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Research Article

VALUABLE WAVELET PACKET INFORMATION TO ANALYZE COLOR IMAGES FEATURES

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ABSTRACT

Wavelet packet tree is an important way of digital signal decomposition, the calculated signal packets at various level of signal decomposition contain very important and valuable information, which can be used to describe the signal including color images. In this research paper we will take some color images, decompose them, then we select a certain packets to create a statistical parameters (features) for the color image, these features will be examined to make sure that they are unique for each color image. A histogram for each color image will be created, then the histogram will be decomposed, a certain packet will be selected to form the images features, the performance of using image histogram will be studied and analyzed, accuracy and flexibility of histogram decomposition will discussed.

INTRODUCTION

RGB color image is a 3D matrix [1], [2], [3], it is composed of 3 2D matrix, the first 2d matrix refers to the red color, the second one refers to the green color, and the third one refers to blue color, each color intensity value ranges from 0 to 255, and mixing the three colors together forms the color pixel as shown in figure 1. [4[, [5].

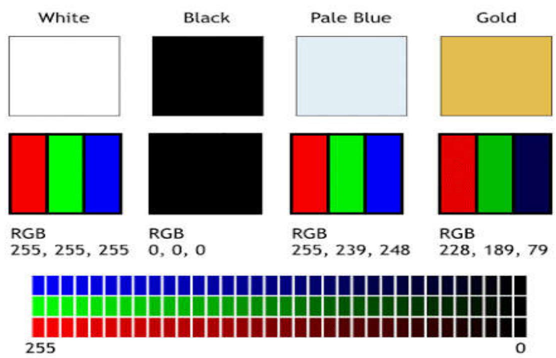

Figure 1 Creating colors with RGB pixels

Digital color images are considered to be one of the most important and widespread types of digital data, as they are used in many vital applications such as banking systems and civil and military security systems, mostly used color images have a high resolution which leads to large images sizes, so it is necessary to search for specific values that can be used as an image identifier and With it's knowledge, the image can be retrieved or identified. Table 1 gives us an idea about color images resolutions, these images will be used later in our experimental part [6], [7].

To reduce the effects of dealing with big size images, we can represent color image with a histogram, which is a one 256 elements arranged in one row matrix, each element points to the repetition of the gray value in the image, for color image we require 3 histogram [8], one for each color. The histograms can be used in the matching process, and to simplify the process of maching we can add the three histograms to form one histogram or we can reshape the original color image from 3D matrix to 2D matrix then we can use the resulting histogram for maching processes, figure 2 shows color image histograms [7], [8].

Table 1 Color image examples

Image number	Resolution(pixel)	Size(byte)
1	1678512	5035536
2	25992	77976
3	172800	518400
4	1713600	5140800
5	1442070	4326210
6	40755	122265
7	50451	151353
8	630000	1890000
9	2039752	6119256
10	50292	150876

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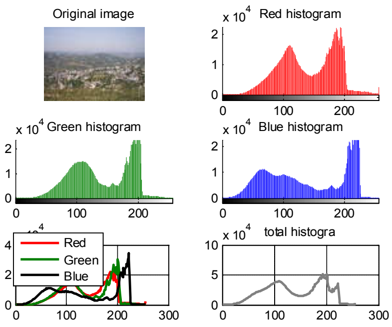

Figure 2 Color image histograms

Many methods were introduced and proposed to create color image features [9], [10], [11]. Some of these methods were based on variant calculations of local binary pattern (LBP) operators[12], [13], [14], [15] here the extacted features were unique, but the features may be changed when we rotate the image.

Some authors proposed methods based on data clustering by mean of K_means or fuzzy K_means methods of clustering [16], [17] , [18], these methods require more time to extract the features and the features are very sensitive to the image position.

Some methods were based on extracting filter coefficients using linear prediction coding (LPC) [19], [20], here the features for each digital signal were unique, but the features were subjective to change when we rotate the input color image.

To increase the efficiency of comparison systems and systems for checking the image and identifying it by reducing the time required to identify the image and take the appropriate continent [11], [12], [13], it is necessary to link the color image with an identifier or a small size group of previously retrieved properties (features) stored in a private database, that is easy to use as an input data set to computer recognition system.

To select a method of color we have to pay attention on the following [9], [11]

1. Increasing the speed of extraction of image features (properties) by reducing the time of extraction.
2. To reduce the size and number of properties as much as possible
3. The properties should be easy to handle
4. The properties of the image must be unique and not repeated for another image
5. The method should be flexible by giving the user an opportunity to specify the number of properties
6. The properties must be fixed and not change by changing the position of the image.

Wavelet packet tree

Any digital signal x[n] can be decomposed using wavelet packet tree (WPT) methods [21], [22], [23] into approximations (low pass part) and details (high pass parts), the process of signal decomposition can be repeated for a defined number of levels forming a binary tree as shown in figure 3, each generated packet at any level contains a valuable information, which can be easily used to study and analyze the signal features.

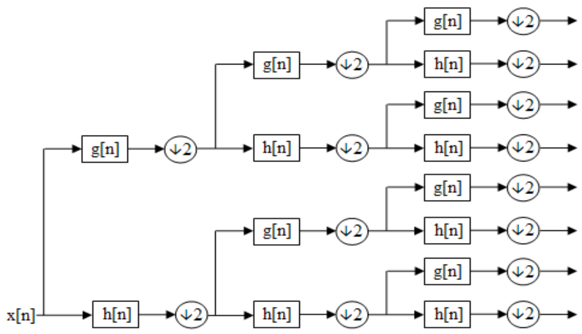

Figure 3 Digital signal approximation using WPT

The approximation packets at any level can be calculated by Haar scaling function shown in formula 1, while the detail packets at any level can be calculated using Haar wavelet function shown in formula 2, and here we have to notice the size of the approximations or/and details will be divided by 2 when we go to the next lower level:

$$\mathbf{A}_{j+1,i} = \frac{even_{j,i} + odd_{j,i}}{2} \qquad \mathbf{1}$$

$$\mathbf{D}_{j+1,i} = \frac{even_{j,i} - odd_{j,i}}{2} \qquad \mathbf{2}$$

Table 2 shows how to decompose a digital signal of 8 values:

Table 2 Signal decomposition

Level	3	-5	4	0	6	9	12	7
	Approximation A10				Details D10			
1	-2	2	7.5	9.5	4	2	-1.5	2.5
	A20		D20		A21		D20	
2	0.5	8.5	-1.5	-1	3	0.5	1	-2
	A30	D30	A31	D31	A32	D32	A33	D33
3	4.5	-4	-1.25	-0.25	1.75	1.25	-0.5	1.5

Figure 4 shows the approximation packets for image 1 histogram using 4 levels of signal decomposition:

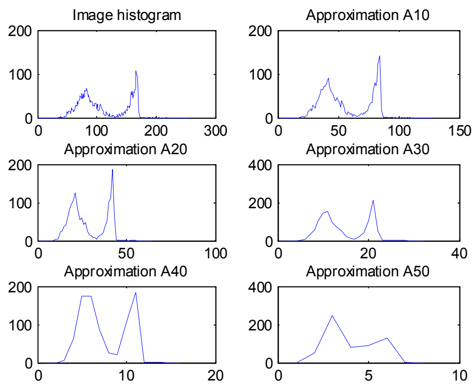

Figure 4 Decomposed image histogram

Implementation and experimental results discussion

In this part we arrange the implemented experiments into 2 groups in order to study and analyze the image properties, and select the best way of using image decomposition to create image features:

Group 1: Dealing with the image as an input of the process of decomposition

To decompose color image we have to follow the following steps

1. Get the color image.
2. Reshape the image into 1 row matrix.
3. Select the level of decomposition, here we select 12, and the calculated approximation packets at levels 12, 11, 10 and 9 will be used to form statistical features of the image, here for example we will use the average.
4. Apply decomposition with the selected level of decomposition.

Table 3 shows the results of implementation this group of experiments

Table 3 Packets averages

Image	A12	A11	A10	A9	Calculation time(seconds)
1	3167.8	4479.9	6335.5	8958.7	1.002
2	4826	6826	9659	13673	0.112
3	1954.1	2762.8	3905.1	5522.6	0.192
4	2297.0	3248.2	4593.1	6494.1	1.0
5	2889.2	4085.9	5778.0	8170.4	0.876
6	2362.5	3340.8	4724.6	6681.6	0.122
7	1984.3	2806.3	3968.7	5612.6	0.126
8	3089.1	4368.6	6178.2	8731.4	0.45
9	3082.5	4359.3	6165.0	8718.6	1.333
10	3189.8	4521.5	6394.4	9043.0	0.131
		Average			0.5344

From table 3 we can see that the averages of each set of 4 packets is unique, thus it can be used as an image identifier. The images shown in table 1 were rotated, and the previous experiment was repeated, here we got diffident values for the packets averages, this mean that using the color image as an input will create unfixed features, which can be considered as a big disadvantage.

To overcome the previous disadvantage we can use total image histogram as an input data set for the process of image decomposition.

Group 2: Using image histogram as an input

To implement this experiment we have to apply the following

1. Get the color image.
2. Calculate the total histogram to decomposed, this will decrease the decomposition time, thus will decrease the features extraction time.
3. Select the levels of decomposition, the number of extracted features will depend on the selected level number, for level 3 the number of features will equal 8, while the level 4 will generate a 4 elements features vector.
4. Apply decomposition, each level start with the approximation of the previous level..
5. Use the obtained at last level of decomposition as an image features.

The above steps were implemented using matlab, the images shown in table 1 were used in the implementation, first we set the decomposition level to 3 and we got for every image a features of 8 values, each set of values for each image was a unique, thus we can use each of the as an image identifier to retrieve or recognize the image.

The same procedures were done but with 4 levels of decomposition, table 4 shows the obtained experimental results for this stage of implementation.

The same images were taken and rotated using various degrees of rotation, table 5 shows the implementation results of this experiment (the extraction time includes the time required to calculate total histogram)

Table 4 Results of 4 levels of images decomposition

Image number	Packet A60 contents(image features)				Extraction time(seconds)
1	34.6250	229.875	155.500	0.7500	0.942
2	0.2500	1.1250	1.8750	53.7500	0.019
3	64.1250	46.2500	22.3750	2.2500	0.100
4	17.1250	284.3750	90.3750	9.7500	1.087
5	82.0000	124.6250	60.6250	100.6250	0.786
6	22.1250	32.1250	7.3750	0.2500	0.029
7	1.6250	8.5000	61.7500	3.5000	0.033
8	101.5000	63.5000	18.7500	41.2500	0.346
9	0	10.5000	411.3750	7.1250	1.124
10	0.6250	19.0000	6.3750	48.2500	0.033
		Average			0.4499
		Speedup of using histogram 1.1878			

Table 5 Results of 4 levels of rotated images decomposition

Image number	Packet A60 contents(image features)				Extraction time (seconds)
1	34.6250	229.875	155.500	0.7500	0.942
1 rotated 10 degrees	34.6250	229.875	155.500	0.7500	0.942
1 rotated 30 degrees	34.6250	229.875	155.500	0.7500	0.942
1 rotated 50 degrees	34.6250	229.875	155.500	0.7500	0.942
1 rotated 90 degrees	34.6250	229.875	155.500	0.7500	0.942
10	0.6250	19.0000	6.3750	48.2500	0.033
10 rotated 30 degrees	0.6250	19.000	6.3750	48.250	0.033
10 rotated 60 degrees	0.6250	19.000	6.3750	48.250	0.033
10 rotated 90 degrees	0.6250	19.000	6.3750	48.250	0.033
10 rotated 135 degrees	0.6250	19.000	6.3750	48.250	0.033

From the obtained experimental result shown in tables 4 and 5 we can see the following

- ✓ The proposed procedures in group 2 are efficient; the process of features extraction requires a significant small time and using histogram has a speedup greater than 1.
- ✓ The extracted features are fixed and do not change from implementation to another.
- ✓ Using image histogram instead of the image will decrease the extraction time and will fix the features even if the image was rotated, this cannot be done by other methods of features extraction.

- ✓ The proposed procedures are flexible; we can select the features size by determining the decomposition level.

CONCLUSION

Wavelet packet tree method was used to decompose color images, a set of decomposition levels were selected, the approximation packets were calculated and the contents of these packet were studied and analyzed, it was shown that we can get statistical information from approximation packets of various level of decomposition, these information can be used as an image features.

To enhance the efficiency of features extraction, and to fix the features and make them unchangeable we can use image histogram in the process of image decomposition.

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