PARALLEL ARCHITECTURES FOR MACHINE VISION

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ABSTRACT

The thrust toward parallel processing in machine vision has been unusually intense for several reasons: there is a tremendous amount of parallelism inherent in algorithms for image processing; the spatial regularity of image data structures lends itself well to VLSI implementations; and programming for parallel systems is probably better understood in the context of image processing than in any other realm of application. The SIMD variety of parallel computer systems matches well with many machine-vision problems, and these systems permit large amounts of parallelism to be applied to a problem with relatively little programming effort and relatively high efficiency.

Parallel architectures for machine vision may be classified according to the dimension across which they achieve their parallelism. Most common are those that achieve parallelism across an image; their different processing elements treat different parts of the image simultaneously. Other architectures are pipelined, performing at any one time the different steps of an algorithm on part of a stream of pixels. The image-parallel and the pipelined architectures do not exhaust the list, for there are more dimensions for parallelization: across goals, across pixels, and across neighborhoods, to mention several.

Some parallel architectures can take advantage of more than one dimension of parallelism. The "pyramid-machine": architecture is one of these. This architecture combines features of meshes such as the "CLIP4" and the "Massively Parallel Processor" with tree machine capabilities, yielding a system with considerable flexibility and efficiency. Some features of a pyramid machine under study at the University of Washington are described. Algorithms for pyramid machines have been investigated by several research groups, and they can be classified according to the control and data-flow paradigms they follow.

A challenging problem exists today in developing architectures that can bridge the "iconic-to-symbolic gap". The high-performance architectures for vision that currently exist focus their efforts on either the pixel-level operations or symbolic operations quite well, but they are not efficient in transforming information from iconic form or vice-versa. Some of the proposals for bridging this gap are discussed.

KEYWORDS: machine vision, image processing, parallel processing, architecture, pyramid machine.