Color Based Image Retrieval by Combining Various Features

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Abstract: Content based image retrieval system retrieve the images according to the strong feature related to desire as color, texture and shape of an image. Although visual features cannot be completely determined by semantic features, but still semantic features can be integrate easily into mathematical formulas. This paper is focused on retrieval of images within a large image collection, based on color projection by applying segmentation and quantification on different color models and compared for good result. This method is applied on different categories of image set and evaluated its retrieval rate in different models.

Keywords: segmentation, image retrieval, color feature

I. INTRODUCTION

In today’s scenario, due to utilization of internet and web technologies there is wide spread range of collection of databases with enormous categories of images. Different type of information are going to be gathered from online in terms of categorized books, learning content, newspaper, advertisement etc. which are digitized and also available as per user requirement. With respect to access these in terms of images from databases, different methods have been implemented to retrieve image as per usefulness. The content based image retrieval system is the application of computer vision with reference to the viewpoint of image problem. This paper is based on the automatic retrieval of most similar images to the given Query image on the basis of local feature extraction like colors, shapes, texture etc. In image retrieval system for searching, browsing, and retrieving images from a large database of images. Most usual and general method of image retrieval, make use of some method of adding up metadata such as descriptions, keywords, tokens, captioning, to the images so that retrieval can be performed well. Few systems are functioning with lower level features; manually image annotation is time-consuming, difficult and costly. To address this, many researchers proposed an automatic user friendly image retrieval system using different methods. Searching any query image which is Content-based (which might be referred to colors, shapes, textures, or any other information) analyzed for actual image to be present in database. In this paper, we try to provide best solution in large number of data.

II. COLOR IMAGE

Any colored image is a blend of few basic colors. In this each individual pixel of a color image down into Red, Green and Blue values. For different color band R, G & B different matrix is generated. The three matrices are arranged in sequential order, next to each other creating a 3 dimensional m by n of 3 matrices. A RGB image converted to an indexed image which reduces the number of colors in the process.

III. COLOR IMAGE FEATURE EXTRACTION

There are different features related to the colored images:-

3.1 Color histogram:

An image histogram refers to the probability mass function of the image intensities. This is extensive for color images to confine the joint probability of the intensities of the three different color channels. More formally, the color histogram is defined as:

\[ H_{c1,c2,c3}(x,y,z) = P(Prob(c1 = x, c2 = y, c3 = z)) \]

Where c1, c2 and c3 are the three channels of color model image (RGB, HSV, L*a*b or YCbCr) and the P is the no of pixels in given image

3.1.1 Color Histogram Euclidean distance:

There are three distance formulas that can be used for image retrieval: histogram Euclidean Distance, histogram intersection and histogram quadratic (cross) distance. In this paper, histogram Euclidean Distance has been chosen to work. By considering the H’ and H” as two color histogram of Query image and searched image respectively. The Euclidean Distance between the H’ and H” can be computed as:

\[ D(H', H'') = \sqrt{\sum_{x} \sum_{y} \sum_{z} (H'(x,y,z) - H''(x,y,z))^2} \]

Where E is the Euclidean distance to be calculated between two color histogram H’ and H”. In the above formula maximum of histogram value of individual channel of an image has been taken.

3.2 Color Moments

The second feature has been taken as color moments. The Mean and standard deviation of each channel have been calculated as:

\[ \text{Mean}(M) = \frac{1}{n} \sum_{i=1}^{n} M_i \]

\[ \text{Standard Deviation}(SD) = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (M_i - \text{Mean}(M))^2} \]

\[ \text{Variance}(V) = \text{Standard Deviation}(SD)^2 \]
Standard Deviation$(\delta) = \sum_{i,j=1}^{n}(i,j-Er,i)^2\sqrt{\sum_{i=1}^{n}(i,j-Er,i)^2}$

3.2.1 Color Moments Euclidean distance:

The Euclidean distance of mean and standard deviation respectively can be computed as:

$D_M = \sqrt{(M'-M)^2}$

$D_{\delta} = \sqrt{(\delta'-\delta)^2}$

3.3 Colormap:

The colormap which gives three column matrix of RGB triplets. Each one of the row of matrix define single RGB triplet that specifies one color of the colormap. The values are in the range. There will be any length of the colormaps, but there should be widely three columns. Each one of the row in the matrix shows one color by use of an RGB triplet. There are number of elements which specify the intensities of the red, green, and blue components of the color of RGB triplets which is three-element row vector. The intensities must be in between the range. A 0 value shows no color and 1 value shows full intensity.

3.3.1 Colormap Euclidean distance: The colormap Euclidean distance can be compute as:

$D_{Colormap} = \sqrt{\sum_{n=1}^{1}(c'_n-c''_n)^2}$

Where $D_{Colormap}$ Euclidean distance for Colormap, $c_n$ is the number of channels i.e., where $n=1,2,3$ for three channels respectively.

IV. CBIR SYSTEM ON THE BASIS OF COLOR FEATURES

Proposed algorithm uses combinations of color feature to overcome the problem description. The Framework of CBIR system is displayed in figure 5. Query image having similar characteristic from database has to retrieve. Proposed system is implemented and concentrated on visual contents of an image especially color applying on the roses dataset. Proposed system retrieve image from image databases with common, feature values as color histogram. In this paper, the proposed work will try to provide a platform to extract images from the database using query method. Input image before and after segmentation is shown in figure 3. Segmented image is shown in figure 4 using different color model.

Figure 3: input image (a) before segmentation (b) after segmentation

Figure 4: different Color Models for input image

Database of the image set are display in figure 6.

Figure 5: Framework of CBIR System
Feature1: Color Map value of RGB
Same has been carried out for the next YCbCr, HSV and L*a*b models respectively, Table1 shows the feature of query image in different models.

To retrieve the image according to the query image, score is calculated as given formula:

$$Distance Vector = \sum_{i=1}^{4}(F_q - F_n)^2$$

Where n denotes the number of F features of dataset image I, q denotes the number of features for an query image.

After taking four features as mentioned above the Euclidian distance (D) has been calculated. Feature1 is taken as F1 for D(H,H'), Feature2 as F2 for DM, Feature3 as F3 for Dsd, Feature4 as F4 for Dmax. In this research paper, Number of features (F_i,q for four features of dataset images and Fq for four features of query image) are taken, the distance vector for these four images can be calculated as:

$$Distance Vector = D = [(F_1 - F_{q1})^2 + (F_2 - F_{q2})^2 + (F_3 - F_{q3})^2 + (F_4 - F_{q4})^2]$$

Here D is considering as a score card for each images in the dataset.

F1=Rmax, Gmax, Bmax of Histogram of Image
F2= Color Map value of RGB color
F3= mean of image
F4= Standard Deviation of image
Same has been taken for Query image as Fq1, Fq2, Fq3, Fq4 respectively.

The maximum value of color histogram of each channel in different color model for each image in database is shown in Table 2. The score of the dataset images are arranged in ascending order by using the RGB color model in Table 3 with respect to query image. Table 4 display the score of the image in YCbCr model with respect to query image. Table 5 display the score of the image in HSV model with respect to query image. From the given tables we analyzed that YCbCr and RGB not retrieve a related image from top 1 to 14 images. L*a*b retrieve top 14 image of same color and HSV retrieve top 14 of same color.

V. EXPERIMENTAL ANALYSIS

In this research paper different color model as RGB, YCbCr and HSV have been taken for feature collections which are as mention below:

**Feature1** for RGB model: maximum value of R, G, and B in RGB Histogram
**Feature2**: Mean of image intensity
**Feature3**: Standard Deviation of RGB image

### Table 1: features extracted for Query Image

| Sn. | Query Image | Color Models | F1 max value of Histogram | F2 Color Map | F3 Mean | F4 Standard Deviation |
|-----|-------------|--------------|---------------------------|--------------|--------|----------------------|
|     |             | L*a*b        | Channel1 | Channel2 | Channel3 | Channel1 | Channel2 | Channel3 |               |               |               |
| 1.  | Red2        | L*a*b        | 44005   | 48590   | 48800   | 0.1529  | 0.0117  | 0.0117  | 0.0614     | 0.1609     |
| 2.  | Red2        | RGB          | 40620   | 46276   | 47635   | 0.1568  | 0.0039  | 0.0039  | 14.5222    | 40.0809    |
| 3.  | Red2        | HSV          | 46211   | 50367   | 50427   | 0.1568  | 0.0078  | 0.0078  | 15.0010    | 42.9606    |
| 4.  | Red2        | YCbCr        | 39666   | 45014   | 45549   | 0.1921  | 0.0156  | 0.0156  | 19.4967    | 46.7806    |

| Sn. | Image | L*a*b | HSV | YCbCr | rgb |
|-----|-------|-------|-----|-------|-----|
| 1   | Red1  | 57423 | 60483 | 57722 | 57702 |

### Table 2: Maximum value of color histogram of each channel separately

| Sn. | Image | L*a*b max(L) | max(a) | max(b) | max(H) | max(S) | max(Y) | max(Cb) | max(Cr) | max(R) | max(G) | max(B) |
|-----|-------|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1   | Red1  | 57423        | 60483  | 60839  | 51721  | 57722  | 57702  | 51550  | 57215  | 57591  | 51721  | 57722  | 57702  |
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Table 1: Score in RGB color model

| Sn. | images | R1 | G2 | B3 | F4 | Score |
|-----|--------|----|----|----|----|-------|
| 1   | Red2   | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 2   | Red11  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 3   | Red12  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 4   | Red13  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 5   | Red14  | 0.00| 0.00| 0.00| 0.00| 0.00  |

Table 2: Score in YCbCr feature extracted

| Sn. | images | Y1 | C2 | b3 | F4 | Score |
|-----|--------|----|----|----|----|-------|
| 1   | Red2   | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 2   | Red11  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 3   | Red12  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 4   | Red13  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 5   | Red14  | 0.00| 0.00| 0.00| 0.00| 0.00  |

Table 3: Score in L*a*b color model

| Sn. | images | L1 | a2 | b3 | F4 | Score |
|-----|--------|----|----|----|----|-------|
| 1   | Red2   | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 2   | Red11  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 3   | Red12  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 4   | Red13  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 5   | Red14  | 0.00| 0.00| 0.00| 0.00| 0.00  |

Table 4: Score in HSV color model

| Sn. | images | H1 | S2 | V3 | F4 | Score |
|-----|--------|----|----|----|----|-------|
| 1   | Red2   | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 2   | Red11  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 3   | Red12  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 4   | Red13  | 0.00| 0.00| 0.00| 0.00| 0.00  |
| 5   | Red14  | 0.00| 0.00| 0.00| 0.00| 0.00  |
Table 7 and Table 8 use to compare the retrieval rate of HSV and L*a*b for best result. Three categories of databases of specific color images have been taken like apple dataset, bus dataset, flower dataset to compare with the proposed method as well as famous precision and recall measures have been calculated for given pre-categorized databases. Both precision and recall are strong evaluation measure. Most of each experiment, image retrieval performed for given every query image. In this regard all the red images in different dataset are renamed as ‘r’, green as ‘g’ and yellow as ‘y’ in table 7 and table 8. In table 7 using HSV model, it retrieved all top similar red images from apple dataset, and same retrieve all top in bus dataset with reference to query image and retrieved all top red images from flowers dataset. L*a*b color model it also gives the same result for apple dataset and bus dataset and lower dataset.

Table 7: HSV color image score for three different categorized dataset

| HSV color image score for three different dataset | apple | score | bus | score | flower | score |
|---|---|---|---|---|---|---|
| red1 | 0 | r2 | 0 | r2 | 0 |
| r13 | 1293 | r12 | 1267 | r9 | 3288 |
| r15 | 2564 | r5 | 1992 | r15 | 8187 |
| r12 | 4132 | r7 | 3483 | r3 | 8450 |
| r9 | 4233 | r17 | 3773 | r10 | 8668 |
| r8 | 5707 | r3 | 5053 | r5 | 9102 |
| r7 | 6416 | r6 | 5582 | r11 | 9194 |
| r14 | 9033 | r4 | 5755 | r14 | 10147 |
| r11 | 9054 | r14 | 6124 | r4 | 10684 |
| r6 | 15667 | r8 | 8052 | r1 | 11726 |
| r2 | 16902 | r15 | 8083 | r13 | 12162 |
| r3 | 16902 | r16 | 8087 | r12 | 12707 |
| r4 | 17839 | r10 | 13043 | r8 | 18007 |
| r10 | 18558 | r11 | 14442 | r7 | 18548 |
| r5 | 19621 | r9 | 14816 | y11 | 21363 |
| g16 | 24171 | r1 | 21162 | y4 | 23826 |
| g17 | 28078 | y4 | 24172 | y9 | 28470 |
| g18 | 28078 | y3 | 24889 | y10 | 28898 |
| g19 | 28078 | y6 | 25090 | y1 | 28900 |
| g20 | 28078 | y7 | 25190 | y2 | 28900 |
| g21 | 28078 | y9 | 25199 | y3 | 28900 |
| g22 | 28078 | y2 | 25220 | y5 | 28900 |
| y23 | 28078 | y5 | 25221 | y7 | 28900 |
| y24 | 28078 | y1 | 25223 | y8 | 28900 |
| y25 | 28078 | y8 | 25223 | r6 | 31884 |

Table 8: L*a*b color image score for three different categorized dataset

| L*a*b color image score for different category dataset | apple | score | bus | score | flower | score |
|---|---|---|---|---|---|---|
| r1 | 0 | r2 | 0 | r2 | 0 |
| r2 | 2844 | r5 | 707 | r11 | 4431 |
| r6 | 3977 | r14 | 1046 | r3 | 5610 |
| r5 | 4622 | r8 | 1061 | r9 | 5843 |
| r11 | 7070 | r15 | 3130 | r5 | 7881 |
| r8 | 1163 | r12 | 5946 | r15 | 8549 |
| r13 | 1331 | r10 | 6936 | r14 | 11510 |

5.1 The image retrieval Efficiency:
The precision of the system significantly shows the total number of similar images present in retrieved images and the total number of retrieved images from the database. In the same way recall is the ratio of the number of similar images present in the retrieved images and the total number of relevant images in the database. In this paper, for given Query image Q, if total N numbers of images have been retrieved so far for this, The retrieval efficiency named as precision, recall and accuracy can be calculated given below:

\[
\text{Precision} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images in database}}
\]

\[
\text{Recall} = \frac{\text{Number of relevant images retrieved}}{\text{Total no of relevant images in database}}
\]

Table 9: image retrieval results with respect to precision and recall

| Proposed Techniques using given HSV in different image categories | Apple database | Bus database | Flowers database |
|---|---|---|---|
| Query Image(n1) | R1 | R2 | R2 |
| Number of images in database(n2) | 24 | 24 | 24 |
| Recall | 1.00 | 1.00 | 0.93 |
| Precision | 0.60 | 0.64 | 0.56 |

As it can be seen from the above Table 9 the proposed technique is implemented in different category of dataset. First dataset is for collection of images of apple dataset of Red, Green and Yellow colored images, second dataset is the collection of buses of red and yellow color and the third dataset is the collection of roses of red and yellow colors.

5.2 Comparative Study by using different color models in proposed work:

Table 10: Comparative Study by using different color models in proposed work

| Proposed Techniques using given color model | RGB | YCbCr | L*a*b | HSV |
|---|---|---|---|---|
| Input Images | Red2 | Red2 | Red2 | Red2 |
| Precision | 0.28 | 0.25 | 0.20 | 0.40 |
On the basis of above comparative study of different color models by implementation of the proposed steps of CBIR system, it’s clear from the above Table 10 that both L*a*b and HSV give the better result as the accuracy of both L*a*b and HSV are same. Both are giving the best top 14 images related to query image out of 15 relevant images. So in this paper it can be say that on the basis of color feature both HSV and L*a*b doing well their job rather than RGB and YCbCr. Since HSV and L*a*b both shows same accuracy on the basis of color features, hence in this research paper, there are mix of all three dataset (shown in figure 7) category and making the one dataset for more accurate result which is shown through the Table 11.

![Figure 7: mixed dataset of dataset for apple, bus and flower](image)

| Table 11: Comparative analysis of proposed work using HSV and L*a*b color models |
|-----------------|-----------------|-----------------|-----------------|
| sn. | image | score | image | score |
| 1 | RedRose2 | 0 | RedRose2 | 0 |
| 2 | RedRose9 | 3288 | RedBus15 | 3753 |
| 3 | RedApple13 | 3329 | RedApple12 | 3828 |
| 4 | RedApple1 | 3478 | RedApple9 | 4116 |
| 5 | RedBus5 | 3728 | RedBus8 | 4199 |
| 6 | RedApple15 | 3890 | RedRose11 | 4431 |
| 7 | RedBus12 | 4068 | RedBus2 | 4749 |
| 8 | RedBus14 | 4222 | RedBus12 | 4801 |
| 9 | RedBus2 | 4854 | RedBus5 | 5255 |
| 10 | RedBus15 | 5726 | RedApple2 | 5302 |
| 11 | RedApple12 | 5849 | RedApple3 | 5302 |
| 12 | RedApple9 | 5936 | RedApple15 | 5305 |
| 13 | RedApple8 | 6093 | RedBus14 | 5404 |
| 14 | RedApple7 | 7472 | RedApple13 | 5429 |
| 15 | RedBus7 | 7635 | RedBus10 | 5508 |
| 16 | RedBus17 | 7799 | RedBus4 | 5560 |
| 17 | RedRose15 | 8187 | RedRose3 | 5610 |
| 18 | RedRose3 | 8450 | RedRose9 | 5843 |
| 19 | RedRose10 | 8668 | RedApple7 | 6160 |
| 20 | RedApple11 | 9065 | RedApple8 | 6819 |
| 21 | RedApple14 | 9083 | RedApple4 | 7566 |
| 22 | RedRose5 | 9102 | RedBus7 | 7610 |
| 23 | RedBus3 | 9165 | RedRose5 | 7881 |
| 24 | RedRose11 | 9194 | RedBus3 | 8326 |
VI. CONCLUSION

Most Content-Based Image Retrieval (CBIR) systems focus on different stock of photo collections and try to address challenges of large specialized image collections and topics such as efficient image retrieval by image content. The research work concentrated on large set of images with different categories.

This paper analyzed that the retrieval rate of HSV model and L*a*b model for color based image retrieval are approximately same using the proposed approach. While of RGB and YCbCr color model.

REFERENCES:

1. Xiang-Yang Wang et.al, “An effective image retrieval scheme using color, texture and shape features”, Computer Standards & Interfaces 33 (2011) page no 59-68
2. Jun You et. El, “Content-based image retrieval using color and texture fused feature” Mathematical and Computer Modeling, 54(2011), 1121-1127
3. Yogita Mistry et-al, “Content based image retrieval using hybrid features and various distance metric”, Journal of Electrical Systems and Information Technology, 2017https://electronicsforum.com/electronics-projects/prototypes/histogram-color-image-matlab
4. Alsamadi M, Omar K. Fish, “classification: fish classification using memetic algorithms with back propagation classifier”, 2012
5. Alsamadi MK, Omar KB, Noah SA.,“Fish classification based on robust features extraction from color signature using back-propagation classifier”, J Comput Sci 2011, 7(1):52
6. Hany Fathy Atlam, et.al, "Comparative Study on CBIR based on Color Feature” International Journal of Computer Applications Volume 78 – No.16, September 2013, ISSN 0975 – 8887
7. Mark Nixon & Alberto Aquado, “Feature Extraction and Image Processing”, second Edition 2008, Academic Press is an imprint of Elsevier, ISBN: 978-0-12372-538-7
8. R.Venkata Ramana Chary, et. al “FEATURE EXTRACTION METHODS FOR COLOR”
9. Series Editor W. Bruce Croft, “Chapter 3: Color Feature Extraction”, The Kluwer International Series On Information Retrieval, Amherst, Kluwer Academic Publishers Massachusetts, ISBN: 0-792-37944-6
10. Mohammed Hamzah Abed, et.al, "Content based Image Retrieval based on Histogram", International Journal of Computer Applications, Volume 110 – No. 3, January 2015 42.ISSN 0975 – 8887

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