Image Retrieval Based on GA Integrated Color Vector Quantization and Curvelet Transform

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Abstract. Color and shape information have been two important image descriptors in Content Based Image Retrieval (CBIR) systems. The focus of this research is to find a method representing images with color and shape information in the way of human visual perception. The image retrieval approach proposed here depends on the color and shape features extracted by color Vector Quantization (VQ) and the Digital Curvelet Transform (DCT), respectively. The extracted color and shape features were combined and weighted by Genetic Algorithm (GA), then used for image similarity measurement. Experimental results show that the GA combined features can bring about improved image retrieval performance.

Keywords: Image retrieval, color vector quantization, curvelet transform, genetic algorithm.

1 Introduction

As one of the most important applications of image analysis and understanding, CBIR (Content-Based Image Retrieval) has received more and more attention. The tremendous growth of the quantities and sizes of digital image and video require powerful tools for searching in image and video databases. Since a lot of image databases are poorly indexed or annotated, there is a great need for developing automated, content-based systems to help users to get images they want.

There have been a large number of CBIR systems developed in the recent years such as IBM’s QBIC project \cite{5}, VisualSeek \cite{15}, PicSOM \cite{13}, PicToSeek \cite{7} and a lot more. When facing with a query, the system extracts features from the query, compares them to that of the images stored in the database, the distance between the query image and each image in database is evaluated according to the similarity of features. Sometimes the searching result can be quite different from user’s expectation because of the ‘semantic gap’, the main reason
of semantic gap is the extracted visual features mismatch human’s judgements on similarity. The focus of our research is mining image features which can represent images in the way of human visual perception.

In human visual perception system, humans use a combination of features (color and shape) to recognize objects and do not rely on any one individual feature. In our research, the color vector quantization is selected for image color feature representation; digital curvelet transform is used to extract shape information in images. Genetic Algorithm was then used to optimize weights for all the curvelet and color features of each image category. The combined and weighted features were used for similarity measurement. Experimental results show that the combined and weighted features can bring about good retrieval performance in terms of precision and recall.

2 Image Feature Extraction by Vector Quantization

2.1 Color Vector Quantization

When processing color data in images, one is always faced with the problem that color information on the one hand needs to be quantized as compactly as possible and on the other hand must be represented with sufficient accuracy.

Vector Quantization can take into account the actual color distributions for quantization by exploiting training images from the database. That is, a set of representative color components from training images can be determined and each representative color component serves as a color histogram bin. Although there are various color scalar quantization (SQ) methods, they have apparent drawbacks when using them in image retrieval work. Since they do not consider the spatial relationship between pixels, as we can see from Fig.1, VQ can provide a way of better exploiting the spatial information to generate different histograms in such case.

![Comparison of histograms generated by SQ and VQ](image)

(a) Two different images (b) Histogram of the left (c) Histogram of the right have same numbers of two image. Left: SQ. Right: VQ image. Left: SQ. Right: VQ colors

Fig. 1. Comparison of histograms generated by SQ and VQ

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