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Quadhistogram Based Image Retrieval

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Abstract: *With the increasing demand for need of retrieval of images based on different properties, characteristics there has been tremendous research going on in the field of Content-based image retrieval (CBIR), also known as query by image content. Content here is referred to visual features such as colour, texture,shape, spatial layout of an image.*
This paper proposes a novel approach wherein content based image retrieval is based on color and texture primarily implementing color histogram for color based and gabor filter for texture based retrieval. Colour histogram comprises of two colour models (RGB and HSV). For texture based, Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. Main aim of this paper is to implement a new technique that is quadtree segmentation on query and database images and then apply feature extraction, color histogram and match the query and database images using similarity criteria. Quadtree is a segmentation technique which divides image into homogeneous blocks. Hence the name Quadhistogram is a new revised technique to implement colour based retrieval under local colour histogram which divides the images into homogeneous blocks and then compute histogram of each block.
Keywords: *Colorhistogram, Gabor Filter,Hsv,Rgb, Quadhistogram.*

I. Introduction

Images make the communication process more interesting, illustrative, elaborate, understandable and transparent. The conventional image retrieval is mainly based on the text, using keywords, or free text to descript each image and uses text- matching to search. However, the current computer vision technology is not mature, fail to extract automatically the keywords and semantic information. Text based retrieval failed due to many reasons mainly because of polysemy ie same word can be used to submit more than one object. Retrieval based on visual representations of an image makes indexing and searching images more accurate. Content-Based Image Retrieval (CBIR) uses the visual contents of an image such as color, shape, texture, and spatial layout to represent and index the image. Query-by-example or pictorial-query approach gives similar images to the query image given by a user. The query images can be a photograph, user-painted example, or line- drawing sketch.

Retrieval process and the algorithm process is as follows:
1. Analyze and compute the visual features of the image by feature extraction technique, extract features of each image and then construct a feature vector for all the images which could be further used for matching purpose.
2. During the image retrieval, user need to provide some input such as sample image or a sketch, then select a feature extraction method to extract features of the query image and database images as well.
3. Select the similarity comparison, for matching the feature vector of both query image and database images
4. Return the relevant results to the user by similarity according to smallest distance criteria.

This paper is organized as follows: Section 1 describes the problem pertaining to image retrieval and overall process flow. Section 2 describes the literature survey, previous work related to content based image retrieval using various techniques. Section 3 presents the various methods for feature extraction and section 4 presents the proposed work and proposed algorithms.

II. Literature Review

2.1 Analysis Of Papers

In paper [1] Color retrieval system works in two stages
1) In the first stage, Histogram based comparison is done and matching images are short listed.

2) In the second stage, the Color Coherence Vectors of the short listed images (stage 1) are used to refine the results.

The proposed shape retrieval system based on the automatic segmentations process to get approximate information about the shape of object. Then three attributes: Mass, Centroid and Dispersion for each class are calculated and stored as the shape vector. Experimental results of this paper show that the proposed methodology had increased the average precision .

In [4] author describes that image mining is the main concept which can extract potential information from the collection. For color based image extraction RGB model is used, RGB component taken from each and every image. Images are stored by mean values of Red, Green, blue components of target images. The top ranked images are further regrouped according to texture features. The gray level co-occurrence matrix used texture calculations (contrast, dissimilarity, homogeneity). The images are classified into clusters with the help of GLCM based on Low texture, average texture and high texture. Texture based classification is simply easy and efficient for real time applications as compared to Entropy method.

In [8] the proposed technique of dominant color identification based on foreground objects is a meaningful technique to retrieve the images based on color. The first step of segmenting foreground from background is a good improvement over a work of existing dominant region color indexing in which there is a chance of considering the background as the dominant color region even though that doesn't provide any semantics to the image. The Experimental result shows that the proposed technique is efficient compared to the existing dominant color region based Indexing.

III. Methods For Feature Extraction

3.1 Techniques For Implementing Colour Based Extraction

3.1.1 Color Histogram

A histogram is a graphical representation of the number of pixels in an image. A histogram is a bar graph, whose X-axis represents the tonal scale, and Y-axis represents the number of pixels in an image in a certain area of the tonal scale.

A color histogram of an image represents the distribution of the composition of colors in the image. It shows different types of colors appeared and the number of pixels in each type of the colors appeared.

There are two types of color histograms, Global color histograms (GCHs) and Local color histograms (LCHs). A GCH represents one whole image with a single color histogram while the LCH divides an image into fixed blocks and takes the color histogram of each of those blocks

3.1.2 Local colour histogram

- Segments the image into blocks and then obtain a color histogram for each block.
- While comparing two images, distance is calculated using their histograms, between a region in one image and a region in same location in the other image
- The distance between the two images will be determined by the sum of all these distances.

3.1.3 Global color histogram

- Represents one whole image with a single color histogram
- Using the global color histogram an image will be encoded with its color histogram.
- The distance between two images will be determined by the distance between their color histograms.

Selection of color spaces: The color space selection plays a significant role when image retrieval is done on the basis of color features. There are 11 color models (RGB, I1I2I3, YIQ, HSV, HSI, YUV, LAB, XYZ, CMYk, YCbCr and HMMD). The RGB image is first converted into one of the color spaces then the feature exaction is done.

RGB Color Space: The most popular color space is RGB which stands for Red-Green-Blue. This space consists of the additive primary colors of light Red, Green and Blue This histogram is the most used histogram in computer graphics and it uses its red, green and blue components to create a new color. To form a new color it is necessary to increase the values of one or more of the components of the RGB components.

HSV Color Space: The HSV color space are defined in terms of three constituent components: Hue, Saturation and Value. Hue varies from 0 to 1.0, the corresponding colors vary from red through yellow, green, cyan, blue, magenta, and back to red, so that there are actually red values both at 0 and 1.0. As saturation varies from 0 to 1.0, the corresponding colors (hues) vary from unsaturated (shades of gray) to fully saturated. As value, or brightness, varies from 0 to 1.0, the corresponding colors become increasingly brighter.

3.2 Methods For Texture Based Retrieval

A texture is a repeated pattern of information or arrangement of the structure with regular intervals. Texture refers to surface characteristics and appearance of an object given by the size, shape, density, arrangement, proportion of its elementary parts. A basic stage to collect such features through texture analysis process is called as texture feature extraction. Due to the signification of texture information, texture feature extraction is a key function in various image processing applications like remote sensing, medical imaging and content based image retrieval. Texture segmentation makes a partition of an image into a set of disjoint regions based on texture properties, so that each region is homogeneous with respect to certain texture characteristics.

An image texture is a set of metrics calculated in image processing designed to quantify the perceived texture of an image. Image texture gives us information about the spatial arrangement of color or intensities in an image or selected region of an image.

3.2.1 Gabor filters

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. Gabor filters have been used in several image analysis applications including texture segmentation, defect detection, face recognition, motion tracking, document analysis, retina identification, target detection, edge detection, line characterization, image representation, and image retrieval. Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function.

Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

$$g(x,y;\lambda,\theta,\varphi,\sigma,\gamma) = \exp\left(\frac{-x'^2+\gamma^2y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda}+\varphi\right)\right) \quad (1)$$

Real

$$g(x,y;\lambda,\theta,\varphi,\sigma,\gamma) = \exp\left(\frac{-x'^2+\gamma^2y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\varphi\right) \quad (2)$$

Imaginary

$$g(x,y;\lambda,\theta,\varphi,\sigma,\gamma) = \exp\left(\frac{-x'^2+\gamma^2y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\varphi\right) \quad (3)$$

Where

$x' = x\cos\theta + y\sin\theta$
$y' = -x\sin\theta + y\cos\theta$

In all the above equations,

- Lambda represents the wavelength of the sinusoidal factor.
- Theta represents the orientation of the normal to the parallel stripes of a gabor function.
- Psi is the phase offset, sigma is the sigma/standard deviation of the gaussian envelope.
- Gamma is the spatial aspect ratio, and specifies the ellipticity of the support of the gabor function.

Purpose of using gabor filters for texture based extraction
Gabor filters have various properties that make them particularly suitable for texture segmentation.

- It has been shown that the Gabor function is a band-pass filter that can be tuned to a narrow set of frequency anywhere in the frequency domain.
- Each texture contains most of its energy in a narrow band of frequencies and orientations.
- A gabor filter tuned to that frequency range exhibits a strong response in the presence of the texture
- Gabor filters consists of a group of wavelets each of which capturing energy at a specific resolution and orientation. Therefore, to capture the local energy of the entire signal or image gabor filters are able, especially for texture features, the Gabor filter has been widely used to extract image features.

3.3 Similarity Measurement

A similarity metric gives us the measure of how similar a feature vector to another vector is the features extracted from the query image are used to retrieve the similar images from the image database. Instead of directly comparing two images, comparison of their feature vectors is done. The retrieval systems return the relevant images whose computed distance from the query image is the least.

By analyzing feature vector for color based extraction, first calculate the number of colors and distribution of colors to state in what proportion it is present in both query image and database image. Then both the images are matched by seeing if the proportions of a particular color in both the images are comparable. The image which satisfies most of the conditions is the best match. Retrieval result is not a single image but a list of images ranked by their similarities with the query image.

3.3.1 Euclidean Distance

Euclidean distance is the most common metric for measuring the distance between two feature vectors and is implemented in a number of content based image retrieval approaches. The Euclidean distance is given by the square root of the sum of the squares of the differences between vector components. The Euclidean distance between the feature vectors

P = (p1, p2 ,…, pn) and Q = (q1,q2 ,…., qn) is expressed by

$$\text{ED} = \sqrt{\sum_{K=1}^{N} (P_K\text{-}Q_K)}^2 \qquad (4)$$

where n is the length of the feature vector and D is the distance between the two vectors. The Euclidean distance provides the most obvious approach to calculating the distance between two feature vectors along with one that is very simple to implement with a low level of complexity. For these reasons it provides a good method for feature vector comparison.

3.4 Image Segmentation

Image segmentation technique is used to partition an image into meaningful parts having similar features and properties. The main aim of segmentation is simplification i.e. representing an image into meaningful and easily analysable way. The goal of image segmentation is to divide an image into several parts/segments having similar features or attributes. The outcome of image segmentation is a set of surface extracted from the image, a set of segments that as a group cover the entire image. In a segment every pixels are similar with regard to computed property or some characteristic, such as intensity, texture, or color.

IV. Proposed Methodology

4.1 Implementation Flow

The main aim is to implement color and texture based extraction on a given query image using colour histogram for color based extraction and gabor filter for extracting textures specifying the no of scales, orientations.

In the figure Fig.1, the overall process is been depicted wherein, for colour based retrieval two colour models are implemented ie RGB and HSV. Further colour histogram approach is been divided into 2 categories, local and global colour histogram. Under local colour histogram new approach i.e quadtree segmentation is applied and further histogram computation is done, whereas for global colour histogram globally histogram is computed for entire image both RGB and HSV. For texture based, gabor filter is been implemented.

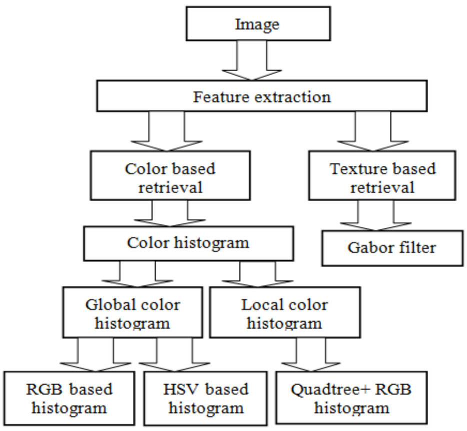

Fig 1. Proposed Architecture

4.1.1 Creation of feature vector

Construction of datasets for creating feature vector for database images is required. These datasets will store images along with extracted feature values. While comparing, these feature vector datasets are compared with feature vector of query image using similarity criteria. In order to construct datasets comprising feature values, the algorithm scans all the images from the directory and computes the feature values and stores the images along with its corresponding feature values in .mat format.

4.1.2 Feature matching

For feature comparison, in this paper RGB, HSV are considered to be feature values, for which feature vectors in .mat format are stored. Those vectors are compared with extracted feature vector of submitted query image. For comparison, Euclidean distance metric is used which will compute the distance between feature vectors of query and database images. The best relevant image will have the lowest distance. Hence ordering of retrieved images are done in ascending order.

4.2 Quad tree segmentation technique

The quadtree decomposition is based on successive subdivision of the image block into quadrant depending on the complexity of the block. If a sub image is not a homogeneous block, it is subdivided into four equal sized sub images again until all the sub images are homogeneous block.

Qtdecomp divides a square image into four equal-sized square blocks, and then tests each block to see if meets some criterion of homogeneity. If a block meets the criterion, it is not divided any further. If it does not meet the criterion, it is subdivided again into four blocks, and the test criterion is applied to those blocks. This process is repeated iteratively until each block meets the criterion. The result may have blocks of several different sizes.

Fig 2. Original image

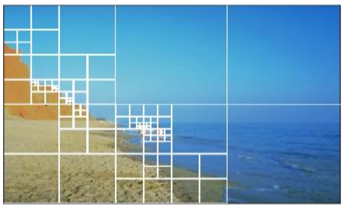

Fig 3. Quadtree decomposition of Fig 2

In the above figure Fig .2 Original image is given which can be further processed for quad tree segmentation. The result of quadtree decomposition is shown in Fig. 3. It shows subdivision of image into homogeneous blocks. The decomposed image is further used for histogram computation.

4.3 Proposed Algorithms

4.3.1 Algorithm for Colour based Retrieval

Step1: Browse for the query image from the directory of images.
Step 2: Apply feature extraction, RGB /HSV based histogram on query image and construct a feature vector for query image.
Step3: Apply feature extraction, RGB/HSV based histogram on database images and construct a feature vector in .mat file.
Step4: Compare the feature vectors of both query image as well as database images one by one using similarity metric Euclidean distance will be calculated between histograms of both images.
Step 5: Sort the images according to smallest distance.
Step 6: Specify the number of images to be retrieved and display the results which satisfies the similarity criteria the most. The top 5 results will be the most relevant results.

4.3.2 Proposed Algorithm for quadtree Color (quadhistogram) based Retrieval

Step1: Browse for the query image from the directory of images.
Step2: Apply image segmentation, quadtree decomposition on a given query image.
Step 3: Apply feature extraction
Apply RGB histogram on segmented sub image homogeneous blocks.
Step 4: Construct a feature vector comprising histograms of all segmented sub image blocks.
Step 5: Apply the same steps from 2-4 on database images
Step 6: Compare the feature vectors of both input and database images using similarity criteria.
Step 7: Sort the images according to smallest distance.

Step 8: Retrieve and display the results which satisfies the similarity criteria the most.

4.3.3 Algorithm for texture Retrieval
Step1: Browse for the query image from the directory of images.
Step 2: Apply feature extraction, gabor filter on query image and construct a feature vector for query image.
For constructing feature vector for extracting texture we need to create gabor filter, Specify the no of scales, orientations.
Step3: Apply feature extraction, gabor filter on database images and construct a feature vector .
Step4: compare the feature vectors of both query image as well as database images one by one using similarity metric
Euclidean distance will be calculated between histograms of both images.
Step 5: sort the images in ascending order
Step 6: specify the number of images to be retrieved and display the results which satisfies the similarity criteria the most. The top 5 results will be the most relevant results.

V. Conclusion

Various feature extraction techniques are studied for implementing content based image retrieval. Colour histogram (RGB and HSV) is used as a feature extraction technique for retrieving images based on colour. Gabor filters are found to be best for implementing texture based extraction. After implementing, comparative analysis needs to be done to compare between existing and proposed image retrieval methods. A new approach to implement colour based retrieval under local colour histogram is been implemented which is much better in terms of retrieval than global colour histogram. Quadhistogram is an improvement over existing technique which outperforms local colour histogram methods. CBIR has got applications in diverse areas such as police force for picture recognition in crime prevention, Medical Diagnosis, Architectural and Engineering Design, Fashion and Publishing, Geographical information and remote sensing, Art collections, Nudity-detection filters, Face Finding, Textiles Industry.

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