Autonomous pilotage using optic flow in a real world environment

Autonomous Pilotage using Optic Flow in a Real World Environment

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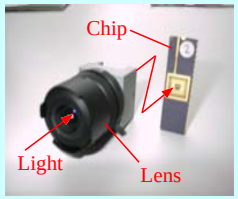
Introduction

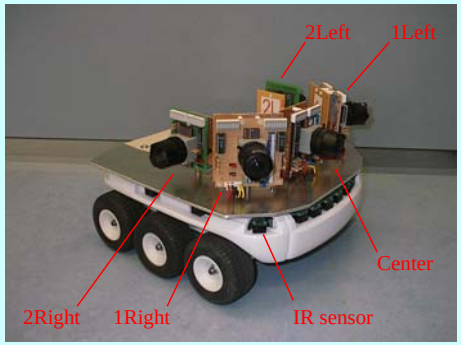
Flies and bees possess a visual system that allows them to perform fast and reliable manoeuvers, despite the fact that their brain has six orders of magnitude fewer neurons than a human brain.
Observations of the visual behaviour of flies and bees suggest that their simple nervous system uses computational "short cuts" to achieve their goals.
Many of the strategies evolved rely on image motion information as a significant cue for pilotage and navigation.

The aVLSI (analog Very Large Scale Integrated) vision chips in this work provide an interesting and biologically inspired solution to the problem of realtime image processing. They compute 1D-motion by correlating the temporal modulation of image intensities in the neighboring pixels.
Implementing neuromorphic aVLSI circuits results in a sensor that provides interesting possibilities in terms of processing speed in autonomous robotics.
Also, aVLSI vision chips operate robustly over large speed and illumiation ranges and their power consumption is several orders of magnitude lower than that of CCD imagers.



This is one of the five aVLSI chips used for the robot as a motion sensor. Photoreceptor circuits on the chip transduce the light (which is first passed through a lens sitting on the chip) directly into currents. All image processing is done on-chip.

Methods:

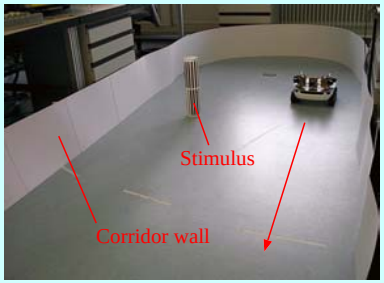


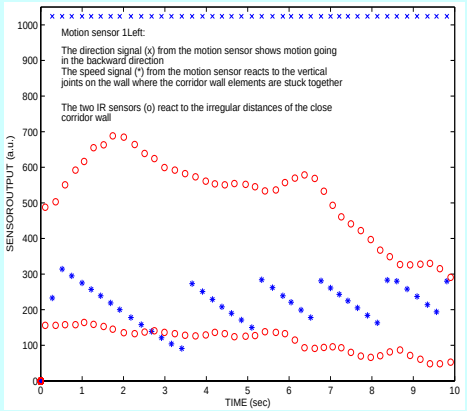
The "Koala" robot used in the experiments.

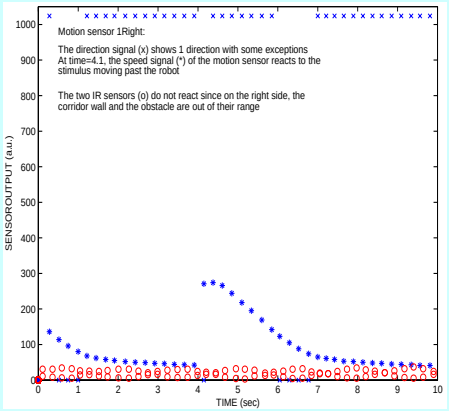
- The motion sensor ’Center’ measures the position of the focus of expansion, the position of the fastest stimulus and its speed and direction.
- The motion sensors ’1Left’ and ’1Right’ measure the speed and the binary direction of the fastest stimulus.
- The motion sensors ’2Left’ and ’2Right’ measure the averaged speed of all perceived stimuli.
- The 16 IR sensors are used when the motion sensors are ineffective and they are also used to correlate the outputs of the motion sensors.

Results:

The results from the experimental setup are shown here. The robot moved in a straight line in a white featureless corridor passing a black and white stimulus. During this time the data from four motion sensors and from the IR sensors were recorded.







The arrangement of the motion sensors and six of the 16 IR sensors: