

# Images retrieval using wavelets, histograms and sub images

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**Abstract.** In this paper are presented three methods of images retrieval through the Daubechies 4 Wavelet Transform in the color space RGB; two of global characteristics, which they are: 1. - Extraction Wavelet Coefficients of the all images, 2. - Extraction Wavelet Coefficients of the histogram of a circular window circumscribed in the image; and one of local characteristics, 3. - Extraction Wavelet Coefficients of sub images histograms disjoints distributed of uniform way in the entire image. It is presented the system that contains the three methods and the results upon proving with different data bases of images.

## 1. Introduction

The information processing often involves the recognition, storage and visual information retrieval.

It is conceived that an image contains visual information and that what is important within such information retrieval process is to return the original image or a group of images with similar information [5][8]. The images retrieval is referred to seek and recover visual information in form of images, within a collection of data bases of images, being one of their investigation areas the organization and retrieval based on the content, in color terms.

The organization and retrieval based on the content in color terms is used as a means of codification through the organization of the information of an image using the Wavelets coefficients and as technical of retrieval spatial relationships through the Euclidian distance.

### 1.1 Justification

In the article "Next generation Web searches for visual contents", of the magazine Computer [3], in their pages 46-53, is appointment that, though the objective principal of a search machine is to facilitate to find it text in the Web, in digital libraries, Intranets, on the image data bases, etc., these have few or no capacity of finding images or video.

Many user of the Web, newspaper publishers, or professional, designers of site Web need to find images using few global characteristics. With hundred of million of sites to seek and with 73 percent of the Web devoted to images, to find it the necessary exact image can be a task very complex.

As is observed, this investigation line is important, since the relevancy of the problem bases in the great quantity of existing visual information in the Web, the which is not structured.

For the foregoing, in the development of a methodology for the images retrieval in banks of image data bases, it must be made emphasize, first in the estructuraton of the images space, and second in the information technologies to use in the retrieval process given a query image.

## **2. Methodology**

Due to the fact that the images in a data base of images can have different formats and different sizes, it should be to normalize the scale so that the comparison between images will be possible. The only one purpose to normalize images scales is to make possible the use of the Wavelet transform and with this to normalize the characteristic vectors. The images can be normalized to any size, where the length of each side is a power of two [9], for example 256.

In the process of normalizing images scales, is made a sampling of the entry image overlapping a grid, for example of 256 x 256 points. This gives a point of the grid by each pixel in the exit image. The entry image is sampled in each point of the grid to determine the colors of the pixel in the exit image. When the points of the grid lie between centers of pixels, the color values of the point of the grid are determined by bilinear interpolation between the colors of adjacent pixels (both vertical and horizontally).

Is expressed the general methodology to use for the images retrieval; first is opened the size image  $n \times m$  in some graphic format from among the following: BMP, JPG, PNG and ICO; immediately it is used bilinear interpolation to normalize the picture size to 256 x 256 pixels, these common steps, are observed in the three methods, in addition to that the three use the discreet algorithm of the Wavelet transform.

### **2.1 Extraction of Wavelet Coefficients of the images (EWCI)**

It is intended indexer images by color distribution. The information of color distribution is an alternative to describe the content of an image. If is required to recognize objects as content in an image, is proposed to use Wavelet transform, to decompose the image in characteristic vectors of color distributions and to detect through these the presence of certain objects in the images [7][10].

The process of indexed applies a Daubechies 4 Wavelet transform for each one of the three-color components of the RGB space.

The Wavelet coefficients of the frequency bands more lowers, they are stored as characteristic vectors.

In the Wavelet transform matrix, the sub matrixes of the left upper corner, represent the frequency bands more lowers of the image 2-D, and the sub matrixes of the straight inferior corner represent the highest frequency bands.

Generally the frequency bands more lowers into the Wavelet transform represent configurations of objects in the images, and the highest frequency bands represent texture variations.

It is developed a indexed for color distribution using the Daubechies 4 Wavelet transform, which represents the semantics of an image, to know, the configuration of the objects and the local color variation, both represented by Daubechies 4 Wavelet coefficients.

An image file in graphic format contains samples in the dominance of the time; therefore to filter them (dominance of the frequency), is accomplished an operation of convolution. Since the Wavelet transform is a linear transformation, the transformation of a two-dimensional sign can be calculated to the convolution first in horizontal address and then in vertical address, or conversely.

It is part of a image of size 256 x 256, is applied in the horizontal address the discreet algorithm of the Wavelet transform, such be has a image size of 128 x 256, now the discreet algorithm of the Wavelet transform is applied in the vertical address to obtain a size image 128 x 128, thus from now on to obtain images of sizes 64 x 64, 32 x 32, 16 x 16, 8 x 8 and 4 x 4. This is made in the flat of three colors RGB; to obtain 16 coefficients by each color plan RGB [11].

## **2.2 Extraction of Wavelet coefficients of the histogram of a circular window (EWCHCW)**

In this method are analyzed the images in global form, seeking invariance to the rotation [1]. First is opened a window in circular form registered in the image of size 256 x 256, or rather, the diameter of the circle is of 256.

Below it is proceeded to calculate the histograms of the three colors in the flat RGB of the image in the circular window, are normalized the values of the three histograms, to proceed to apply the discreet algorithm of the Daubechies 4 Wavelet transform of 256 original values of the histograms, first of 256 to 128, of 128 to 64, of 64 to 32 and of 32 to 16, for thus to count finally on 16 wavelet coefficients in each color in the flat RGB.

## **2.3 Extraction of Wavelet Coefficients of histograms of sub images (EWCHS)**

In this method is analyzed the image through local characteristics, for something which the image of size 256 x 256 is split into sub images of size 64 x 64, covering to

all the image with 16 sub images disjoint [4][6]; of these sub images are calculated their histograms, and such be have 16 histograms of 256 values; immediately it is applied the discrete algorithm of the Daubechies 4 Wavelet transform, to obtain 256 original values, first from 256 to 128, from 128 to 64, from 64 to 32, from 32 to 16, from 16 to 8 of 8 to 4 and from 4 to 1. Finally they have to be by each sub image a wavelet coefficient; in total 16 wavelet coefficients in each color plan RGB.

## **2.4 To store processing or to consult**

To store the processing are applied the three methods described in the points 3.2, 3.3 and 3.4, for each one of the flat three of color RGB. The low-frequency coefficients of the Wavelet transform are stored as characteristic vectors, depending on the specific method [2].

To consult, the Euclidian distance between the characteristic vectors of the images previously processed and that of the query image are compared and the images with distances smaller are selected and shown as images of matching to the query image.

## **3. Tests, results and conclusions**

The tests consist of making queries through an image. It is considered to seek in the images data base 8 images that more are seemed to her visually, the user of the system determines the degree of seemed between the query image and 8 images that shows the system for each one of the three methods, determining thus the percentage of efficiency.

The three methods, sections 3.2, 3.3 and 3.4, were proven with the following bases of images data

### **3.1 Images Library of objects of the University of Columbia [12]**

It is considered 7000 images of different real objects isolated in different positions against contrasting homogeneous fund, such as those, which are observed in the figure 2.



**Fig. 1.** Some objects of the Library of the University of Columbia

Description of the test: They were accomplished 25 experiments of 10 images at random, each one of the same images data base, or rather, that the query images are found previously processed together with the rest of the images of the data base. Therefore they were analyzed 250 images obtaining the averages from the efficiency results from 25 experiments.

The final efficiency results of the three methods are shown in table No. 1, and in table No. 2 is shown the average of an experiment of 10 images of the 25; the entire value expresses how many images of the images data base are seemed of a total of 8 to the query image; table No. 3 expresses the average of 25 experiments.

**Table 1.** Final efficiency results

Extraction of Wavelet Coefficients of the images (EWCI)	0.355
Extraction of Wavelet Coefficients of the histogram of a circular window (EWCHCW)	0.575
Extraction of Wavelet Coefficients of histograms of sub images (EWCHS)	0.75

**Table 2.** Results of an experiment of the 25, in each one of the three methods

Query	EWCI	EWCHCW	EWCHS
1	1	3	5
2	2	5	6
3	1	4	5
4	2	4	6
5	3	5	5
6	2	3	6
7	3	4	6
8	1	3	7
9	2	5	6
10	3	4	8
Averages	0.25	0.5	0.75

**Table 3.** Results of 25 experiments of 10 queries in each one, of the three methods

Experiment	EWCI	%	EWCHCW	%	EWCHS	%
1	2	0.25	4	0.5	5	0.625
2	1	0.125	4	0.5	5	0.625
3	3	0.375	4	0.5	5	0.625
4	2	0.25	5	0.625	5	0.625
5	2	0.25	5	0.625	4	0.5
6	1	0.125	4	0.5	6	0.75
7	3	0.375	3	0.375	7	0.875
8	3	0.375	4	0.5	7	0.875
9	3	0.375	5	0.625	7	0.875
10	3	0.375	3	0.375	8	1.0
11	3	0.375	5	0.625	4	0.5
12	2	0.25	4	0.5	4	0.5
13	2	0.25	4	0.5	4	0.5
14	3	0.375	4	0.5	5	0.625
15	1	0.125	4	0.5	5	0.625
16	2	0.25	5	0.625	4	0.5
17	3	0.375	5	0.625	5	0.625
18	3	0.375	7	0.875	7	0.875
19	4	0.5	7	0.875	7	0.875
20	5	0.625	6	0.75	8	1.0
21	4	0.5	4	0.5	8	1.0
22	4	0.5	4	0.5	8	1.0
23	5	0.625	7	0.875	6	0.75
24	4	0.5	3	0.375	8	1.0
25	3	0.375	5	0.625	8	1.0
Averages	0.355	0.355	0.575	0.575	0.75	0.75

### 3.2 Library of planes images of Aircraft -Images.co.uk [13]

Consist of 1068 real planes images, all different mutually, as those, which are observed, in the figure 3.

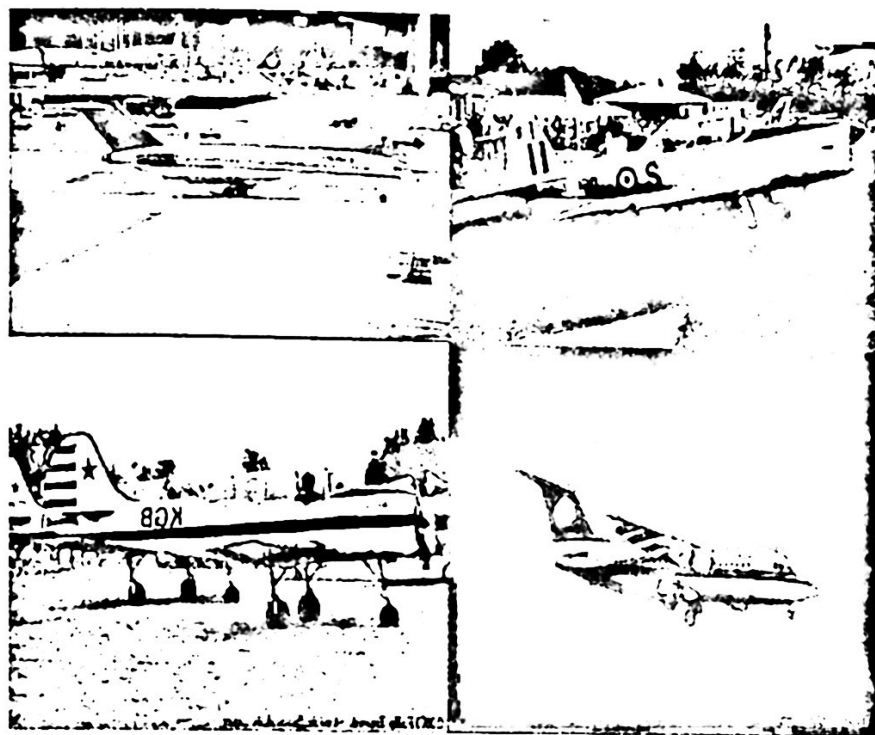


Fig. 2. Some planes of the Library Aircraft-Images.co.uk

Description of the test: They were accomplished 30 experiments of 10 images at random each one, or rather, that the query images are not found previously processed together with the rest of the images data base. Therefore they were analyzed 300 images obtaining the averages from those of the efficiency results from 30 experiments. The final efficiency results of the three methods are shown in table No. 4, and in table No. 5 is shown the average of an experiment of 10 images of 30, the entire value expresses how many images of the images data base are seemed of a total of 8 to the query image; table No. 3 expresses the average of 30 experiments.

Table 4. Final efficiency results

Extraction of Wavelet Coefficients of the images (EWCI)	0.44583
Extraction of Wavelet Coefficients of the histogram of a circular window (EWCHCW)	0.48333
Extraction of Wavelet Coefficients of histograms of sub images (EWCHS)	0.5125



**Table 5.** Results of an experiment of 30, in each one of the three methods

Query	EWCI	EWCHCW	EWCHS
1	2	2	5
2	3	5	6
3	4	5	5
4	5	2	6
5	2	5	4
6	3	4	5
7	2	5	5
8	3	4	5
9	4	5	5
10	2	3	4
Averages	0.375	0.5	0.625

**Table 6.** Results of 30 experiments of 10 queries in each one, of the three methods

Experiments	EWCI	%	EWCHCW	%	EWCHS	%
1	1	0.125	0	0.0	3	0.375
2	4	0.5	5	0.625	4	0.5
3	3	0.375	5	0.625	4	0.5
4	6	0.75	1	0.125	4	0.5
5	1	0.125	6	0.75	4	0.5
6	3	0.375	5	0.625	4	0.5
7	2	0.25	4	0.5	1	0.125
8	4	0.5	5	0.625	6	0.75
9	3	0.375	5	0.625	4	0.5
10	2	0.5	1	0.125	2	0.25
11	1	0.125	2	0.25	0	0.0
12	1	0.125	2	0.25	2	0.25
13	1	0.125	1	0.125	0	0.0
14	0	0.0	2	0.25	3	0.375
15	3	0.375	4	0.5	4	0.5
16	4	0.5	5	0.625	4	0.5
17	2	0.25	3	0.375	1	0.125
18	3	0.375	2	0.25	4	0.5
19	4	0.5	1	0.125	5	0.625
20	5	0.625	4	0.5	6	0.75
21	8	1.0	8	1.0	8	1.0
22	8	1.0	7	0.875	7	0.875
23	4	0.5	8	1.0	4	0.5
24	1	0.125	1	0.125	3	0.375
25	6	0.75	6	0.75	8	1.0
26	4	0.5	3	0.375	4	0.5
27	8	1.0	7	0.875	8	1.0



28	4	0.5	3	0.375	5	0.625
29	8	1.0	8	1.0	8	1.0
30	3	0.375	2	0.25	3	0.375
Averages	0.44583	0.44583	0.48333	0.48333	0.5125	0.5125

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