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Abstract:

Modelling MST Optic Flow Responses Using Receptive Field Segmental Interactions

Chen-Ping Yu+, William K. Page*, Roger Gaboriski+, and Charles J. Duffy*

*Dept. of Neurology, Univ. of Rochester, Rochester, NY 14642

+Dept. of Computer Science, Rochester Institute of Technology, Rochester, NY 14623

The patterned visual motion of optic flow indicates the heading direction of observer self-movement. Neurons in monkey medial superior temporal (MST) cortex respond selectively to optic flow stimuli in a manner that may contribute to heading perception. We recorded MST neuronal responses to large-field (90° X 90°) optic flow and to four directions of planar motion with nine stimulus segments (3 X 3 array of 30° X 30° segments). Responses to segmental planar motion were then used to model receptive field mechanisms that might support optic flow selectivity in these neurons.

Genetic algorithms were used to generate dual Gaussian models of each receptive field segment tested with local planar motion stimuli. The genetic algorithm optimized local direction preferences, response strength, and selectivity. Typically, the optimized model of each segment contained one excitatory and one inhibitory directional mechanism. Although the dual Gaussians successfully modelled the responses of each segment to planar motion, the sum of the segments were unable to predict the profile of neuronal responses to large-field optic flow.

We added a second stage to the modelling operation in which the genetic algorithm modulated only the relative strength of the responses from the receptive field segments without changing directional preferences or selectivity. These gain modulated models were highly successful at fitting the optic flow response profiles of the MST neurons. Commonly, gain modulation imposed the multi-segmental reciprocal changes in excitatory and inhibitory mechanisms.

Neurophysiological experiments in which two sites were simultaneously stimulated suggested the existence of inter-segmental interactions that promote changes in local responsiveness based on direction specific co-activation. We hypothesize that such interactions reconcile differences between local planar motion responses and large-field optic flow responses in MST neurons.