Bio-inspired vision system for depth perception in humanoids

Flavio Mutti mutti@elet.polimi.it
Giuseppina Gini gini@elet.polimi.it

DEI - Dipartimento di Elettronica e Informazione
Politecnico di Milano
Italy

Motivation and Objective

The aim is to develop a vision system that is able to perceive the depth of the enviroment.

To design a complete controller for humanoid robots it could be suitable to try to exploit the intrinsic structure of the brain information processing (1).

Stereo information processing

Image preprocessing — Normalized luminance mean

↓

Feature-selection based multi-scale Disparity Energy Model

Features:
Spatial pooling
Orientation pooling
Scale pooling
Normalized Response
Phase and Position-shift

↓

Estimation map refinement — Median filter

Architecture and implementation

The idea is to simulate the primary visual cortex in order to produce a disparity map for depth perception.

The algorithm simulates the cortex neuron responses and implements the internal communication mechanisms of V1 as spatial pooling, orientation pooling and scale pooling.

We develop a hybrid architecture that mixes together the pooling mechanisms (in the context of disparity energy model) and the initial position-shift choice through feature analysis, unlike (2).

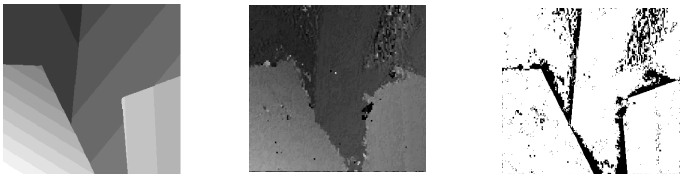
The simulator software is written in C++.

Experimental results

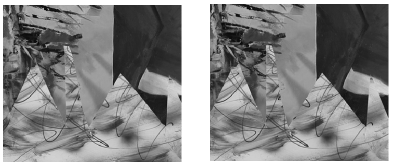
Error measure: bad pixel matching percentage

Venus images

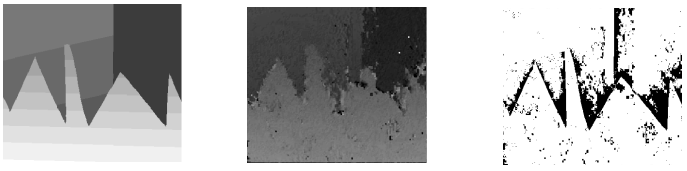
Ground Truth Estimation Error ~ 22%



Sawtooth images



Ground Truth Estimation Error ~ 20%



Images from Middlebury Image Stereo Database (3)

Conclusion and future works

The paper (2) presents results about the disparity estimation of stereo images coming from Middlebury database (3). In our model the percentage of pixels being incorrectly estimated is about 20%; our results improve the accuracy reported in (2) that has 27,8% of pixels incorrectly estimated.

Next step will be to take advantage of the statistical features of the natural scenes in order to further improve our results.

References:
(1) R. Pfeifer, et al., "Self-Organization, Embodiment, and Biologically Inspired Robotics", Science, 318, 1088, 2007
(2) Erik.K.C. Tsang, Bertram E. Shi "Estimating disparity with confidence from energy neurons", Advance in neural information processing systems, vol. 20, 2007
(3) D. Scharstein and R. Szeliski, A taxonomy and evaluation of dense two-frame stereo correspondence algorithms. International Journal of Computer Vision, 47(1/2/3):7-42, April-June 2002. Microsoft Research Technical Report MSR-TR-2001-81,November 2001.