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Poster presentation

Model of the regulation of *Drosophila* flight by mechanosensory feedback

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The aim of this theoretical work is to understand how the fruit fly uses sensory input from wings and other structures to be able to quickly maneuver during flight. We capture in the model the qualitative features of flight dynamics that depend on the mechanosensory feedback.

To describe mechano-transduction in the campaniform sensillum, we use a leaky integrate-and-fire neural model. Its excitatory conductance is dependent on strain, corresponding to a mechanically gated ion channel. The parameters of this first part of the model were fixed with the help of previously published physiological data on campaniform receptors, as well as the closely related bristle sensillae.

In a second part of the model we study how the mechanosensory information is used in flight control. The output of mechanoreceptors is coupled to a dynamical model of the activation of control muscles and its effect on the wing motion. As the mechanics of the wing hinge and its reconfiguration by the action of control muscles is not known in detail, we adopt a highly simplified description of the system. In this part of the model, a nonlinear oscillator, representing the indirect power muscles, is coupled to two linear mechanical subsystems, representing the wing, the sclerites, and the direct control muscles on the left and right sides. Sensory input perturbs the dynamics of the system by altering parameters of the linear subsystems. Motivated by the experimental data of Tu and Dickinson [1], we take the stiffness of the control muscle to depend on the timing of the mechanosensory spike in the previous wingbeat cycle.

Our goal is to capture the dynamics of a saccade, a fast maneuver in the yaw plane. In the model, the saccade is initiated by a strong transient perturbation on the left or right side. (In experiment, this is usually a consequence of an optical stimulus). The saccade then continues until the left and right subsystems are fully phase- and amplitude-synchronized. The synchronization dynamics is driven by the coupling of the left and right subsystems though the nonlinear oscillator, as well as by ipsilateral and contralateral mechanosensory feedback. We analyze the characteristic features of synchronization through these distinct neural and muscular mechanisms, and we compare the predicted courses of a saccade to experimental recordings.

References

1. Tu MS, Dickinson MH: **The control of wing kinematics by two steering muscles of the blowfly (*Calliphora vicina*).** *J Comp Physiol [A]* 1996, **178:**813-830.