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Neuromorphic vision sensors for mobile robots

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Neuromorphic Sensors

Neuromorphic vision sensors are compact, low power focal plane processors implemented in standard CMOS technology. Visual preprocessing operations are performed in a massively parallel way by using analog circuits operated in the subthreshold domain. These circuits are inspired by the neural circuits found in insect and mammalian visual systems.

Adaptive Photoreceptor

One of the most commonly used circuits in neuromorphic vision sensors is the adaptive photoreceptor designed by Tobi Delbruck. This circuit is the input stage of both chips presented here.

Collective computation of 2D optical flow in analog VLSI networks

The optical flow field is a useful source of information about the relative dynamics between an observer (mobile robot) and its environment. Traditionally, the accurate real-time estimation of optical flow requires a significant amount of computational power. We are now able to design computationally very efficient single-chip solutions for optical flow computation.

1D Tracking Chip

This sensor processes visual input in real-time to provide one continuous analog signal encoding the position of the highest contrast moving target. The photoreceptors allow the sensor to operate correctly in a wide variety of illumination conditions. Additional circuitry performs spatial smoothing and data reduction operations to improve the robustness of the system.

Preliminary versions of this chip have already been interfaced to the Koala and Khepera mobile robots. Their successful application to line following and obstacle avoidance tasks demonstrates the feasibility of this approach.

Additional vision sensors of the type described here are being designed at the Institute of Neuroinformatics. These include 1D motion chips for computing motion parallax and a 2D tracking chip with on-chip A/D converters.