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An Efficient CBIR Technique with YUV Color Space and Texture Features

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Abstract---In areas of government, academia and hospitals, large collections of digital images are being created. These image collections are the product of digitizing existing collections of analogue photographs, diagrams, drawings, paintings, and prints. Retrieving the specified similar image from a large dataset is very difficult. A new image retrieval system is presented in this paper, which used YUV color space and wavelet transform approach for feature extraction. Firstly, the color space is quantified in non-equal intervals, then constructed one dimension feature vector and represented the color feature. Similarly, the texture feature extraction is obtained by using wavelet. Finally, color feature and texture feature are combined based on wavelet transform. The image retrieval experiments specified that visual features were sensitive for different type images. The color features opted to the rich color image with simple variety. Texture feature opted to the complex images. At the same time, experiments reveal that YUV texture feature based on wavelet transform has better effective performance and stability than the RGB and HSV. The same work is performed for the RGB and HSV color space and their results are compared with the proposed system. The result shows that CBIR with the YUV color space retrieves image with more accuracy and reduced retrieval time.

Keywords---Content based image retrieval, Wavelet transforms, YUV, HSV, RGB

1. Introduction

Content-based image retrieval means that the search will analyze the actual contents of the image. The term 'content' in this context refers colors, shapes, textures, or any other information that can be derived from the image itself. Without the skill to examine image content, searches must rely on metadata such as captions or keywords, which may be laborious or expensive to produce (Fleck et al. 1996). There are various content-based image retrieval techniques, such as those based on color, texture and shape. In this paper, YUV Color Space with Texture Features based Image retrieval is proposed. There are two reasons for this choice. Firstly, the color based technique has been reported to produce good retrieval performance. Secondly, it is simple to implement. Unlike the shape based methods and texture based, it doesn't require image segmentation which itself is a hard image processing problem

Compared to the traditional image retrieval using text index, Content-Based Image Retrieval (CBIR) technology automatically calculates and extracts the visual characteristics of images, directly establishes index in accordance with the characteristics of image information. Image retrieval is achieved according to the similarity of image features. CBIR is a highly challenging problem for general-purpose image databases because of the large size of the database [1, 2]. Color and texture is the most important visual feature. YUV color space is widely used in computer graphics, visualization in scientific computing and other fields (Rui et al. 1997).

YUV is a color space usually used as part of a color image pipeline. It encodes a video or color image, taking human perception into account, allowing reduced bandwidth for chrominance components, thereby typically enabling transmission errors or compression artifacts to be more efficiently masked by the human perception than using a "direct" RGB-representation. The main reason to investigate properties of Y'UV would be for interfacing with analog or digital television or photographic equipment that conforms to certain Y'UV standards. The Y'UV model describes a color space in terms of one luma (Y') and two chrominance (UV) components. The Y'UV color model is worn in the NTSC, PAL, and SECAM composite color video standards. Previous black-and-white systems made used of only luma (Y') information. Color information (U and V) was additionally added separately via a sub-carrier so that a black-and-white receiver would still be able to receive and display a color picture transmission in the receiver's native black-and-white format.

The advantage of YUV color space is that it is closer to human conceptual understanding of colors and has the ability to separate chromatic and achromatic components. Therefore, this paper selects the YUV color space to extract the color features according to luma (Y') and two chrominance (UV). Texture feature is a kind of visual characteristics that does not rely on color or intensity and reflects the intrinsic phenomenon of images. It is the total of all the intrinsic surface properties, such as clouds, trees, bricks, fabric texture have their own characteristics. That is why the texture features in CBIR has been widely used.

To improve the accuracy the combination of both color and texture features are used for YUV. The rest of the paper is organized as follows. Section II gives the literature survey. Section III discusses the RGB and YUV feature extraction techniques. Section IV displays the experimental results and the paper is concluded in section V.

2. LITERATURE SURVEY

Sclaroff et al. (1997) proposed a CBIR technique. Image Rover is a search-by-image-content navigation tool for the World Wide Web (WWW). To collect images expediently, the image collection subsystem utilizes a distributed fleet of WWW robots running on different computers. The image robots collect information about the images they find, computing the appropriate image decompositions and indices, and store this extracted information in vector form for searches based on image content. At search time, users can guide the search through the selection of relevant examples. Search performance is efficiently made through the use of an approximate, optimized k-d tree algorithm. The system employs a new relevance feedback algorithm that selects the distance metrics that are appropriate for a particular query

Vogel & Schiele (2002) investigated the face recognition problem via energy histogram of the DCT coefficients. Several issues related to the recognition performance are discussed, in particular the issue of histogram bin sizes and feature sets. In addition, the author proposed a technique for selecting the classification threshold incrementally. Experimentation was conducted on the Yale face database and results indicated that the threshold obtained via the proposed technique provides a balanced recognition in term of precision and recall. Furthermore, it demonstrated that the energy histogram algorithm outperformed the well-known Eigen face algorithm.

Pentland et al. (1994) described a perceptual approach to generate features for use in indexing and retrieving images from an image database. Most important regions that immediately attract the eye are large color regions that usually dominate an image. Features obtained from these will allow search for images that are similar perceptually. The author compute color features and Gabor color texture features on regions obtained from a multiscale representation of the image, generated by a multiband smoothing algorithm based on human psychophysical measurements of color appearance. The combined feature vector is then worn for indexing all salient regions of an image. For retrieval, those images are chosen that contain more similar regions to the query image by using a multipass retrieval and ranking mechanism. Matches are found using the L2 metric. The results displays that the proposed method performs very well.

Wang et al. (2001) proposed a fuzzy logic approach, UFM (unified feature matching), for region-based image retrieval. In this recovery system, an image is represented by a set of segmented regions, each of which is characterized by a fuzzy feature (fuzzy set) reflecting color, texture, and shape properties. As a result, an image is related with a family of fuzzy features corresponding to regions. The UFM has been implemented as a element of the experimental simplicity image retrieval system. The performance of the system is illustrated by means of examples from an image database of about 60,000 general-purpose images

3. Methodology

An image I_{WxH} of a 2-dimensional array of pixels is considered. There are W columns and H rows in each image. Each pixel is a triple comprising the RGB values of the color that it represents. Hence, the image has three color components:

$$I(R)_{W\times H}, I(G)_{W\times H}, I(B)_{W\times H} \tag{1}$$

3.1. *Feature extraction in RGB*

Selecting gradient-based features makes the scheme robust to illumination variations whereas use of orientation information to define features provides robustness against contrast variations (Chai & Bouzerdoum, 2000). Basic idea behind these features is to split an image into tiles called cells and then extract a weighted histogram of gradient orientations for each cell.

Defining multiple resolutions, Gradient computation and computing histogram of gradient orientations are the steps in feature extraction.

3.2. *Feature extraction in HSV*

It is essential to quantify HSV space component to reduce computation and improve efficiency. Unequal interval quantization according the human color perception has been applied on H, S, and V components. In accordance with the different colors and subjective color perception quantification, quantified hue (H), saturation (S) and intensity (V) are obtained.

3.3. *Feature extraction of YUV and Texture*

3.3.1. Color features of YUV

A color space is a process by which the color can be specified, created and visualized. Different color spaces are better for different applications (Martinkauppi, & Soriano, 2001) for example some equipment has limiting factors that decide the size and type of color space that can be used. Some color spaces are perceptually linear, i.e. a one-unit change in stimulus will produce the same change in perception wherever it is applied. Many color spaces, particularly in computer graphics, are not linear in this way. Among these color spaces, the YUV color space is a bit unusual. The vast majority of DVDs already store information in the YUV color space. The Y component decides the brightness of the color (referred to as luminance or luma), while the U and V components establish the color itself (the chroma). Y ranges from 0 to 1 (or 0 to 255 in digital formats), while U and V range from -0.5 to 0.5 (or -128 to 127 in signed digital form representation, or 0 to 255 in unsigned form). Some standards moreover limit the ranges so the out-of-bounds values indicate special information like synchronization.

In the proposed approach, the YUV (Brand & Mason, 2000) color space is used for two reasons: 1) efficiency and 2) ease of extracting the features based on the color tones. One another neat aspect of YUV is that you can throw out the U and V components and get a grey-scale image. Since the human eye is much responsive to brightness than it is to color, many lossy image compression formats throw away half or more of the samples in the chroma channels to reduce the amount of data to deal with, without severely destroying the image quality. Therefore, only the Y component is used in our preliminary study. There are a lot of slightly different formulas to convert between YUV and RGB. The only major difference is a few decimal places. The following equations are used to convert from RGB color space to YUV spaces:

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} + \begin{bmatrix} 0.257 & 0.504 & 0.098 \\ -0.148 & -0.291 & 0.439 \\ 0.439 & -0.368 & -0.071 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \tag{2}$$

The chromaticity information is encoded in U and V components (Bourke, 1994). Hue and saturation are obtained by the following transformation.

$$ch = \sqrt{|U|^2 + |V|^2} \tag{3}$$

And

$$\theta = tan^{-1}\left(\frac{|V|}{|U|}\right) \tag{4}$$

θ represents hue, which is described as the angle of vector in YUV color space. Ch stands for saturation, which is defined as the mode of U and V (Bourke, 1994).

As the components of feature vector may have different physical meaning entirely, their rate of change may be very different. It will be much of the deviation of the calculation of the similarity if it is not normalized, so the components are normalized to the same range. The process of normalization is to make the components of feature vector equal importance.

3.3.2. Texture feature based on the wavelet transform

Wavelet analysis has been widely used in the image processing because of the unique characteristics and advantages of signal analysis, especially in the field of image retrieval. The powerful time-frequency analysis ability of the wavelet makes the image characteristics can be well described and provides a feasible way for high-accuracy retrieval system. The signal is decomposed into a series of basic functions $\psi_{mn}(x)$ through the wavelet transform. These basic functions can be obtained by Wavelet generating function $\psi(x)$ defined as the follows:

$$\Psi_{mn}(x) = 2^{-m/2}\Psi(2^{-m}x - n) \tag{5}$$

Where m and n are integers, so the signal f (x) is expressed as:

$$f(x) = \sum_{m,n} c_{mn}\Psi_{mn}(x) \tag{6}$$

Two-dimensional wavelet transform makes image decomposed into four sub-bands, are known as LL, LH, HL and HH according to the frequency characteristics, each band can be used for each decomposition level, the energy distribution of the mean and standard deviation expressed image texture features. The Daubechies-4 wavelet transform is applied to decompose the image, and then extract the mean and standard deviation of the four-band wavelet decomposition coefficients after one-level wavelet transform decomposition (Wang et al. 2001). The distribution of the four bands is organized as shown in figure 1.

After a one-level wavelet transform, the wavelet coefficients are $c_{i,j}$ at the point (i, j), then the mean and standard deviation of any band are calculated as:

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} c_{i,j} \tag{7}$$

$$D = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(c_{i,j} - \mu)^2} \tag{8}$$

Texture feature extraction algorithm based on wavelet transform is that using formula (7) and (8) calculate the mean and standard deviation of the four-band of the image and form eight-dimensional texture feature.

3.3.3. Integration of the Color and Texture feature

Assuming that images A, B, extracted the normalized feature as:

$$F_A = [f_{1A}, f_{2A}, \cdots, f_{NA}] \tag{9}$$

$$F_B = [f_{1B}, f_{2B}, \cdots, f_{NB}] \tag{10}$$

Here, N is the scale of the feature. Through the similarity computation by Euclidean distance, design this model:

$$D(A, B) = \omega_1 D(F_{CA}, F_{CB}) + \omega_2 D(F_{TA}, F_{TB}) \tag{11}$$

Here ω_1 is the weight of color features, ω_2 is the weight of texture features, F_C* represents the 72-dimensional color features, F_T* on behalf of 8-dimensional texture features. For a more precise measure of the similarity between images, usually the calculated Euclidean distance has to be normalized, because Euclidean distance range is [0, 2] , normalized Euclidean distance is as follows:

$$D(A,B) = \omega_1 \frac{\sqrt{2} - D(F_{CA}, F_{CB})}{\sqrt{2}} + \omega_2 \frac{\sqrt{2} - D(F_{TA}, F_{TB})}{\sqrt{2}} \quad (12)$$

The feature extraction methods for the RGB and YUV based images are explained. These features are used for the further processing in the content based image retrieval techniques.

4. Experimental Results

The dataset provided at webdocs.cs.ualberta.ca is used to test the proposed method. Experimental images cover a rich of content, including landscapes, animals, plants, monuments, transport (cars, planes) and so on. Experiments show that $\omega_1 = \omega_2 = 0.5$, with better retrieval performance. Image retrieval based on texture feature, the use of the above-mentioned method of similarity measure to calculate the texture feature distance between the sample image and the library image. According to a similar distance from small to large with the image, the smaller the distance, that is, the more similar. Image retrieval examples are done by means of the RGB, HSV and YUV (Bourke, 1994).

Figure 3 gives the retrieved images when the RGB color space is used. The input image given is shown in figure 2. Figure 4 and 5 shows the retrieved images when HSV and YUV color space is used respectively. When comparing the YUV color space used CBIR with RGB and HSV method, YUV have higher performance and retrieves the most similar images. The images retrieved by YUV are the bonsai tree image which is given as query image. The time consumed by RGB to retrieve similar images is around 0.95 seconds. When using the YUV the same images are retrieved within 0.8 seconds.

5. Conclusion

This paper presents an approach based on YUV color space and texture characteristics of the image retrieval and comparison with RGB and HSV color space. Through a variety of statistics the experimental results can be concluded that a feature extraction method cannot adapt to all the images. Based on the color feature, the rich color images, such as the type of landscape images or planes, the color characteristics of the use of regular search colors can be similar to the image. The use of color and texture features of wavelet transform is more suitable for segmentation of objects and classification of related image from thousand of images. In which the retrieved images are much similar when the YUV is used and the retrieval time is also less when comparing with the previous RGB and HSV methods.

References

J. Feng, M. J. Li, H. J. Zhang, B. Zhang (2005), “A unified framework for image retrieval using keyword and visual features”, IEEE Transactions on Image Processing, vol.14, no.7, pp. 979–989.

Pentland, R. W. S. Picard, Sclaroff (1996), “Photobook: Content-based manipulation of image databases,” In International Journal of Computer Vision, vol.18, no.3, pp. 233–254.

Y. Rui, T. Huang, S. Mehrotra (1997), “Content-Based image retrieval with relevance feedback in MARS, ” In Proc of the IEEE Int'1 Conf. on Image Processing, New York, vol.2, pp. 815–818.

S. Sclaroff, L. Taycher, and M. La Cascia (1997), “ImageRover: A content-based image browser for the World Wide Web”, IEEE Workshop on Content-based access of image and video libraries.

J. Vogel and B. Schiele (2002), On Performance Characterization and Optimization for Image Retrieval, 7th European Conference on Computer Vision, Springer, 49-63.

Pentland, R. Picard, and S. Sclaroff (1994), “Photobook: tools for content-base manipulation of image databases,” in Storage and Retrieval for Image and Video Databases II, vol. 2185, (San Jose, California, USA), pp. 34–47, SPIE, February.

J. Wang, J. Li, G. Wiederhold (2001), “Simplicity: Semantics-sensitive integrated matching for picture libraries,” Transactions on Pattern Analysis and Machine Intelligence, vol.23, no.9, pp.947–963.

B S Manjunath, W Y Ma (1996), “Texture feature for browsing and retrieval of image data,” IEEE Transaction on PAMI, vol.18, no.8, 1996, pp. 837–842.

Y. Rui, C. Alfred, T. S. Huang (2009), “Modified descriptor for shape representation, a practical approach” in IEEE explore Proceedings of First International Conference on Image Database and Multimedia Search.

Cao Li Hua, Liu Wei, Li Guo Hui (1999), "Research and Implementation of an Image Retrieval Algorithm Based on Multiple Dominant Colors," Journal of Computer Research & Development, vol.36, no.1, pp.96–100.

CBIR image data sets: http://webdocs.cs.ualberta.ca/~mn/CBIRone//A15344-bonzai/

Martinkauppi, B. and M. Soriano (2001), "Basis functions of the color signals of skin under different illuminants" in Third International Conference on Multi-spectral Color Science, June 18-20, pp: 21–24.

Albiol, A., L. Torres and E. J. Delp (2001), Optimum color spaces for skin detection. In: Intl. Conf. on Image Processing, October 7-10, Vol. 1. pp: 122–124. DOI: 10.1109/ICIP.2001.958968.

P.Bourke (1994), "Converting between RGB and CMY, YIQ, YUV", Available from http://local.wasp.uwa.edu.au/~pbourke /texture_colour/convert/ (Accessed on 23.07.2009)

Brand, J. and J. Mason (2000), "A Comparative assessment of three approaches to pixel level human skin detection" in International Conference on Pattern Recognition, September 3-8, Vol. 1. pp: 1056–1059. DOI: ICPR.2000.905653.

Chai, D. and A. Bouzerdoum (2000), A Bayesian approach to skin color classification in YCbCr color space. In: Institute of Electrical and Electronics Engineers IEEE Region Ten Conference (TENCON'2000), September 24-27, Vol. 2. pp: 421–424

Fleck, M., D. A. Forsyth and C. Bregler (1996), Finding naked people. In: European Conference on Computer Vision (ECCV), April 15-18, Vol. 2, pp: 592–602.

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I_{LL}	I_{LH}
I_{LH}	I_{HH}

Figure 1. Four frequency bands of wavelet transform

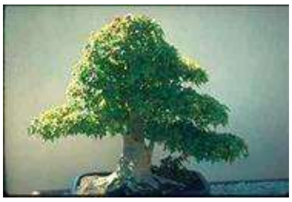

Figure 2. Sample image given to test for RGB, HSV and YUV

Figure 3. Retrieved images when RGB Color space is used

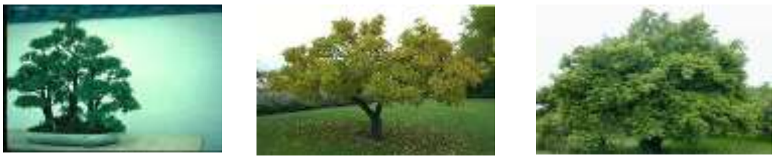

Figure 4. Retrieved images when HSV Color space is used

Figure 5. Retrieved images when YUV Color space and Texture features are used

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