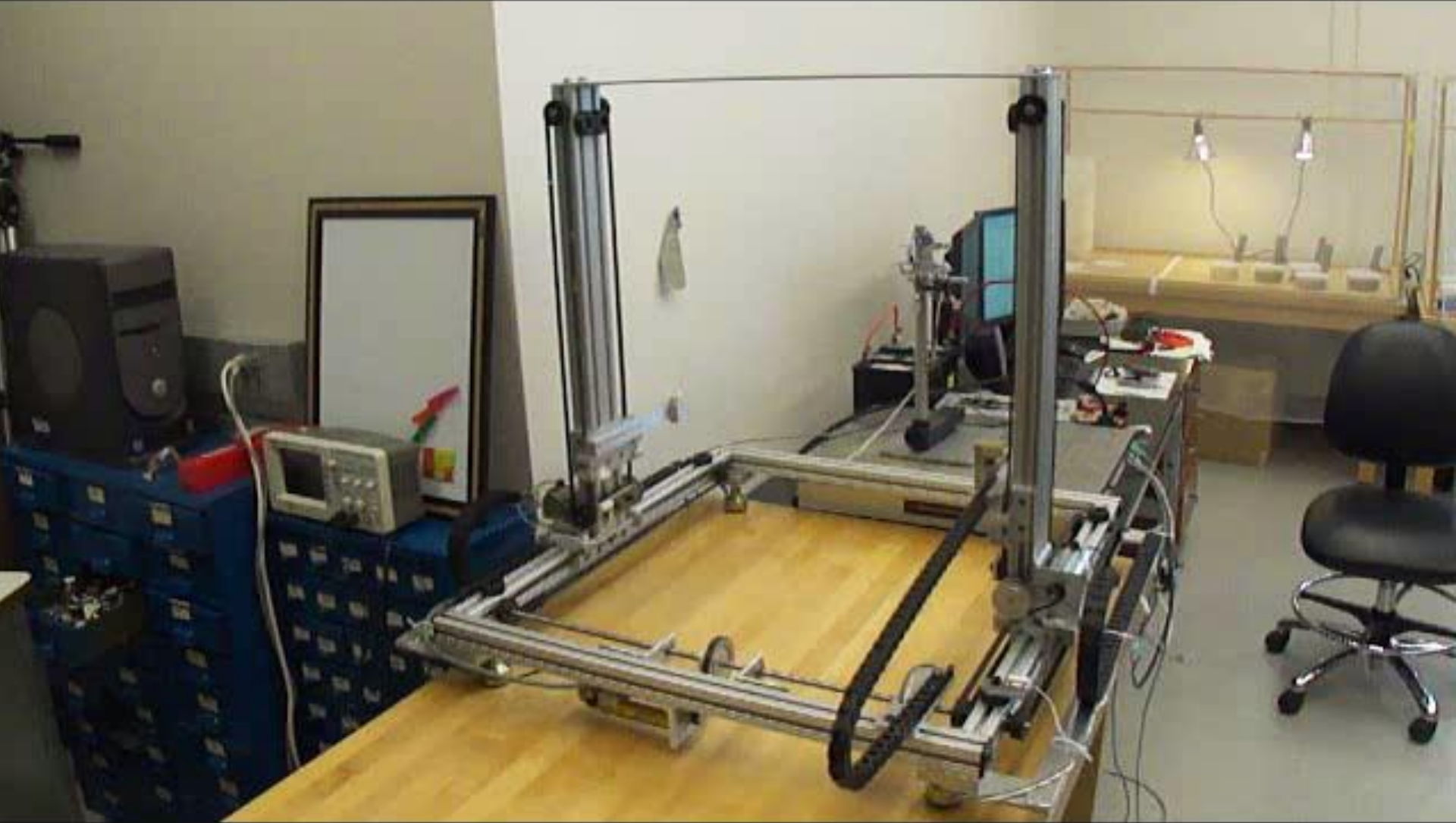


Methods

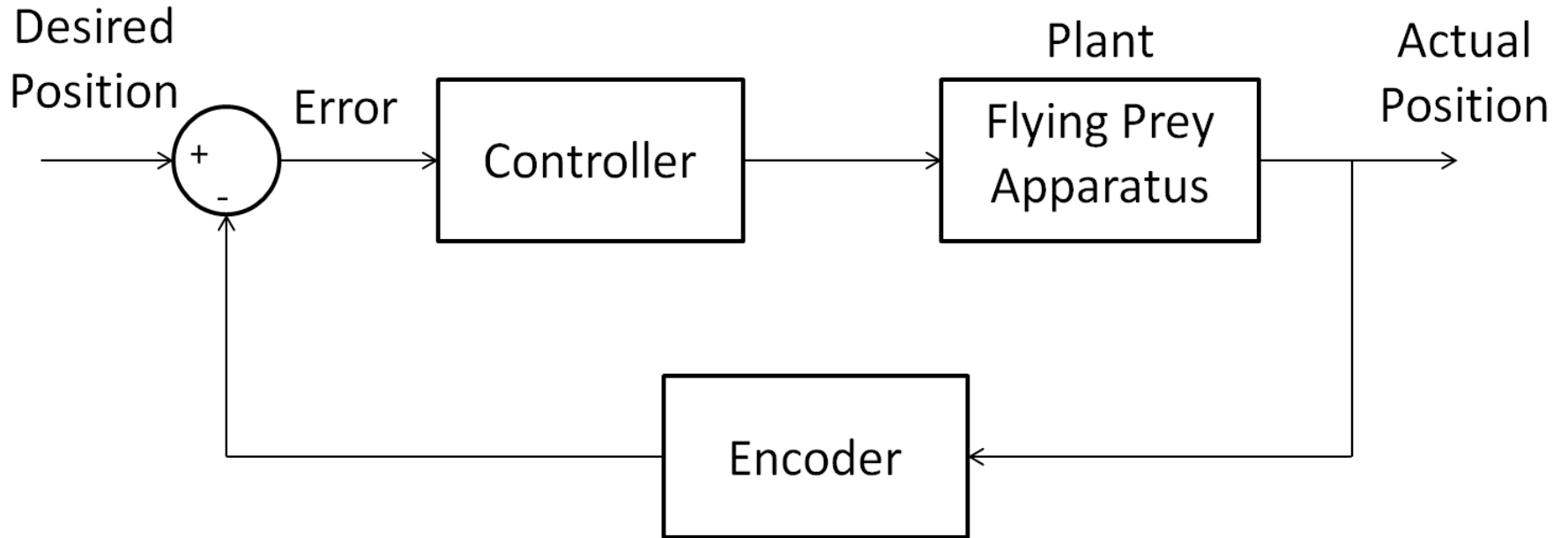
- Structural framework
- Open loop control
- Closed loop control
- Neurobiological experiments

Flying Prey Simulator

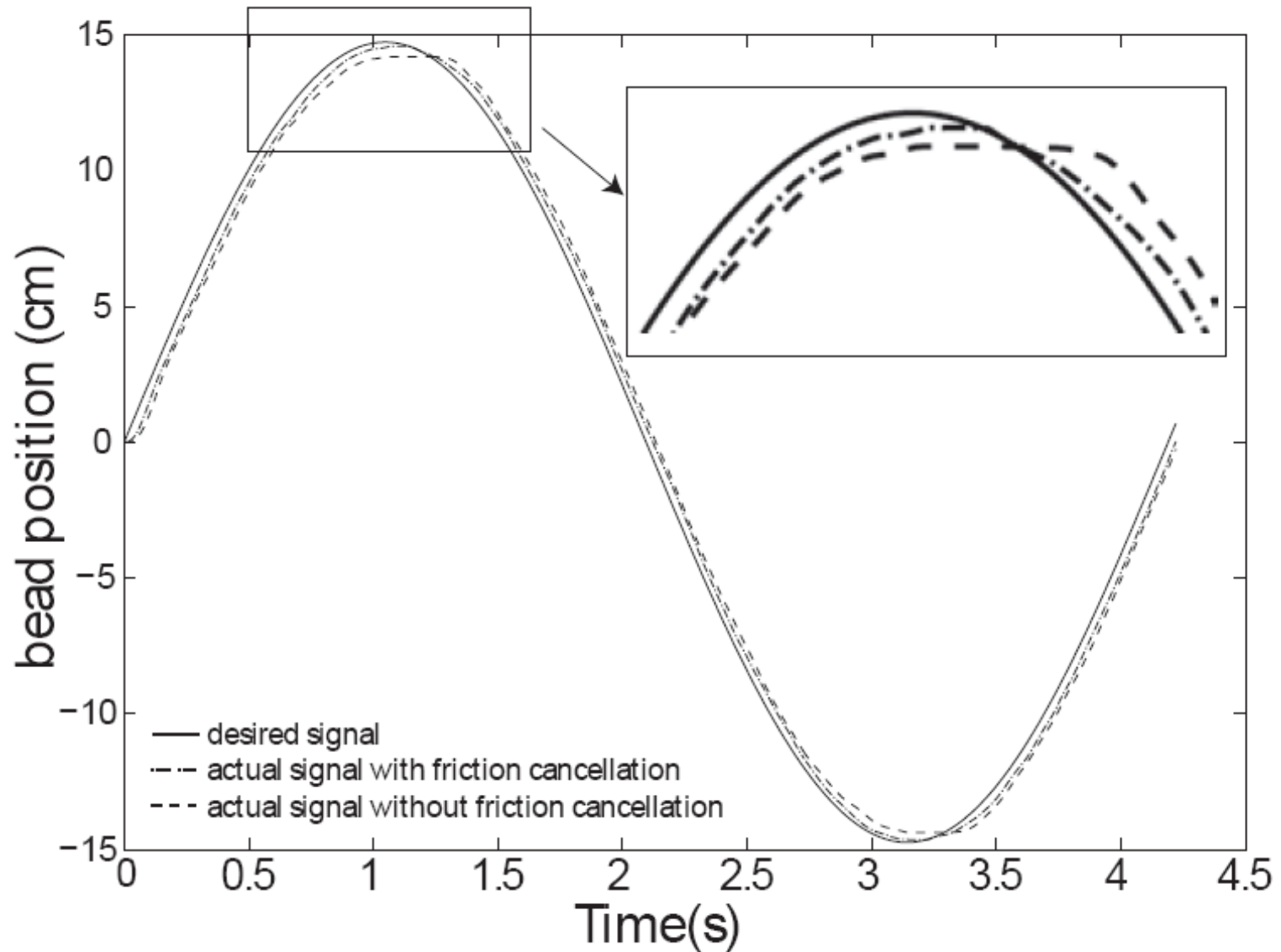




Closed Loop System

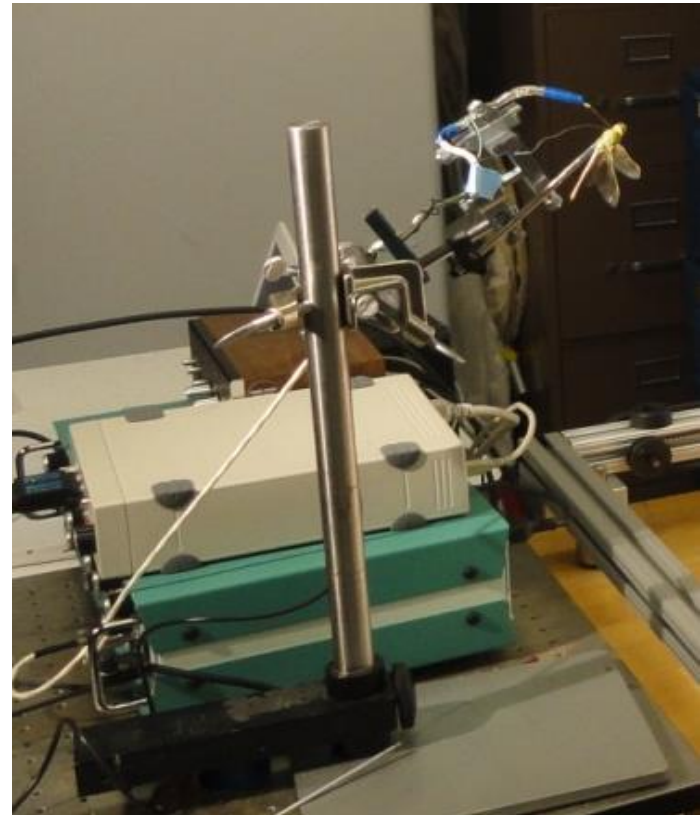


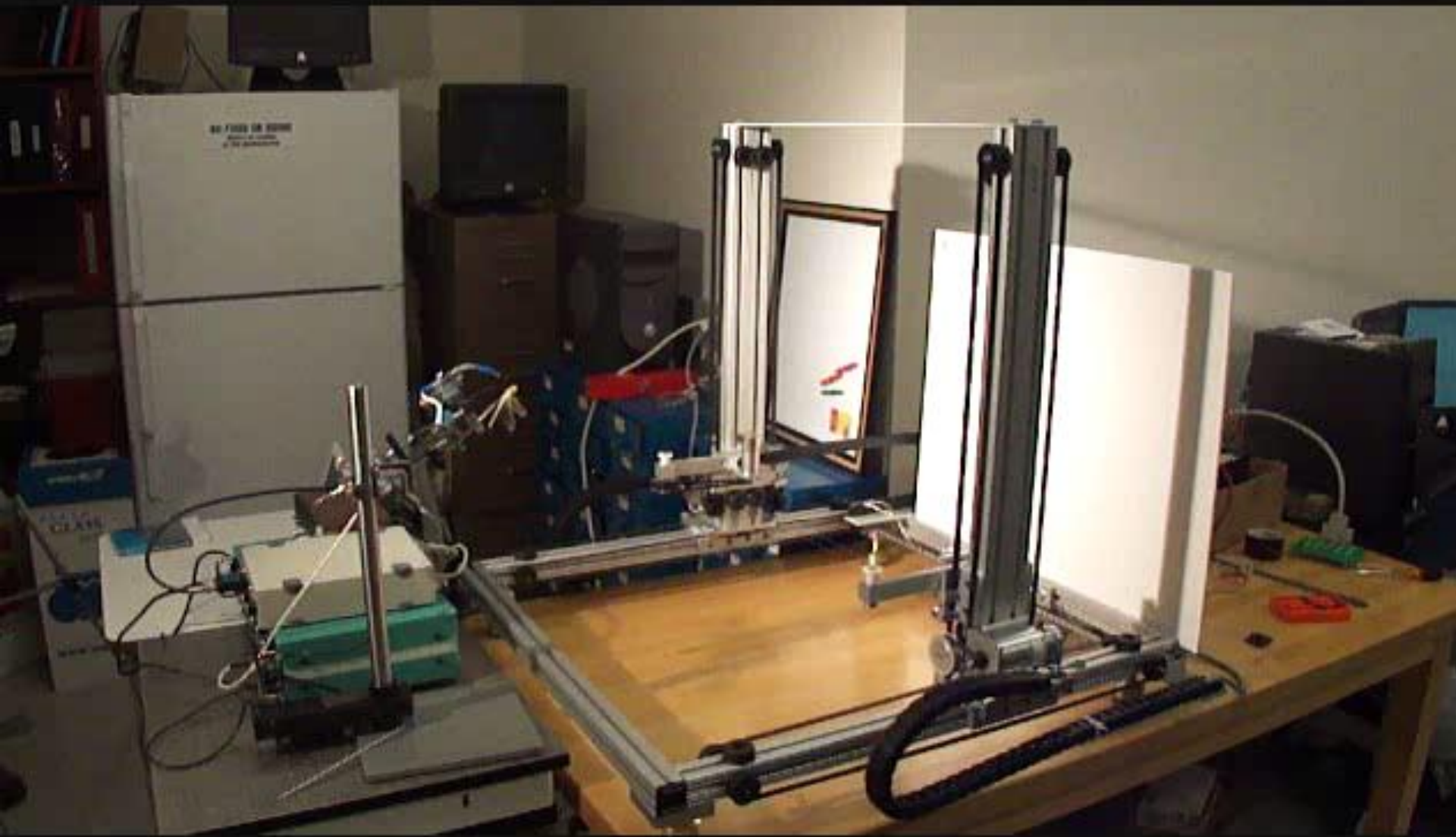
Sinusoidal Tracking Results



Dragonfly Test Setup

- Dragonfly (*Anax Junius*) was mounted with wax to a rigid bar
- Hook electrode fashioned from bare 100 μm silver wire
- Placed so the 3 mm bead was centered on the acute region of the dorsal compound eye

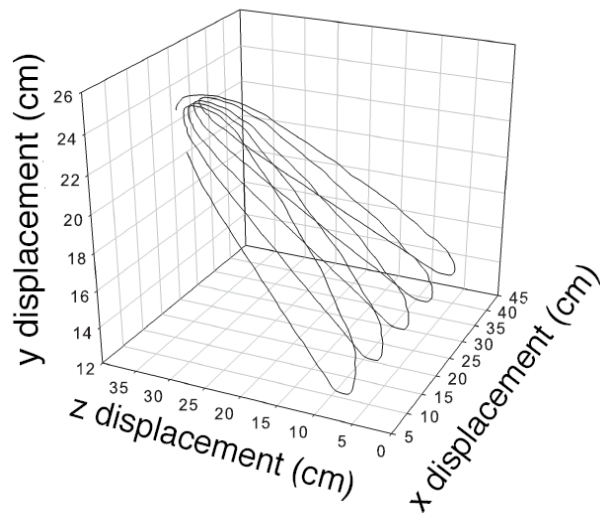




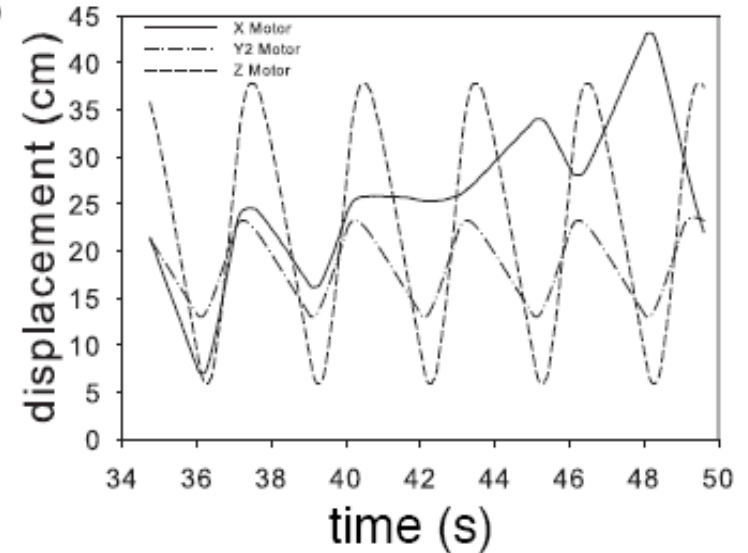
Dragonfly Testing Results in 3D

- Bead performed collision-like path to simulate a small insect flying toward the live dragonfly
- Bead trajectory formed shape of a pyramid with the pyramid's apex positioned at the head of the dragonfly

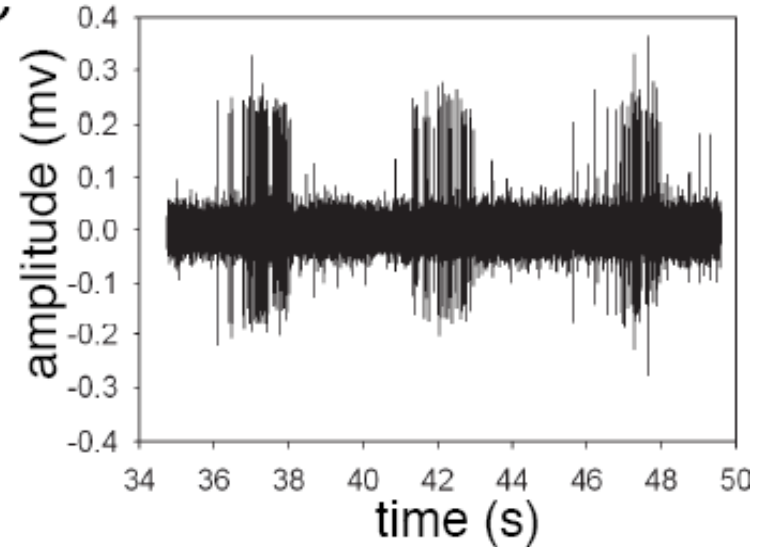
A



B



C



Conclusions

- Apparatus has a remarkable level of repeatability
- Device will help further our understanding of the information transmitted by TSDNs in the dragonfly
 - Little is known about the way in which information concerning the prey distance (Z dimension) is integrated into their responses
- Unraveling the neural basis of visually guided prey interception by dragonflies could reveal how a small group of neurons can drive a fast, complex, and highly reliable behavior such as the interception of flying insects

Acknowledgments

- Air Force Office of Scientific Research (AFOSR grant # FA9550-10-1-0472 to RO) for equipment and summer fellowship support
- Union College Student Research Grants
- Special Thanks to :
 - Professors David Hodgson, Ashok Ramasubramanian, and Robert Olberg