Two-Dimensional Shape Recognition Using Sparse Distributed Memory

Pentti Kanerva and Bruno Olshausen

Research Institute for Advanced Computer Science
NASA Ames Research Center

We propose a method for recognizing two-dimensional shapes (hand-drawn characters, for example) with an associative memory. The methods consists of two stages: First, the image is preprocessed to extract tangents to the contour of the shape. Second, the set of tangents is converted to a long bit string for recognition with sparse distributed memory (SDM). [SDM provides a simple, massively parallel architecture for an associative memory. Long bit vectors (256-1000 bits, for example) serve as both data and addresses to the memory, and patterns are grouped or classified according to similarity in Hamming distance. See Kanerva (1988) for details on SDM, and Keeler (1988) for a comparison to Hopfield nets.]

At the moment, tangents are extracted in a simple manner by progressively blurring the image and then using a Canny-type edge detector (Canny, 1986) to find edges at each stage of blurring. This results in a grid of tangents, such as shown in Figure 1 for the letter A. While the technique used for obtaining the tangents is at present rather *ad hoc*, we plan to adopt an existing framework for extracting edge orientation information over a variety of resolutions, such as suggested by Watson (1987, 1983), Marr and Hildreth (1980), or Canny (1986).

The grid of tangent is converted to a long bit pattern by encoding the orientation at each point with three bits. The three-bit encodings for each orientation are chosen in such a way that the Hamming distance between code words is related to angular distance, as shown in Table 1. The encodings at all the grid points are then concatenated into a long bit pattern, as shown in Figure 2. This bit pattern then serves as a reference address and/or data word for SDM.

The main advantages of this approach are that 1) SDM is capable of searching among many stored patterns in parallel, 2) SDM corrects for noise in the address and data, and 3) the features obtained from the preprocessing stage are chosen and encoded in such a way that bit patterns corresponding to perceptually similar shapes (as judged by humans) are close to each other in Hamming distance. We are currently running simulations of this method on a SUN 3/60.