Local and Global Color Histogram Feature for Color Content-Based Image Retrieval System

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Efficient Local and Global Color Histogram Feature for Color Content Based Image Retrieval System

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Abstract. Image retrieval systems now a day's have more focus on searching desired image as a query. Search results are based on different contents of query image. Content based approach is more desirable as it neglects manual annotations of images. Systems aim at search and compare images based on similarity in color contents of query image. Comparison is performed by defining distance similarity measures between color histogram properties. Use of color features as important feature makes results more complete as search results and color contents are not affected by image resize and rotation operations. To extract color features of image we consider on color space, color reduction, color feature extraction process. Our image retrieval application aims at color feature comparison efficiency and accuracy. We aim at reduction in dimensions of local and global color feature which is possible through selection of proper quantization level. To define similarity in feature vector we applied Euclidean distance. Our experimental work shows that local hybrid color histogram produced more accurate image retrieval results than global color moments, color coherence vector and traditional color histogram.

Keywords: Spatial Color Distribution, Ring Shaped Concentric Histogram and Directional Histogram.

1 Introduction

Storage process of image data is relatively easy task. When it comes to access and search on image databases, there is a need of intelligent process. Content based image retrieval systems came into picture which operates on collections of images. These systems provide response to visual queries of user and extract relevant image from image database. Effective and easy retrieval process content based image retrieval systems make use of computer technology as a management tool so that actual human involvement during image indexing process get reduced to some good extent[1]. Content based image retrieval system applications give more focus on considering each image as feature. Many times user may have interest in looking for sub regions or particular object in image. In such situation it is not desirable to use complete image as a feature. It is more suitable to consider set of regions of image as a feature [2]. These regions represent unique key features such as color, texture and shape properties. Color content based image retrieval system searching and retrieval of similar images from image databases based color distributions within a query image.

Wlodzimierz Kasprzak, Wojciech Szynkiewicz and Mikolaj Karolczak [3] have proposed global feature index to analyze various color occurrences in an image. They consider local feature index of an image as histogram based on unique color representative. To achieve this sub parts of image are calculated. They select unique color representative for each subpart. Fierro-Radilla and A.N. Escuela Super [4] have proposed color moments, color coherence vector and color correlogram as advances on color feature. Z.C. Huang, P.P.K. Chan, W.W.Y. Ng, D.S. Yeung [5] created fuzzy regions for central regions and worked on regional color distribution with respect to entire image. Stricker and Orengo [6] extracted color moments of all regions. The mean value of color moments of each region is treated as primary feature. To define similarity among two image color moments Euclidean distance is calculated. Pass and Zabih [7] define color coherence vector as feature. They split a color histogram into two different parts called as coherent and incoherent pixels.

All above work is based on considering various color frequencies in image. Extent of how and where each color lies in an image remains unnoticed and unrecorded. In our work we have tried to preserve color distribution manner in specific regions. We focus on uniform HVC color space and color quantization for feature dimension reduction.

2 Color Feature Dimension Reduction

Image is digital representation of visual information. It is made up of variety of pixels with different colors. A field of image matching deals with defining similarity between two images. It requires pixel to pixel mapping among images with a lots of computation time. Running time of image comparison algorithms directly get affected by number of pixel comparisons. One possible way to reduce computation and comparison times is to use image quantization as preprocessing stage.

Quantization provides a way to reduce dimensions of color feature vector. We prefer to use HVC color space as it is uniform color space for image feature representation. Original image in RGB representation is converted to HVC Color Space representation. During quantization each axis is divided into equal sized regions. Each of the original colors is mapped to the region where it falls in. Average of all colors getting mapped to particular region is considered as representative color for individual color [8]. We calculate local features for each region. These features collectively used to represent global feature of image. Transformations like rotation and scaling does not produce any effect of change on color feature [9]. Using histograms of local features along with reduction in dimensionality of color feature we have tried to reduce image retrieval response time as number of color comparisons is reduced.

3. Color Feature Vector Computation

3.1 Global Color Distribution Feature

Different images in database may share similar information like color, shape and texture at different regions in image [10]. This information plays important role during image matching process. We need to maintain, preserve and monitor these characteristics. We need the probability density distribution of regions with lesser numbers of bins. We use the mean value (μ) and the standard deviation (σ) of the color image as global color descriptor which is calculated as formulas proposed in [11].

3.2 Local Distribution Feature

We use global features mentioned to filter and sort images from database. Then we find local features of each and every image from database as well as query image. For this we need to consider color distribution statistics of image. To calculate region wise directional statistical histogram we consider a histogram which considers location directional color occurrences of image colors and regional color occurrences within specific area of image for each bin block [12].

Regional Color Occurrence Feature. During HVC color space quantization we formed 8*4*4 bin blocks which can be varied as per complexity level of computations. Initial 8 blocks are for H color channel. Next 4 blocks are for V and C color channel respectively. For every bin at this stage we find a center single center point and four concentric rings to represent regional color occurrences. We can decide number of rings for each clock from 1 to 8 depending on quantization level. Each bin block has its own set of pixels with (x, y) location. Pixels belong to one particular bin have same color value. So if we have maximum of 8 bins for one color channel we have its 8 different subsets each associated with set of pixels of same color. Now Consider histogram subset S_q for each color bin B_q. Find centroid C_q represented by (X_q, Y_q) location. (X_q, Y_q) values are calculated as average sum of X and Y Co-ordinates respectively for all pixels that belong to subset S_q. Radius for outermost ring is calculated by equation 1.

$$R = \sqrt{(X - Xq)^2 + (Y - Yq)^2} \qquad (1)$$

Where X and Y are maximum co-ordinates belong to S_q. Curved distribution color feature is a matrix ($|R_1|$, $|R_2|$, …., $|R_N|$) if we formed N different ring structures for one bin. So if we have 8 bins, matrix has dimension of 8*N. Elements of matrix is the count of pixels which belong to particular ring region. This process is repeated for all 8*4*4 bin blocks.

Location Directional Color Occurrence Feature. Directional regions are formed by dividing 8*4*4 bin blocks into 8 cornered rings like regions called as quadrants with some fixed directional angle. We can vary number of quadrants depending on quantization level. Consideration of S_q and C_q for each color bin remains same as we have seen in previous section 3.2.1. To check if a point falls in a particular quadrant we calculate its direction angle with respect to center point. We calculate angle formed by a pixel(X, Y) Є Sq with respect to center C_q (X_q, Yq) by equation 2.

$$(\mathrm{X}, \mathrm{Y}) = \arctan\left(\frac{Y - Y_q}{X - X_q}\right) \pm \pi \qquad (2)$$

Where +, - is selected depending upon quadrant number where pixel falls in. Directional distribution is a matrix ($|R_1|$, $|R_2|$,…., $|R_N|$) if we formed N different cornered ring structures for one bin. Here R_N is calculated by counting the number of pixels that belong to each quadrant. This process is repeated for all 8*4*4 bin blocks.

4 Experimental Results

Following figures show results obtained at different stages of processing on image.

4.1 Color space conversion outputs for RGB and HVC image

Fig. 4.1.a

Fig. 4.1.b

Fig. 4.1.c

Fig. 4.1.d

Fig. 4.1.a shows original RGB image and Fig. 4.1.b, Fig. 4.1.c and Fig. 4.1.d show respective Red, Green and Blue color channels

Fig. 4.2.a

Fig. 4.2.b

Fig. 4.2.c

Fig. 4.2.d

Fig. 4.2.a shows original RGB image and Fig. 4.2.b, Fig. 4.2.c and Fig. 4.2.d show respective Hue, Saturation and value color channels.

4.2 Quantized Image Outputs

Following figures show input image quantization using 8 colors. As an effect of quantization we achieved reduction in dimensions of color feature. Reduction is from 256*256*256 dimension size to 8*8*8 dimension size.

Fig. 4.2.a. Input image

Fig. 4.2.b. Quantized image

In Fig. 4.2.a and Fig. 4.2.b we identified quantization difference by observing the dots obtained in image. If we reduced quantization level we get reduced number of dots. These dots reflect pixels which are mapped to particular bin. These show the compactness of bin values of pixels having similar shade.

4.3 Similar Image Retrieval Results

User gives a query image to the color content based image retrieval system. Our image retrieval system computes local hybrid color histogram and global color histogram as feature vector for query image. Fig. 4.3.c shows hybrid color histogram for it.

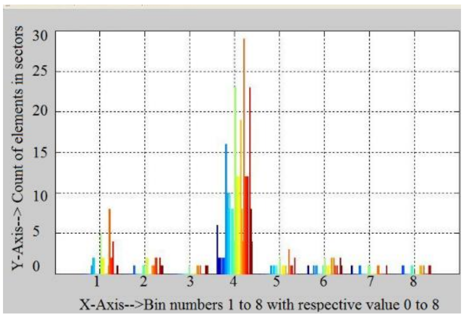

Fig. 4.3.c. Hybrid Histogram

Image Retrieval Results Using Local Hybrid Color histogram and Global Color Moment Histogram. Color features of query image are compared with respective features of every image stored in database. Depending on similarity difference between feature histogram of query image and every database image 10 most similar images in descending order are displayed. Image which is having smallest similarity difference is displayed as first image in sequence. Fig. 4.3.d and Fig. 4.3.e show image retrieval results using local hybrid color histogram and global color moment histogram.

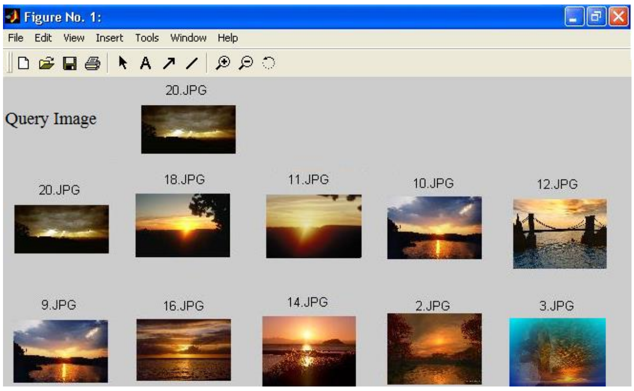

Fig. 4.3.d. Local Hybrid Color Histogram Retrieval

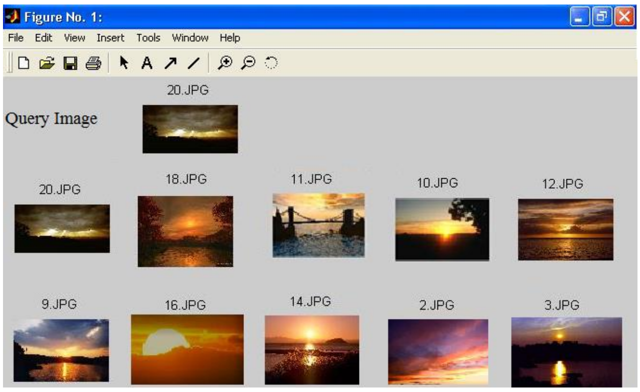

Fig. 4.3.e. Global Color Moment Histogram Retrieval

Above Fig. 4.3.d. and Fig. 4.3.e show 10 similar images retrieved using local hybrid color histogram and global color moment histogram from image database for sunset images.

5 CONCLUSION

By observing precision and recall values [12] for various HVC color space retrieval results depending on query image we found local hybrid color histogram produced more accurate results than global color moment histogram. Our system works for similar color distribution at different regions. To achieve more accuracy in retrieval results we can combine color feature extraction and object detection techniques so that location of object is taken into account.

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