Visual Stereo Processing Discovery on a Mobile Robot

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Introduction
Stereo vision as a rising topic has got more and more attention over these years. However, due to the complexity of the real world situation, its application is still rare to see. In this project, a new algorithm was tested on its real world performance. The input images are taken from a stereo camera which is carried by a mobile robot. A neuron network is then trained based on the input images. Tests were conducted by changing the environment, tuning the parameters and modifying the algorithm. The performance is then evaluated in terms of the shape of the trained receptive fields and the correctness of disparity selectivity.

Background
- Primary Visual Cortex (V1): The algorithm adopted in this project were mainly based on the study of V1. First place can produce disparity selective response. Two major type of cells: Simple Cell, Complex Cell.
- Simple Cell: Only responds to a small area in the view. Has a Gabor filter like receptive field. Indicate the relation between the two eyes. Selective to particularly oriented edges or gratings.
- Complex Cell: Connected to multiple Simple Cells. Connected to a particular feature (e.g. disparity) while remove the effect of the others.

System Specification
- Binocular camera: Resolution 640x480 @ 40Hz
- Mobile Robot: MCU: Renesas SH3-7144 @ 44MHz
- On board computer: Pentium M @ 1.5GHz

Methodology
- Image taking: Image ratification to correct image distortion. Picture naming and storage.
- Robot Motion: Back and forth motion to generate disparities. Sine function speed control to smooth the motion.

Result
- Simple Cell receptive fields generated by looking at paintings.
- Complex Cell disparity tracking result:

Conclusion
- Desirable simple cell receptive fields can be generated.
- Complex cells were trained with good disparity tracking ability.
- The method still cannot be applied to general situation. It would fail if the objects in the current view have too many different disparities.