A study of comparative evaluation of methods for image processing using color features

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Abstract: - In this article shall propose a method for selecting appropriate color space for purposes of processing images using descriptor in the color. I chose the color for that this is the basic characteristic element of an image. Processing methods proposed, allow select of the Download Descriptor is color which offers performances higher. Is being tracked in particular time as well as quality of retrieving retrieval is successfully completed. Using in the process of processing, appropriate color space we will retrieve images similar to the one of more powerful query and more quickly.

Key-Words: - color space, image processing, HSV, RGB, $l_1l_2l_3$, quantification, precision - recall

1 Introduction

The image mining research needs to investigate the following problems:

a) Propose new representation schemes for visual patterns that are able to encode sufficient contextual information to allow for meaningful extraction of useful visual characteristics;
b) Devise efficient content-based image indexing and retrieval techique to facilitate fast and effective access in large image repository;
c) Design semantically powerfull query languages for image database [8];
d) Explore new discovery that take into account the unique characteristics of image data;
e) Incorporate new techniques for the vizualization of image of image patterns.

1.1 Visual information retrieval systems

Visual information retrieval is a new subject of research in information technology. Its purpose is to retrieve , from a database , images or sequences of image that are relevant to a query.It is an extension of traditional information retrieval designed to include visual media[1].

Interactivity with visual contents essential to visual information retrieval. The searching for visual data by reffering directly to its content is the object of new tools and interaction paradigms. Visual elements such as colour, texture and object shape sapatial relationships – directly related to perceptual aspects of image content, together with high-level concepts – the meaning of objects and scenes in the images, are used as clues for retrieving images with similar content from a database. The variety of knowledge required in visual information retrieval is large. Different research fields, which have evolved separately, provide valuable contributions to this new research subject. Information retrieval, visual data modelling and computer vision, multimedia database organization, multidimensional indexing, psyhological modelling of user behaviour, man-machine interaction and data visualization, are only the most important research fields that contribute in a separate but interrelated was to visual information retrieval.

1.2 From databases to visual information retrieval systems

First generation multimedia database systems focussed on kernel support for **blobs** (binary large objects), to efficiently store the sizeable objects.

The second phase concerned techniques for annotation and linking media objects. The database merely contains textual annotations, made accessible efficiently using conventional information retrieval techniques. Multimedia objects remain non-interpreted with respect to retrieval.

The third generation of multimedia database retrieval research focuses on effective techniques for indexing and retrieval by content [7].
The ideal searched for are algorithms to automatiocally index objects according to a semantic framework.
In the shorter term, the best we can hope for is to make progress in the effective usage of automatically derived features that aid pre-selection in a large multimedia database.
New-generation visual information retrieval systems support full retrieval by visual content. Access to visual information is not only performed at a conceptual level, using keywords as in the textual domain, but also at a perceptual level, using objective measurements of the visual content and appropriate similarity models. In these systems, image processing, pattern recognition and computer vision are an integral part of the sistem's architecture and operation.
They permit the objective analysis of pixel distibution and the automatic extraction of measurements from raw sensory input. Other sensory data analysis, like speech and sound analysis , can also be employed to extract useful measurements from video streams. These systems are distinguished according to whether they deal with still 2D images, 2D video or 3D visual data. The rapidly growing WWW environment will soon require the development of solutions for large-scale distributed applications.
The progres in this field , demonstrates the feasibilty the concept of images retrieval , by using the characteristics based on perceptual images propert of low-level such as colour and texture distribution.

2 As color spaces used for image processing

Please, The color systems must satisfy certain properties imposed by the visual search based on content, namely:

1. The colors system be independent of context;
2. The colors system be perceptual uniform ;
3. The colors system be linear;
4. The colors system be intuitive;
5. The colors system be robust, i.e.:

• to be invariante when changing the viewing direction ;
• to be invariante to changing of objects geometry ;
• to be invariante to direction change and illumination intensity;
• to be invariante to changing the spectral energy distribution of lighting.

Taking into account the proprieties required by color systems to be used in visual search based on content, I have selected for experiment three of them (HSV, RGB and l1l2l3), for the purpose of determining if they are the best candidates for use in this sense.
It is also presented the system RGB color due to the fact that it is base of other spaces of color as a result of the application of some non-linear transformations or linear.

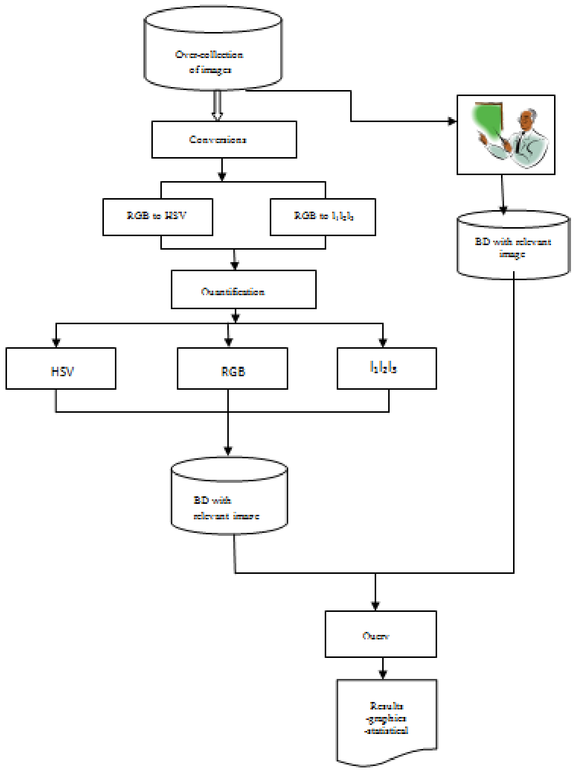


Fig. 1 Processing algorithm and comparison of color spaces

2.1 HSV color space

When HSV (hue, saturation, value) is a nonlinear transformation of RGB color space.

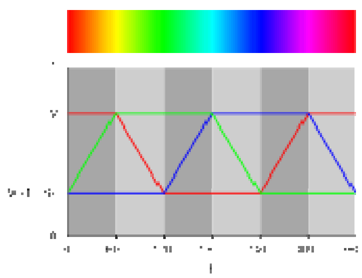


Fig. 2 Transformation RGB color space in HSV

2.1.1 The transformation of RGB color space in HSV

The relationship between HSV and RGB color space

$$H \in \qquad [0, 360)$$

$$S, V, R, G, B \in [0, 1]$$

The conversion from RGB color space to HSV color space is as follows:

$$H = \begin{cases} \text{undefined} & \text{dacã MAX = MIN} \\ 60^0 \times \dfrac{G - B}{MAX - MIN} + 0^0, & \text{dacã} MAX = R \\ & \text{°i } G \geq B \\ 60^0 \times \dfrac{G - B}{MAX - MIN} + 360^0, & \text{dacã} MAX = R \\ & \text{°i } G < B \\ 60^0 \times \dfrac{B - R}{MAX - MIN} + 120^0, & \text{dacã MAX = G} \\ 60^0 \times \dfrac{R - G}{MAX - MIN} + 240^0, & \text{dacã MAX = B} \end{cases}$$

$$S = \begin{cases} 0, & \text{dacã MAX } = 0 \\ 1 - \dfrac{\text{MIN}}{\text{MAX}}, & \textit{altfel} \end{cases}$$

$$V = MAX / 255$$

2.1.2 HSV quantification

Quantification of HSV space produces a compact set of 166 colors.

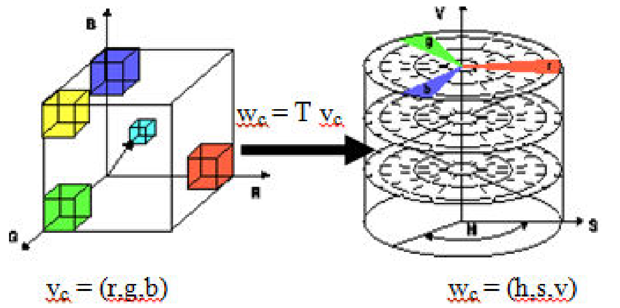


Fig. 3 Transformation from RGB to HSV

Because shade is the most important characteristic of the color, it requires quantification finest. By quantification are obtained: 18 colors, 3 saturations, 3 values and 4 gray color, ie a total of 166 distinct colors in HSV color space.(Fig. 3)

The pseudocode for quantification procedure:

```
color = 0
h_scale = 1 / 18
s_scale = 1 / 3
v_scale = 1 / 3
If s = 0 Then
  color = 162 + Int(v/(1/4))
  If color = 166 Then
    color = color – 1
  End
Else
  If Int(v / v_scale) >= 1 Then
    color=color+54*(Int(v/v_scale))
    If color Mod 3 * 18 * 3 = 0 Then
     color = color - 3 * 18
    End
  End
  If Int(s / s_scale) >= 1 Then
    color=color+18*(Int(s/s_scale))
    If color Mod 3 * 18 = 0 Then
     color = color - 18
    End
  End
  If Int(h / h_scale) >= 1 Then
    color=color+(Int(h/h_scale))
    If color Mod 18 = 0 Then
      color = color - 1
    End
  End
End
End
```

The 166 color values of the histogram are stored in the database.

2.2 RGB color space

A linear function of tristimulus values converts a set of primary colors in others .

Use of the system to query RGB images can cause problems when the conditions are different for base image and images of interviewed.

Features :

- the color model : R, G and B;
- without transformation;
- features:
- dependent of the device;
- it is not perceptual evenly;
- neintuitiv;
- dependent on the angle of observation, of the geometry of object, direction, and intensity of the lighting;
- remarks: do not require transformation.

2.2.1 RGB quantification

The Quantifying of color space of RGB to 64 colors involves keeping the 4 colors on each axis. The 64 values of the color histogram in the RGB space is stored in the database

```
Procedure Cuant_64_colors
color = 0
c_scale = 64
If red / c_scale > 0 Then
    color = color + 16 * Int(red / c_scale)
End
If green / c_scale > 0 Then
```

```
        color = color + 4 * Int(green / c_scale)
    End
     If blue / c_scale > 0 Then
        color = color + Int(blue / c_scale)
    End
    End
```

2.3 Color space $l_1 l_2 l_3$

When the images RGB are correlated with each other, it is preferable to reduce this correlation.
This can be obtained with the Karhunen-Loeve transformation . This transformation is calculated on the basis of cover matrix.
Three models have been derived from orthogonal colors:
$l_1 = R + G + B$
$l_2 = (R - G)/2$
$l_3 = (2G - R - B)/4$
Observe that l_1 corresponds to intensity:.
Special features:
-the color model: L1, L2 and l3 ;
- transformation:

$$l_1 = \frac{(R-G)^2}{(R-G)^2 + (R-B)^2 + (G-B)^2}$$

$$l_2 = \frac{(R-B)^2}{(R-G)^2 + (R-B)^2 + (G-B)^2}$$

$$l_3 = \frac{(G-B)^2}{R-G)^2 + (R-B)^2 + (G-B)^2}$$

- features:
- dependent on the device;
- it is not perceptual evenly;
- linear;
- intuitive;
- dependent on the changing of color illumination ;
- remarks: mismatch is based on the Karhunen-Love transformation.

2.3.1 $l_1 l_2 l_3$ quantification

Quantification to 64 values shall be in accordance with algorithm already submitted, resulting other 64 values in the space $l_1 l_2 l_3$ who must be stored in the database.

3 Experimental study

The methods are studied from two points of view:
- the quality of retrieval ;
- time of execution**.**

For the attainment of this comparative study, for the characteristic of color I established the following experimental conditions:
1. I've created database test;
2. Each image in the database has been processed before performing query. This is important because it requires consumption of time and for this reason it is not advisable to execute at the same time with the query;
3. Has been chosen an image query and have been established by a human observer the images considered relevant for that query (Fig. 5) ;
4. Each of images relevant to the query considerated, has been used at a time to interrogate database with the image. Accuracy and the recall represent an average arithmetic mean of values resulting in every image taken as an image of querying.
5. To compare the results obtained, of each query I did the accuracy graph for each recalll . I have presented in tabular form the values that represent the number of images which are relevant in the first five, ten relevant image. Also number of images to be retrieved that among these to find first five, respective ten relevant image.(Fig. 4), (Table 1)

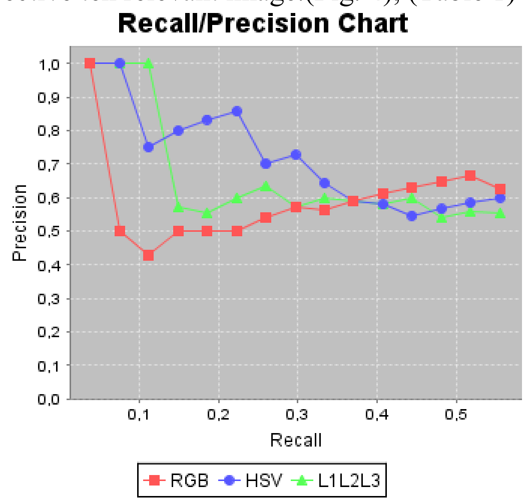


Fig. 4. The graphic for precision-recall

Fig 5 Image used for querying

Results obtained for each color space are:

Fig. 6 Color space HSV

Fig. 7 Color space RGB

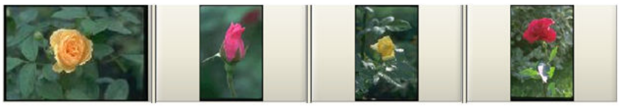
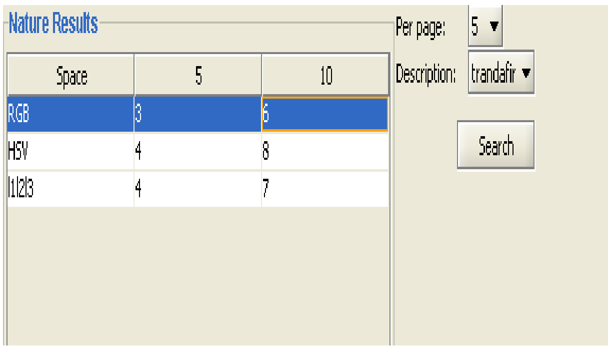


Fig. 8 Color space $l_1l_2l_3$

Statistical results regarding the images obtained are presented in the table 1. The table contains 3 columns: the first column represents color space used, the second column contains the number of relevant image found in the first 5 images and the third column contains the number of relevant image found in the first 10 images (number of relevant images retrieved relative to the total number of items returned).

Table 1 Statistic on the number of images relevant to the color spaces RGB, HSV. $l_1l_2l_3$



Space	5	10
RGB	3	6
HSV	4	8
l1l2l3	4	7

A method is more effective, because the curve of its graph is farther than axes of the origin, and, above the other curves. By concluding, we might say that color space HSV is the better performance.

4 Conclusion

Has been carried out a comparative analysis of the methods implemented, for color images, using descriptor in the color. We have analyzed a series of methods and color spaces, in experiment i compared the efficacy of the following:

- space RGB quantify to 64 colors;
- space HSV quantify 166 colors;
- space l1l2l3 quantified to 64 colors.

We have chosen these transformations it is necessary that the spaces color to be: uniform, complete and natural.

Although RGB color space does not meet all of these conditions, I had to choose due to the use of the large-scale.

A study of visual search on the basis of content can be extended in multiple directions. I could not determine in which of the three spaces color analyzed efficiency is greater, by practical experiments with lifting some charts or tables for the observation performance.

The color is considered to be the most important feature of an image.

In studying methods I had in mind: quality retrieval is successfully completed, the time of the performance.

As you increase the number of relevant image returned by the application, the more will increase recall (i.e. , more and more relevant images are returned) and decreases accuracy (Whose denominator is even total number of images returned).

A method is a task best as it has the graph is furthest from the origin, or has the value of precision greater than to a specific value of the parameter redial.

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