Content Based Image Retrieval Using Color, Texture and Shape: A Review

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Abstract

Image Retrieval system is an efficient and satisfactory tool for organizing huge image databases. Basically, image retrieval is based not on interpretations or keywords, but basically based on features derive straight from the image statistics. Content based image retrieval (CBIR) is found of retrieving the utmost visibly identical images to a given query image from a database of images. In CBIR, low level features are extracted based on their visual content which is Color, Texture & Shape. In other words, we can describe that the information which is derived about color, texture and shape from an image is called image features. In this paper two features are used for retrieving the images such as Color and Texture. Color feature is extracted by using different color space such as RGB, HSV, YCbCr, and CMY. Texture feature is extracted by applying the statistical methods such as Mean, Standard Deviation, Skewness and GLCM.

Keywords

Content Based Image Retrieval, Feature Extraction, Color, Texture, Shape

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Introduction

Due to prevailing growth of images, the information technology has empowered the formation of enormous image datasets. Further, there is a need to expand suitable information systems to dominate these image data collections conveniently[1]. Image Retrieval is technique which is concerned with searching & browsing digital images from database collection[2]. Image Retrieval is of two types:- Text Based Image Retrieval (TBIR) and Content Based Image Retrieval (CBIR). Text Based Image Retrieval is the retrieval in which the search is based on manual or automated interpretation of images. In Text based systems the string coordinating is computationally less time consuming process as they are very fast[3]. But Text based image retrieval has a demerits of efficiency, visual information scarcity and lose of information. To overthrow all these issues Content Based Image Retrieval (CBIR) came into existence[4].

Content Based Image Retrieval

Content Based Image Retrieval (CBIR) is the function of computer vision approach to the problem of digital image search in enormous databases. During the last few years, CBIR emerged as dynamic device to conveniently retrieve images visibly identical to query image[5]. The Content Based Image Retrieval (CBIR) is the name which was actually coined by Kato during 1992[6]. He has created a system for automated retrieval of images from an enormous database which is based on the features i.e., color and shape. Later, it has been extended into lot and it has been extensively used to get knowledge on retrieving desired image from the huge database based on the sets of traits such as color, texture, shape and those can be automatically derived from the images[7]. Content Based Image Retrieval (CBIR) is the technique of retrieving images from a cluster which is based on traits (such as color, texture and shape) automatically derived from the images themselves. It uses the contents of images to represent and access the images[8].

Basically analysis work has been done to derive these low level features, estimate distance metrics and look for dynamic searching strategy. A component vector is derived from any image in the database and the set of all component vectors is classified as a database index[9]. At query time, a component vector is derived from the query image and it is matched in contrast to the component vectors in the index. The typical CBIR system is divided into two types:- Online Image Retrieval and Offline Image Retrieval. In online retrieval image, the end user can give a query object to the retrieval entity in search of relevant images[10].

In offline image retrieval, the system automatically derive visual attributes of any image in the database positioned on its pixel values and then stores them in a distinct database in the system called a feature database[11].

Feature Extraction

A feature can be defined as a chunk of data which is consistent for solving the computational task relevant to a certain operation[12]. Features can be exact format in the image such as points, edges or objects. When the data is too huge to be processed, the data will be converted into a shortened representation set of features. The technique in which we convert the input data into the set of features is called feature extraction. It is a process for obtaining relevant information from an image[13]. For example:- If we detect a face, some valuable information is derive from the image which is used for next step for identifying the

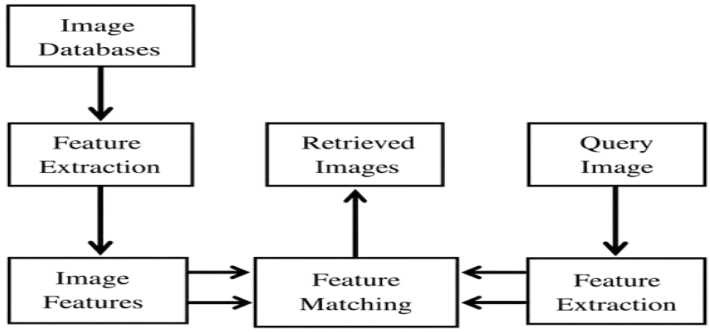


Figure 1. Content-Based Image Retrieval

image. Feature extraction is the foundation of understanding of images, these features can be classified as general or domain specific[14].

General Features:- In this category, features are all application independent e.g., color, shape, texture. In this according to consideration, it can be divided into[15]:-

Pixel-level features:- It can be determined at individual pixel e.g., color, location, and also at the first and second derivatives of gray scale values at individual pixel[15].

Local features:- It can be determined over the outcomes of image segmentation and edge detection algorithms. Object shape is an example of such feature[15].

Global features:- It is determined over the continuous image or just regular sub area of an image[15].

Domain-specific Features:- In this category, features are all application dependent, e.g., Human faces, fingerprints[15].

Features can be introduce into two types i.e., **low level features** and **high level features.** Low level features can be deriving precisely from the first hand images, whereas high level feature are depend on low level features. Color, Texture and shape are the utmost commonly used traits in content based image retrieval.

(A) Color Features:- Color is an essential cue not only in human vision but also in digital image processing where its impact is still rising[16]. Color features are generally used for image illustration by reason of their simplicity and effectiveness. Color features are derived at global level and local level of an image. Images characterized by color features have many merits such as robustness, effectiveness, implementation simplicity, computational simplicity and low storage requirements. In the color features color models play a vital role, some popular color models are:-

RGB model:- In the RGB model, an image subsist of three image planes, i.e., one is of essential colors: red, green and blue. In this an individual color is determine by pointing out the amount of each of the essential components present. RGB uses an additive model which is an aggregate of red, green and blue colors which is used to replicate other colors. RGB color model is simple[17]. It is used for displays in television and computer screens.

HSV model:- HSV is named as Hue, Saturation & Value. This color space illustrates colors (hue or tint) in circumstances of their shadow (saturation or amount of gray) & their brilliance value. HSV is a

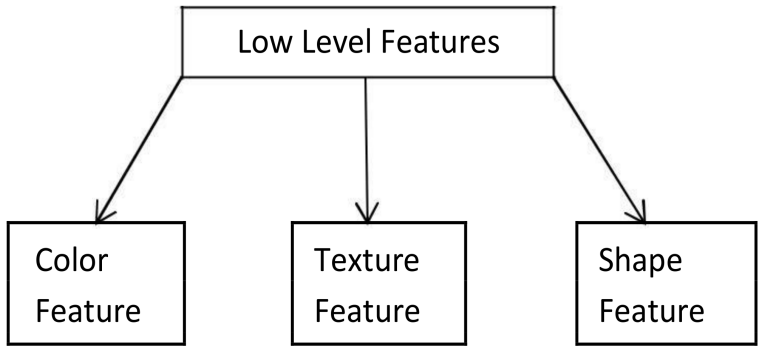


Figure 2. Low Level Features of image

term that is related to how humans identify color. The HSV color wheel illustrates as a cone or cylinder, but there are always these three components. Hue is the color segment of the HSV model & describes as a number from 0 to 360 degrees. Saturation represents the amount of gray in the color, from 0 to 100%. It is considered on a range from just 0-1, where 0 indicates gray and 1 indicates primary color. Value(or Brightness) associates with saturation and represents the brightness or intensity of the color, from 0-100%, where 0 is define as completely black and 100 is define as brightest[18].

Figure 3. RGB to HSV

CMY model:- CMY is named as Cyan, Magenta & Yellow. It is a subtractive model which is convenient to absorption of colors. In this model colors are assemble by subtraction where adding distinct pigments causes different colors not to be reflected and thus not to be seen. It is mainly used for hardcopy devices[19].

YCbCr model:- YCbCr is one of the popular color space in computing. It describes colors in terms of Y. Y is the luma element of the color. Luma element indicates brightness of the color. Cb and Cr represent the blue component and red component which is associated to the green component. As, Y element is

Figure 4. RGB to HSV

Figure 5. RGB to HSV

more sensorial to the human eye, so it needs to be more correct whereas, Cb and Cr is less sensorial to the human eye. Therefore, it needs to be more rigorous [20].

(B) Texture Feature: - Texture is also a relevant cue for the search of many images. It is usually used to point particular properties of surfaces especially those that do not have a smoothly varying intensity [21]. Texture can be defined as a descriptor of local brightness variation from pixel to pixel in a small neighborhood through an image. Texture basically looks for visual arrangement in images and how they are structurally determined. And also basically these sets not only characterize the texture, but also specify the position of texture in the image. Texture is a challenging concept to represent [22]. The identification of distinct textures in an image is accomplished mainly by modeling texture as a two-dimensional gray level variation. There are mainly two categories of extracting textural features:-

1) Statistical methods

2) Structural methods

Figure 6. RGB to CMY

Figure 7. RGB to CMY

Statistical Methods:- Statistical methods computes local features parallelly at each point in a texture image, and derives a set of data from the distribution of the local features. It represents the texture diffusely according to the non-deterministic properties that manage the relationships among the gray levels of an image. The statistical methods can be introduced into first order i.e., one pixel, which includes mean, standard deviation, variance, skewness and kurtosis. Second order i.e., pair of pixels which includes Gray-Level Co-Occurrence Matrix (GLCM) and higher order i.e., three or more pixels statistics. The second order statistics is the best established technique which is computed from the query and stored images[23].

Mean: - The first color moment is mean. It can be explained through the average color in the image[24]. It can be calculated by

$$E_i = \sum_{j=1}^{N} \frac{1}{N} P_{ij} \tag{1}$$

Figure 8. RGB to CMY

Figure 9. RGB to YCbCr

Standard Deviation: - The second color moment is the standard deviation. It is achieved by calculating the square of the variance of the color dissemination[24].

$$\sigma_i = \sqrt{\left(\sum_{j=1}^{N} \frac{1}{N} \left(P_{ij} - E_i\right)^2\right)} \tag{2}$$

Skewness:- The third color moment is skewness. It spans how asymmetric the color dissemination is and it also presents information about the shape of the color distribution[24].

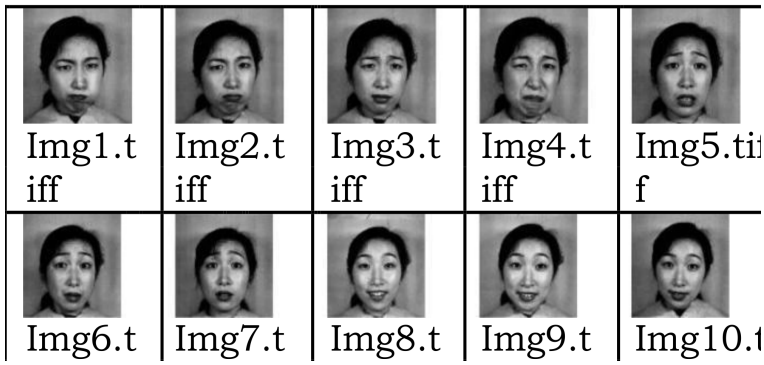
$$S_i = \sqrt[3]{\left(\sum_{j=1}^{N} \frac{1}{N} \left(P_{ij} - E_i\right)^3\right)} \tag{3}$$

Figure 10. RGB to YCbCr

Figure 11. RGB to YCbCr

Table 1

Image	Mean	Standard Deviation	Skewness
Img1.tiff	106.5303	55.7285	-0.6376
Img2.tiff	102.6205	51.5168	-0.6097
Img3.tiff	104.5538	52.8537	-0.7346
Img4.tiff	101.1662	53.6513	-0.6824
Img5.tiff	101.9955	51.6055	-0.6456
Img6.tiff	102.7252	53.2007	-0.6864
Img7.tiff	100.9063	50.4791	-0.5499
Img8.tiff	124.8373	54.6923	-0.9174
Img9.tiff	122.4062	55.6185	-0.9043
Img10.tiff	106.1784	53.6724	-0.5988



JAFFE DATABASE[25]

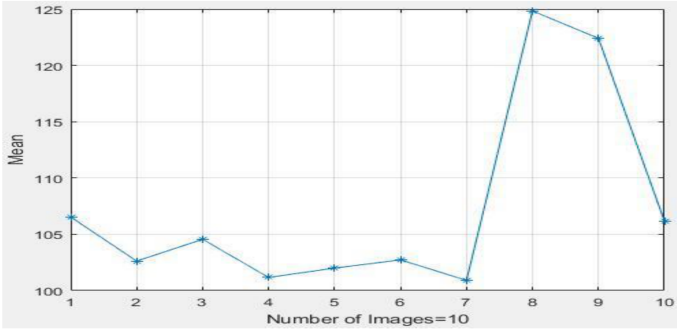


Figure 12

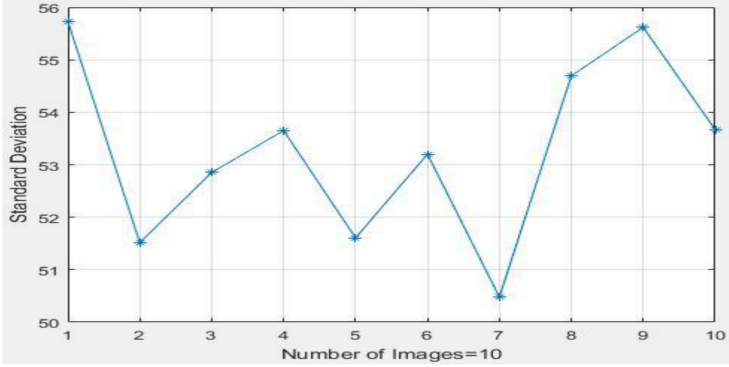


Figure 13

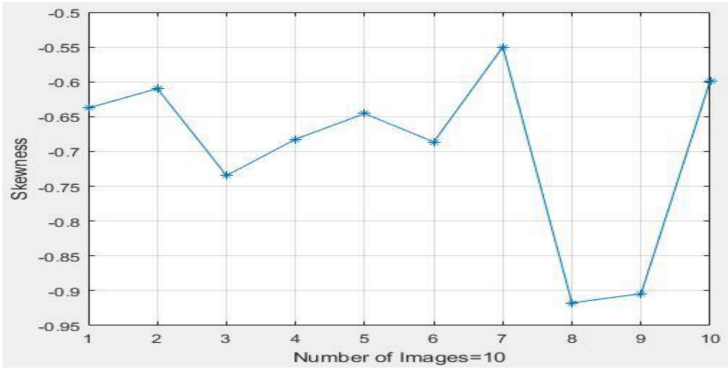


Figure 14

The most commonly used second order statistics method is Gray- Level Co-Occurrence Matrix (GLCM) or Co-occurrence distribution method.

Gray-level co-occurrence matrix (GLCM):- Gray- level co-occurrence matrix (also known as Grey Tone Spatial Dependency Matrix) is one of the classical well-known texture analysis methods. It is a second order statistical method that considers the spatial relationship of pixels in image texture which is also known as gray-level spatial dependence matrix. In this co-occurrence distribution, it is used for representing the statistics of how distinct sequence of grey-levels occur in an image, Each entry (i, j) in GLCM correlates to the number of instances of pair of grey levels i and j which are distance d apart in original image[26].

Haralick, Shanmugan and Dinstein recommended fourteen measures of textual features and they each correspond to certain image characteristics such as contrast, homogeneity and coarseness[27]. Some of them which are commonly used are:-

Entropy- Entropy is used to measure the disorder or complexity of an image. It also describes that when the entropy is large, and then image is non - texturally uniform[28].

$$= -\sum_{i}\sum_{j} P(i,j)\log P(i,j) \tag{4}$$

Contrast- Contrast is used to measure the image contrast. It shows the difference between the highest and lowest values of a neighboring set of pixels. It measure the spatial frequency and local deviations present in an image[29].

$$= \sum_{i,j}(i-j)^2 P(i,j) \tag{5}$$

Correlation- Correlation is used to measure the continuous dependency of grey levels on those of neighboring pixels[29].

$$= \sum_{i,j}\frac{(i-\mu_i)(j-\mu_j)P(i,j)}{\sigma_i\sigma_j} \tag{6}$$

Inverse Difference Moment- IDM is also called as Homogeneity. This feature measures the proximity of dissemination of GLCM elements to GLCM diagonal[29].

$$= \sum_{i,j} \frac{P(i,j)}{1+(i-j)^2} \tag{7}$$

Energy- Energy is used to measure the uniformity of an image, we can also say that when the pixels are very similar then the energy value will be large[29].

$$= \sum_{i,j} P(i,j)^2 \tag{8}$$

Table 2

Image	Entropy	Contrast	Correlation	Homogeneity	Energy
Img 1 	2.5410	0.4298	0.9235	0.8616	0.1223
Img 2 	2.4370	0.3783	0.9206	0.8800	0.1321
Img 3 	2.4432	0.4123	0.9173	0.8694	0.1360
Img 4 	2.4550	0.4101	0.9201	0.8681	0.1321

Structural Methods:- Structural methods defines a texture as layout of unambiguous texture components such as regularly spaced parallel lines. It mainly describes features of objects or images. It is based on topological and geometric properties[30].

(C) Shape Feature:- Shape is the most vital technique at the pristine level. By this concept, the natural objects are mainly perceived by their shape[31]. Shape can be defined as the physical structure of the objects, or the geometric shapes present in the image. In this they are figure out from every object to determine within the stored images. Then, the same set of features is used to figure out from given query image. Shape of object is regulating by its external boundary abstruse from different properties as color or content. There are two major form of shape features:- Global Feature and Local Features. The first one global feature is basically aspect ratio, moment invariants and circularity. The second one local feature is the sets of successive boundary segments[32]. The properties of shape features are- Identifiability,

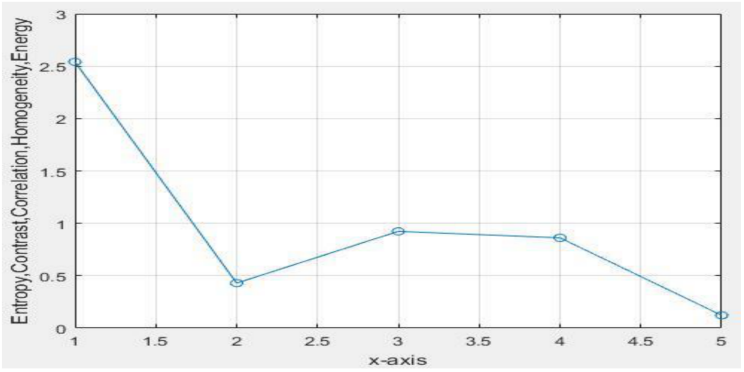


Figure 15

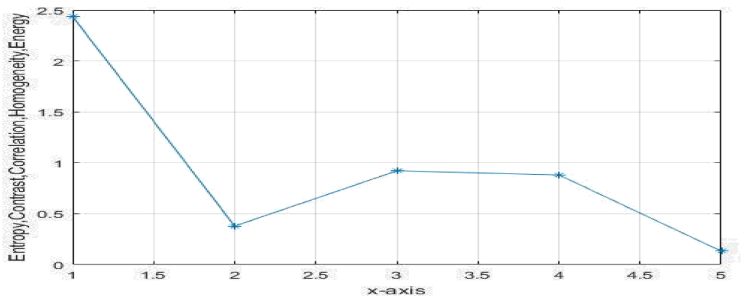


Figure 16

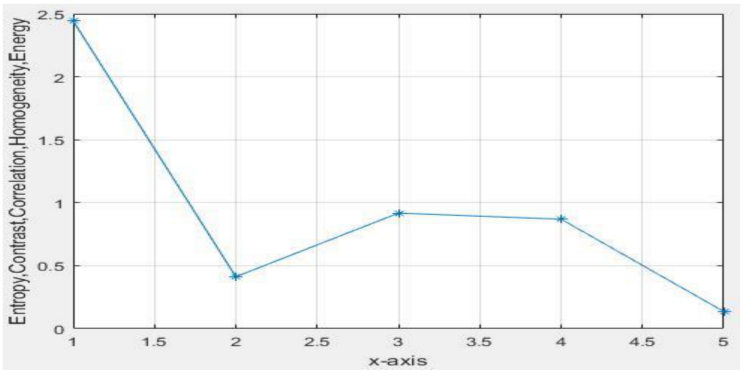


Figure 17

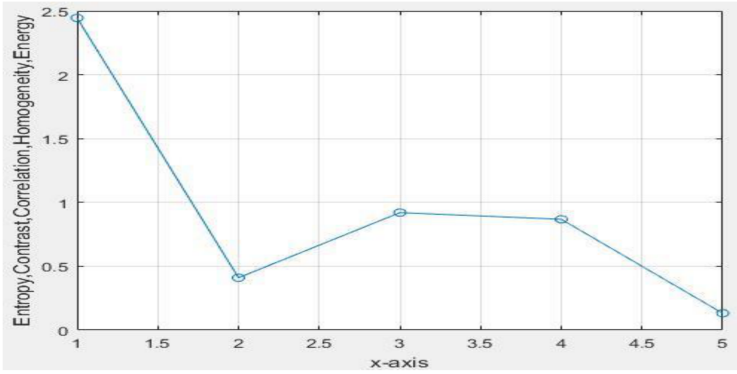


Figure 18

translation, rotation, scale invariance, noise resistance. Shape descriptor is defined as a set of numbers that is originated to represent a given shape feature[33]. It has two methods: Region-based and Contour-based methods. Moment, area and perimeter are components which are used for shape feature extraction[34].

Conclusion

An image retrieval method using color and texture feature has been proposed. For color, color space models have been used which simplify the stipulation of colors in some standard generally accepted way. These models used various components of an image to display on specific hardware platform. For texture, the analysis has been done that second order statistical method GLCM can only be applied on gray scale images. In this paper Jaffe database has been used to evaluate the statistical methods.

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