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Query Adaptive Image Retrieval System

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ABSTRACT
Images play a crucial role in various fields such as art gallery, medical, journalism and entertainment. Increasing use of image acquisition and data storage technologies have enabled the creation of large database. So, it is necessary to develop appropriate information management system to efficiently manage these collections and needed a system to retrieve required images from these collections. This paper proposed query adaptive image retrieval system (QAIRS) to retrieve images similar to the query image specified by user from database. The goal of this system is to support image retrieval based on content properties such as colour and texture, usually encoded into feature vectors. In this system, colour feature extracted by various techniques such as colour moment, colour histogram and autocorrelogram and texture feature extracted by using gabor wavelet. Hashing technique is used to embed high dimensional image features into hamming space, where search can be performed by hamming distance of compact hash codes. Depending upon minimum hamming distance it returns the similar image to query image.
Keywords – Hamming distance, Hash codes, Hamming space, Hashing, Query adaptive image retrieval.

I. Introduction

The rapid evolution of multimedia and application has brought about an explosive growth of digital images in computer vision. This development has actually increase need for image retrieval system which is able to effectively index a massive amount of images and to efficiently retrieve them based on their visual contents. The term content based image retrieval (CBIR) appears to have been first used in the literature by Kato [1992] to describe his experiment in the automatic retrieval of images from database by colour and shape [1].In the past decade, many image retrieval system have been successfully developed, such as IBM QBIC system [2], developed at the IBM Almaden Research Centre, the Photobook system [3], developed my MIT Media Lab.

There are two main approaches to image retrieval: text-based retrieval and content based retrieval [4]. The text-based approach requires a previous annotation of the database images, which is very lengthy and time consuming. Furthermore, the annotation process is inefficient because, users generally, do not create annotation in a proper way. Actually, different users tend to use different keywords to describe the same image characteristics. The lack of systemization in annotation process decreases the performance of text-based image retrieval. The alternative content-based method indexes images in database by identifying similarities between them based on low-level visual features as colour, texture, shape and spatial information. In this approach, it is possible to retrieve images similar to the image chosen by user. Advantage of this approach is the possibility of an automatic retrieval process, which reduces efforts required for annotating the image.

The query adaptive image retrieval system performs two major tasks. The first task is feature extraction; here a set of features is extracted to describe the content of each image in the database.
The second task is the similarity measurement between the query image and each image in the database, using the feature extraction. The feature extraction values for a given image are stored in a vector that can be used for retrieving similar images. Feature vector are descriptions of the visual features of the contents in images that produce such descriptions. They describe simple characteristics, such as colour, texture. The key to successful retrieval system is choosing the right feature to accurately represent images and the size of feature vector.

This system uses low-level colour and texture feature. For colour feature extraction uses colour moment, autocorrelogram, colour histogram and for texture feature extraction uses gabor wavelet. The extracted features are embedding into hamming space using hashing technique. Hashing is preferable over tree-based indexing structure as it requires greatly reduced memory [5]. These extracted features are then embedded into hash codes for efficient search. Hash codes are used for similarity measure by using hamming distance.

II. Proposed System

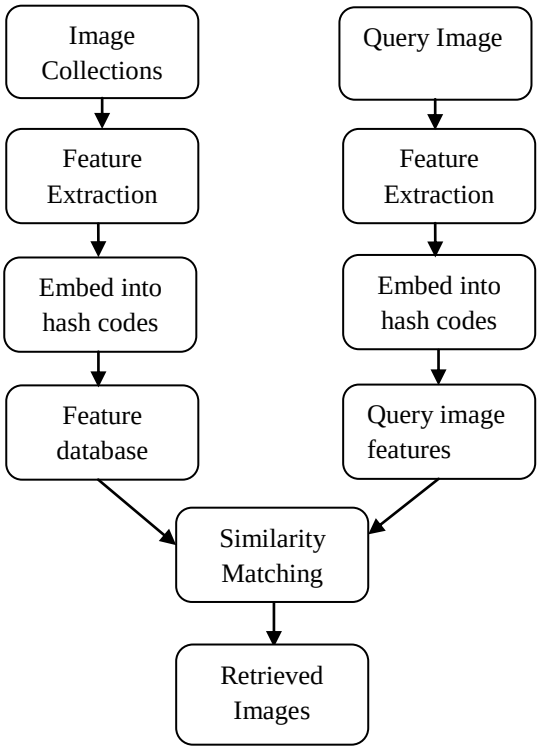

figure1. Block diagram of proposed query adaptive image retrieval system.

Fig.1 shows block diagram of proposed query adaptive image retrieval system. Two main tasks are supported: image collections and query image processing. For the image collections, colour and texture features are extracted first from individual images. The extracted features are described by feature vectors. These extracted feature vectors are embedded into hash codes and stored in feature database. Query image is the input for system, which is taken as input query for search operation. User is supposed to select an image in order to find similar images to that query image. For a given query image, similarly extract its features and form a feature vector. This query image feature vector compares with already store feature vectors in image database. This process usually called similarity matching and is based on some similarity measure to calculate distance between the query image feature vector and feature database. From the system's point of view the similarity of two images depends on the distance in feature space between the feature points defined by the vectors. Means, shorter the distance between two points, the images are similar. Depending on similarity measure it retrieves images.

III. Colour Features Extraction

Colour is intuitive features and plays important role in image matching. Colour feature extraction involves analyzing absolute value of each colour pixel. Colour distribution is a statistical feature and techniques such as colour moment an colour histogram [6].The colour moment and colour histogram contains only colour information of each pixel in an image, the relation between neighbouring pixel is not involve. Another kind of feature, called as colour correlogram which express the spatial correlation of pairs of colour changes with distance.

3.1 Colour Moment

Colour moments are used as feature vector for image retrieval. Since any colour distribution can be characterized by its moments and mainly information is concentrated on the lower order moments, only the first moment is mean and second moment is standard deviation are taken as feature vectors [6].
The first moment is:

$$\mu_i = \frac{1}{N}\sum_{j=1}^{N} f_{ij} \qquad (1)$$

The second moment is:

$$\sigma_i = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(f_{ij} - \mu_i)^2} \qquad (2)$$

Where fij is the value of i-th colour component of the image pixel j, and N is the number of pixels in the image.

3.2 Colour Histogram

Colour histogram is an effective representation of the colour content of an image. The colour histogram is an effective method for characterizing both the global and local distribution of colours in an image. A histogram is the distribution of number of pixels for each quantized bins. Quantization in terms of colour histogram refers to the process of reducing the number of bins by taking colours that are very similar to each other and putting them into same bins. A colour histogram for given image is represented by vector:

H= {H [0], H[1], H[3],……H[m]…… H[n]} (3)

Where m is a colour bin in colour histogram and H[m] represents the number of pixels of colour m in the image and n is the total number of bins used in colour histogram. For comparing images of different sizes, colour histogram should be normalized. The normalised colour histogram H' is given as:

H'= {H' [0], H'[1], H'[3],…H'[m]… H'[n] } (4)

Where $H'[m] = \frac{H[m]}{p}$, p is total number of pixels in image.

3.3 Correlogram And Autocorrelogram

Let I be an M×N image which comprises of pixel p(m, n). Let [C] denote the set of C colours $c_{1,\ldots\ldots,}c_C$ that can occur in the image. For pixel p, let I (p), denote its colour c, and I_c corresponds to a pixel p, for which I (p) =c. Let [D] denote a set of fixed distances $d_{1,\ldots\ldots,}d_D$ which are measure using L_1 norm [7]. The correlogram of image I is defined for colour pair (c_i, c_j) and distance d as:

$$\Upsilon_{c_i,c_j}^{(d)}(I) = Pr_{p_1 \in I_{c_i}, p_2 \in I}\left[p_{1 \in I_{c_j}} || p_1 - p_2| = d\right] \quad (5)$$

It gives the probability that given in any pixel p_1 of colour c_i, a pixel p_2 at a distance d from the given pixel p_1 is of colour c_j.

Autocorrelogram is a subset of correlogram.The autocorrelogram of image I give the probability of finding the identical colours at distance d:

$$\alpha_c^{(d)}(I) = \Upsilon_{c,c}^{(d)}(I) \quad (6)$$

It gives the probability that pixel p_1 and p_2, d away from each other are of the identical colours. Autocorrelogram provides significant benefit in comparison to correlogram. First, it requires smaller storage and second, the average number of entries per histogram cell increases, which improves the statistical reliability of histogram.

IV. Texture Feature

Texture can be defined as; it provides the measures of properties such as coarseness, regularity and smoothness. Furthermore, texture can be thought as repeated pattern of pixels over a spatial domain. If the texture has exposed to some noise, the patterns and their repetition in the texture can be random and unstructured. Three types of methods are used for feature extraction such as statistical, model-based and frequency-based methods. In this, uses a frequency-based method such as gabor wavelet. The wavelet transform obtains a flexible resolution in time and frequency domain. The 2D gabor function is defined as:

$$g(x,y) = \frac{1}{2\pi}\exp\left[\frac{x^2+y^2}{\sigma^2}\right].\exp[j2\pi\omega_0(x\cos\theta + y\sin\theta)] \quad (7)$$

Where σ is the variance of Gaussian distribution in both x and y directions, ω_0 is the frequency of sinusoid and θ is orientation of sinusoid. Gabor function is a two dimensional Gaussian envelope modulated by a sinusoid with frequency ω_0 and orientation θ.

V. Mapping Features To Hash Codes

The hash code is substantially smaller than the features itself, and is generated by formula in such a way that it is extremely unlikely that some other features will produce the same hash codes. Therefore, it requires less memory storage. The image features mapped into hamming space using hashing method and then quantized into hash codes.

VI. Similarity Measures

A similarity measure is finding the distance between two images. The distance between two images is calculated using feature vectors that are extracted from the images. Therefore, retrieval result is not a single image, but many images will be retrieved similar to the query image. In this, uses hamming distance for similarity measure. With hash codes of feature vectors, similarity measure can be performed in hamming space using hamming distance. By definition, hamming distance between two hash codes is the total number of bits at which the binary values are different [5]. Specific locations of the bits with different values are not considered. For example, given three hash codes A=1100, B=1111, C=0000, the hamming distance of A and B is equal t that A and C, regardless of the fact that C differs from A in the first two bits while B differs in the last two bits. Due to this nature of the Hamming distance, practically there can be hundreds or even thousands of images sharing the same distance to a query. From the given example, suppose we knew that the first two bits are more important for A, then B should be ranked higher than C if A was the query means that B is closer to A than C.

VII. Conclusion

In this paper, we used a colour images to extract colour feature such as colour moment, colour histogram, autocorrelogram and gabor wavelet for texture feature. The image showed different visual contents, including colour, shape and texture. Among them, colour-texture characterization of an image is probably the mainly useful features to be approximated. Hashing is used to generate compact hash code of feature descriptors. It reduces computation time and memory storage. This system uses hamming distance as similarity measure makes the algorithm extremely fast as compared to Euclidean distance. This concept has been widely used in various areas like crime prevention, medical diagnosis, web searching etc.

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