
Optimal Computation of Flow Field Variables from Natural Visual Signals
(0423039-FY04)

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Many animals use vision to estimate their motion through space. Visual input implicitly contains signals related to self motion, but this relation is noisy, indirect, and ambiguous. To make optimal estimates, the brain must therefore use an algorithm that takes into account the statistics of the visual input signals and the probabilistic relation between visual input and self motion. This project will study motion estimation in the natural world as a statistical estimation problem, and compare the predictions of statistically optimal processing to the characteristics of motion computation in the blowfly visual system.

Using a custom built camera-gyrosensor system we will sample both the signals that need to be estimated (rotations) and the data on which this estimate is based (raw visual input). This simultaneous sampling makes it possible to find the probability distribution that describes the relation between motion and visual input. From this distribution we can derive the characteristics of the optimal statistical motion estimator. These predictions are compared to the behavior of motion sensitive neurons recorded from the visual brain of the blowfly.

That comparison allows quantitative assessment of optimality in biological motion processing. Preliminary experiments have shown that both the blowfly and the optimal estimator show specific biases, depending on the statistics of the input signals. There are strong indications that other animals, including humans, share similar biases, suggesting that they arise as an inevitable consequence of optimal processing of natural sensory signals.

PI Website

http://www.physics.indiana.edu/faculty/DeRuyter.shtml