EVALUATING COLOUR FEATURES FOR IMAGE RETRIEVAL

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Introduction

In Content Based Image Retrieval (CBIR) systems, images automatically indexed by summarizing their visual features. A feature is a characteristic that can capture a certain visual property of an image either globally for the entire image or locally for regions or objects (Smulders *et. al.*, 2000). Colour, texture and shape are commonly used features in CBIR systems. Extracted features are used to represent images for searching, indexing and browsing images in an image database. Use of feature space is more efficient in terms of storage and computation. Most of the CBIR systems represent the feature space as a feature vector. Once the features are represented as a vector it can be used to determine the similarity between images. CBIR systems use different techniques to measure similarity. In retrieval stage, query image is also represented as a feature vector and the Vector (CCV) were considered. Euclidean distance or Sum-of-Squared-Differences (SSD) was used as similarity measurements.

A general purpose image database that consists of 14500 images drawn from different categories was used to evaluate the effectiveness and efficiency of the selected colour features. The images were stored in *JPEG* format with size 384x256 and The histogram based image retrieval consists of two techniques: Global similarity between the query vector and stored feature vectors is computed (Yong *et. al.*, 1997). The similarly measure is used to determine the distance between the query image and stored images. After that images are ranked according to the distance and retrieved. In this paper, we present the performance comparison of individual colour descriptors. Five different publicly available image databases were used and the retrieval performance of the features was analyzed in detail. with the objective of examining the performance of each descriptor in CBIR.

Methods and Materials

There are several colour models in use. We used the RBG (Red, Green, and Blue) colour model for this work. In order to evaluate the effectiveness and efficiency of colour features Colour Moments (CM), Colour Histogram and Colour Coherent the *RBG* colour model was used. The colour feature vectors for each image were separately computed and stored in a database.

In this work, colour features are evaluated by means of the ratio of relevant retrieved images to the total number of retrieved images (precision) and the ratio of retrieved relevant images to the total number of relevant images in the database (Recall).

Colour Histograms (GCH) and Local Colour Histograms (LCH). The GCH

represents images with single histogram. First the GCH of database images are computed and stored in a database. Then the GCH of the query image is computed. The Euclidean distance metrics is used to measure the similarity between the query image and the database images. In order to identify the relevant images, a fixed threshold is used. In case of LCH, images are divided into fixed blocks of size 8x8. For each block, its colour histogram is obtained. The same procedure that is followed for GCH is applied for identifying the relevant images.

The next visual feature representation is extracted by incorporating the colour histograms and colour moments. First the mean and standard deviations of database images are calculated and stored in a database. Then it is compared with the mean and standard deviation of the query image. The relevant images are ranked by using a fixed threshold value of the difference of the mean and standard deviation of query image and the database images.

Our coherence measure classifies pixels as either coherent or incoherent. A coherent pixel is a part of a sizable contiguous region, while an incoherent pixel is not. Pixel groups are determined by computing connected components. The connected components are computed using 8-connected neighbours within a given discritized colour bin. Pixels are classified as either coherent or incoherent depending on the number of its connected component. A pixel is classified as coherent if the size of its connected component exceeds a fixed value region. In other words a pixel is coherent if the region to which it belongs is about 1% of the image. Otherwise, the pixel is incoherent. A colour coherence vector is used to represent this classification for each colour in the image. First the image is slightly blurred by replacing pixel values with the average value in a small local neighbourhood. The Gaussian filter is used for this purpose. Then the colour space is discritized so that there are only 3 distinct colours (R, G and B) in the image. In the next step, the pixels within a given colour bin is classified as either coherent or incoherent.

Results and Discussion

A general purpose image database including about 14500 images was used for experimentation. The database consisted of different image categories such as Africans and villages, Beaches, Buildings, Buses, Dinosaurs, Elephants, Flowers, Horses, Mountains and glaciers, Food, Faces, Objects, Drawings, Textures and Natural scenes. These images are stored in JPEG format with size 384x256 and each image is represented in RGB colour space. In order to measure retrieval effectiveness for an image by the retrieval system, precision and recall values were used. The following table summarizes the experiment results obtained by using images of Africans and other images such as buses and animals as query images.

Table 1. Summary of test results

Colour Feature	Category - Africans		Category - Red Buses		Category - Dinosaurs	
	Recall	Precision	Recall	Precision	Recall	Precision
	0.09958	0.54387	0.09862	0.46233	0.09862	0.75421
CM	0.09655	0.62333	0.09758	0.52156	0.09758	0.81509
	0.09255	0.82129	0.09255	0.76641	0.09255	0.91980
	0.09862	0.61664	0.09862	0.32678	0.09862	0.58012
GCH	0.095586	0.64196	0.09655	0.33436	0.09655	0.61511
	0.085517	0.70254	0.09255	0.45770	0.09055	0.64743
	0.096551	0.65298	0.09358	0.40616	0.09558	0.50806
LCH	0.091517	0.65921	0.09151	0.45948	0.09358	0.53467
	0.082482	0.69494	0.08248	0.49688	0.08751	0.67428
	0.100620	0.35594	0.09862	0.40338	0.09958	0.58580
CCV	0.097586	0.36060	0.09558	0.41127	0.09655	0.63148
	0.090551	0.37980	0.090551	0.48130	0.08655	0.65160

Conclusions

An experimental comparison of colour histograms, colour moments and colour coherence vector features for content based image retrieval was carried out. The retrieval efficiency of colour descriptors was investigated by means of recall and precision values. The test results indicate that colour histograms perform equally well compared to other descriptors when images have mostly uniform colour distribution. In most of the image categories colour moments also show better performance. CCV shows better comparison rate for images those have widely scattered colours. According to the above results we can conclude that none of the colour descriptors examined is superior to others. The performance of colour descriptors varies depending on the colour distribution of images.

References

Smulders A.M.W., Worring M., Santini, A. S., Gupta, A., and Jain, R. (2000). Content-based image retrieval at the end of the early years, IEEE Transaction on Pattern Analysis and Machine Intelligence, 22(12): 1349-1380.

Yong Rui, Thomas S. Huang and Shih-fu Chang (1997). Image retrieval: Past, Present, and Future, Journal of Visual Communication and Image Representation. In Journal of Visual Communication and Image Representation, 10: 1-23.