BIOMEDICAL ENGINEERING
Carnegie Mellon University

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4:30 – 5:30 p.m.
Doherty Hall A302

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Computing motion in a small brain: visual navigation in the fruit fly

Abstract: As animals move through the world, they generate optic flow on their retina that is used to regulate their rotational and translational speed. For the last 60 years, *Drosophila* has served as an excellent model system to understand how rotational motion is detected and used to stabilize body orientation in a sensorimotor transformation known as the optomotor turning response. The optomotor turning response is well described by the Hassenstein-Reichardt Correlator (HRC) mathematical model, which accurately predicts that the rotational motion percept is temporal frequency tuned – that is, it depends on both the velocity and the spatial structure of the stimulus. However, in addition to regulating their orientation, animals must regulate their translation through the environment. We investigated how flies use visual inputs to regulate their walking speed. We show that unlike the optomotor turning response, flies regulate their walking speed based on the *speed* of the stimulus, independent of its spatial structure. This different tuning indicates that the walking response is not consistent with an HRC, and suggests that it is regulated by circuits distinct from those mediating the optomotor turning response. To identify the neural implementation of the walking optomotor response, we genetically silenced various neuron types known to be involved in optomotor turning response. Silencing specific cells types produced a variety of outcomes: abolishing walking speed regulation entirely, reducing responses to one direction of motion but not the other, and reverting the characteristic speed tuning to temporal frequency tuning. Finally, calcium activity measurements of the tuning properties of cells required for the optomotor walking response show that they are temporal frequency tuned. Interestingly, cortical models of direction-selectivity show how temporal-frequency tuned signals may be combined to create velocity-tuned ones, suggesting there may be shared computational mechanisms between insects and mammals.