Collision avoidance using a model of the locust LGMD neuron

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 circuits. Many large motion-sensitive neurons have been identified in different species of insect, but their input circuits are often poorly understood. Modelling such circuits can help us to investigate hypotheses on their function and behavior. By implementing these models on robots we can investigate their responses in the real world.

Project goals

Our study of insect vision has three main aims:
1. to develop models of independent pathways of processing which respond to different visual features.
2. to investigate how the information from several pathways can be integrated to produce behavior.
3. to produce artificial decision-making through the simulation of animal behavior.

We are using the LGMD system of the locust as one of our starting points.

The locust LGMD neuron

The lobula giant movement detector (LGMD) is a large neuron in the optic lobe of the locust. Over the past forty years extensive research has been conducted to investigate the LGMD's responses and function.

Approaching objects produce the strongest responses from the LGMD suggesting a role in detecting potential obstacles.

The visual circuitry of the LGMD still remains to be deciphered.

Responsive of the model

The model circuit is designed to reproduce the LGMD's responses and function.

Using LGMD, we have designed a model of the input circuitry to the LGMD.

The circuit was connected to a wide-angle monochrome camera mounted onto the mobile robot Khepera.

The overall circuit 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.

Tracking LGMD responses

We evaluated the properties of the LGMD model by investigating its behavioral implications for the robot.

The robot explored a multi-room environment where the walls were covered 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.

An estimated 80% of avoidance responses were due to activity in the LGMD.

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.