Cognitive Vision Research Group

In the past decade, the necessity for novel approaches in computation has been fully recognized. This need for new computational paradigms is well demonstrated by the differences between the microprocessors used in computers today, and biological computing structures, such as the mammalian brain.

The greater part of the human brain deals with vision, and it is the goal of the Cognitive Vision Research Group to gain inspiration from the biological vision system in solving computer engineering tasks more flexibly and efficiently. Today, we can see many examples of robot systems in which the processing and understanding of images play a central role. Unfortunately, due to the lack of information regarding the cognitive processes in the biological vision system, image processing subsystems like this remain application-dependent. Today's image processing subsystems cannot be put to use in various fields of application without considerable alterations in their architecture, as well as their internal computational processes.

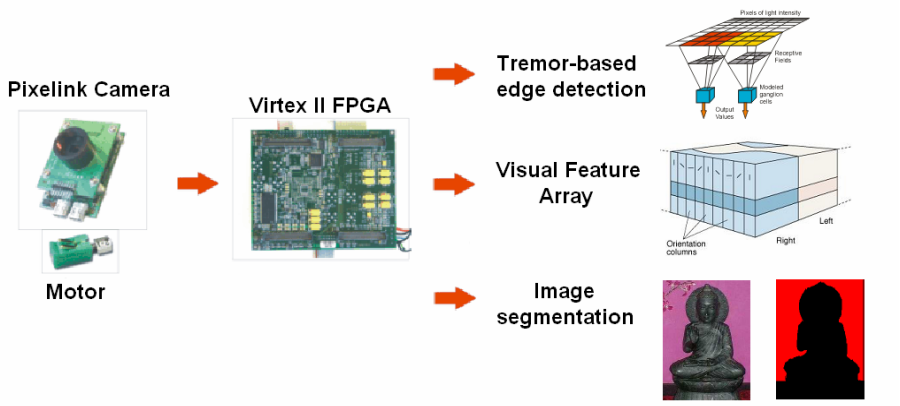
The current activities of the research group are centered on solving low-level visual tasks for robot systems in an application-independent way. Based on the information theoretical relevance of cognitive computational models, two important stages in early visual processing are linked with the retina and the primary visual cortex (V1). Regarding the functionality of contour detection, several models based on involuntary eye tremors were proposed. The models formulate a hypothesis for the role of tremors from an information processing point of view, and early versions have been implemented on an FPGA.

Some other aspects of the visual process, modeled by the research group, pertain to the primary visual cortex, where the filtering of low-level structural information takes place. Information like this includes corners, vertices, and intersections between line segments of different orientations. The importance of visual cues like this had been demonstrated by using psychophysical experiments even before the architectural subtleties of V1 were uncovered. An adaptive data structure (VFA – Visual Feature Array), reminiscent of the hypercolumns defined by Hubel and Wiesel, was proposed. The model clusters line segments according to their length and orientation, and also incorporates lateral excitation and inhibition in order to emphasize information that may be relevant in the processing of visual information.

The aim of the research group is to build flexible and robust engineering applications based on existing neural models. The ultimate goal is to make pervasive use of mathematical structures such as artificial neural networks in creating applications with highly parallel processes (facilitating this way hardware implementation), and not necessarily the modeling of biological processes at the highest possible precision.

The Cognitive Vision Research Group conducts research and creats appliations in collaboration with the Norwegian NTNU, Narvik University College, and PPM/AS (a

company within industrial robotics), as well as the Hashimoto Laboratory at Tokyo University, in its Intelligent Space project.



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