EDGE-ONLY MATCHING TECHNIQUES IN ROBOT VISION

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Abstract

A computation procedure for detecting arbitrary two-dimensional signals embedded in scenes and independent of orientation/size is developed using pipe-line pixel processor procedures. Signals are encoded as edge-only features and cross-correlated with edge-only versions of the input scenes--both in cartesian and log-polar coordinates. These processes are incorporated into a robot visual system capable of locating, moving towards, and pointing to a target signal, again, independent of its size and orientation.

KEY WORDS: robot vision, pattern recognition, edge extraction, invariance coding

1. Introduction.

Many claims have been made as to the importance of edge information in coding images (Marr, 1982), pattern recognition (Rosenfeld & Kak, 1982) and fast computational vision in general. Secondly, convergent results from human psychophysics (Watt & Morgan, 1983), vertebrate physiology (Pollen, Andrews & Felden, 1978) and computional edge processing (Marr & Hildreth, 1980; Leclerc & Zucker, 1983) point to the "optimal" edge extractor as the logical intersection of band-pass Gaussian filters or pseudo-gamma function band-pass filters (Marr & Hildreth, 1980) approximated by $\nabla^2 G_\alpha$ operators (Watt & Morgan, 1983; Leclerc & Zucker, 1983): a Laplacian operator following low-pass Gaussian filters of specified bandwidths. In this paper we are concerned with using edge information for pattern recognition or pattern matching, as restricted to the two-dimensional environment--though including the problem of matching independent of signal orientation and size--required in our robot pattern recognition system (Figure 1).

Edge-based matching techniques are particularly useful in the context of pipe-line pixel processors where the execution time for convolution operations is critically dependent on kernel size, and the frame memories are restricted to 8- or 16-bit pixel sizes. Though our general model involves the correlation of edge-only pattern features at various levels of resolution according to a strict Laplacian pyramid format, in the present simulations we have restricted our analyses to the highest level of resolution: the original 512x512 input format.

A typical pipe-line pixel processor (Arithmetic Logic Unit: ALU-512) maps frame memories into frame memories with respect to the logical operations of (OR, exclusive OR, AND, 2's complement) and usual addition and subtraction operations. Each pass takes 33 msecs and operates on the full image, except when pixel protects are active. Information passes through a 16-bit register and the device also has an 8x8 bit multiplier--which enables convolution

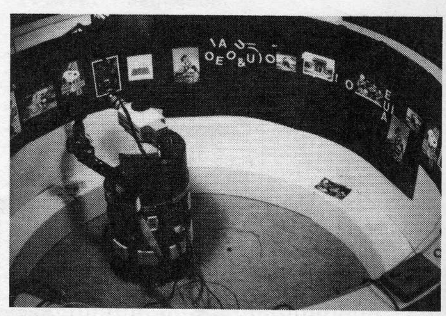

Figure 1

Robot and restricted visual environment used in simulations. Various image montages were placed about the walls and the robot's task was to detect where a specified signal was, move towards and point to it, based on visual information.