Report

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Collision avoidance using a model of the locust LGMD neuron

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Introduction

The visual systems of insects perform complex processing using remarkably compact neural circuitry. Many large motion-sensitive neurons have been identified in different species of insects but their input circuitry is either poorly understood. By implementing these models on robots, we can investigate their responses in the real world.

Model circuit

Using LGMD, we have designed a model of the input circuitry to the LGMD. This circuit was connected to a wide-angle monochrome camera mounted onto the mobile robot Khepera. The overall circuitry consisted of 7000 neurons and 24,000 synapses and ran in real-time. The simulation ran on two Pentium II Linux PCs and comprised three interconnected processes.

Responses of the model

The monochrome image derived from the camera sets the membrane potential of the 400 model photoreceptors. Using a combination of linear-threshold and integrate-and-fire cells, the moving edges within the scene are extracted. Approaching objects are detected by a combination of rapid direct excitation and delayed lateral inhibition. The spike-rate of the LGMD cell triggers an avoidance reflex in the robot.

Tracking LGMD responses

We evaluated the properties of the LGMD model by investigating its behavioral implications for the robot. The robot explored a walled-off circular space with high-contrast circles. Simultaneously, we sampled the responses of the LGMD neuron and the positions visited by the robot. This allowed us to determine which avoidance actions of the robot were triggered by the LGMD cell.

Conclusions

Our preliminary results show that a model which accurately reflects basic properties of the LGMD neuron and its efficient circuitry produces robust visually-guided avoidance behavior on a mobile robot. In subsequent work, we will investigate more closely the detailed response properties of this model and its ability to respond in more natural environments. We will also extend our study of insect vision to explore other motion-detecting pathways using our neuromorphic robotics approach.

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