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Large-Scale Indexing and Retrieval System for Local Image Features

New wavelet method enables management of selected features in image databases.

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Figure 1: Simulation experiment illustrating the local-feature-oriented indexing and retrieval method for an MRI image database. *Left:* MRI query image; *right:* MRI selected feature image.

A new indexing system for multiresolution image retrieval has been developed. The system analyzes not only whole images but also—for the first time—local features present in the images. This capability is important in managing large-scale image systems such as video databases and medical image databases.

Key to the method is the use of an innovative wavelet, called the W-transform. This transform is characterized by its ability to handle signals of arbitrary size. Equally important, the W-transform is not constrained by assumptions about periodicity. That is, the transformed signal in some location is related only to the signals at its neighboring location. These properties make the W-transform a natural tool for analyzing local image features.

The system works as follows. An image can be expressed by a matrix. A feature of the original image is then selected. The one-dimensional W-transform is applied first to each column of the matrix and then to each row of the resulting matrix. By repeating this process, multiresolution decompositions of the selected feature are obtained, and their histograms are used as "indices." When an image is to be restored, the query image is first matched against indexed images. A threshold is used to measure the degree of similarity. The lower the threshold, the more similar the feature contained in the retrieved image and that in the query image. (A threshold of zero means that only images with exactly the same features as in the query image will be retrieved.)

Several different loop strategies can be used for the retrieving algorithm. One may compare all histogram differences, or just the first one from coarse scale to fine scale, to decide whether to

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terminate searching. Experiments indicate that, for most cases, the desired images can be identified by considering images of the coarsest scale.

Figure 1 shows various stages of the retrieval process applied to a typical MRI image. The image on the left has a size of 256×256 pixels and an 8-bit gray scale. A feature 60×80 pixels inside this image was selected (Fig. 1, right), and W-transforms were used to decompose the image. The resultant histogram was compared with indexing histograms, and a limited number of images retrieved.

The feature-oriented image indexing and retrieval method offers two major advantages over traditional multiresolution histogram comparison methods. The response time for retrieving image coarse components is considerably faster than that for retrieving whole images—thereby dramatically speeding image retrieval over the Ethernet. Moreover, the new method can be used to search images that are significantly different from the query image as a whole but contain local features identical with or similar to those in the query image. Thus, the approach seems promising for managing large-scale image systems such as medical image databases.

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