A NEURAL MODEL OF VISUALLY-GUIDED STEERING, OBSTACLE AVOIDANCE, AND ROUTE SELECTION

How does a human steer toward a stationary goal while avoiding contact with obstacles in a cluttered environment? Successful steering behavior involves a dynamical interaction between a person's perceived heading, or self-motion direction, and the egocentric spatial locations of the goal and obstacles. Psychophysical data suggest that a goal acts as an attractor of heading, while obstacles act as repellors of heading. A neural network model has been developed by David Elder, Stephen Grossberg, and Ennio Mingolla in CELEST Thrust 1 (Learning in Visual Perception and Recognition) that combines neural representations of heading and goal and obstacle position to generate realistic steering behavior. The model extracts heading from an optic flow field using network layers that simulate properties of cells in visual cortical areas MT and MST, and it constructs goal and obstacle representations by combining form and motion cues. The model also contains a circuit that generates smooth pursuit eye rotations to maintain fixation on the target during locomotion. Rotating the eye during locomotion introduces systematic distortion of the optic flow field, and the model corrects for the distortive effects of eye rotation using extraretinal signals. The model's architecture captures the attractor-repellor dynamics of steering behavior, while clarifying the role of heading perception in complex steering tasks. Computer simulations demonstrate model properties on several steering tasks, including approaching goals at different distances and initial viewing angles, and steering in the presence of single and multiple obstacles.