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Efficient Methods used to Extract Color Image Features

Mohd Ashraf Zoghoul (Albalqa Applied University)
Saleh Khawatreh (Alahlyyia Amman University)
Ziad A. Alqadi (Albalqa Applied University)

Abstract: This paper produces efficient methods, which can be used to extract color image features. These features can be used as a color image key or signature to retrieve or to recognize color image. The methods will be tested and implemented and the extracted features will be passed to artificial neural network for color image recognition. The experimental results of the introduced methods will be compared in order to select the optimal method, which provides the highest efficiency.

Keywords: Image features, LBP, CSLBP, RLBP, Extreme, speed up.

1- Introduction

Digital color image is a 3D matrix, one dimension for each of the three colors (Red, Green, and Blue) which forms a 2D dimensional matrix for each color as shown in figure (1) [1, 2].

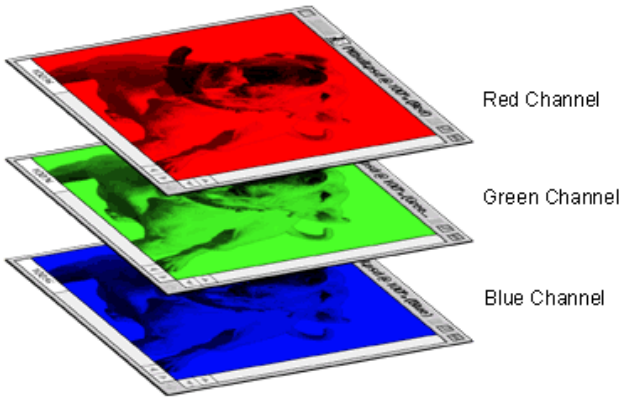

Figure (1): Color image.

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Color image can be represented by 3 histograms, each of them is an array of 256 entries, and each entry points to the number of repetition of intensity value which is equal to the array index [3, 4, and 5]. Table (1) shows samples of these histograms for peppers.png color image, while figure (2) shows a color image with the colors histograms.

Table (1): Histograms samples

Intensity value	Repetition of red intensity	Repetition of green intensity	Repetition of blue intensity
100	671	628	298
101	682	600	278
102	675	607	232
103	684	591	215
104	683	626	247
105	647	548	245
106	689	563	260
107	690	481	226
108	674	551	241
109	709	567	228
110	615	553	225
111	631	539	246
112	616	527	205
113	599	525	205
114	601	491	229
115	611	530	224

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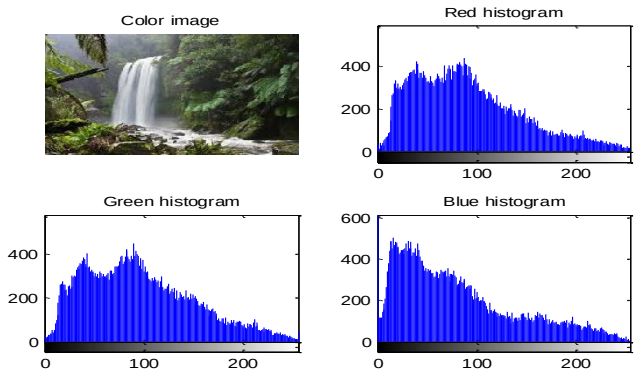

Figure (2): Color image and colors histogram

Histogram method can be used to create color image features [5, 6, and 8] but this method has a lot of the following disadvantages if we want to use the feature for color image recognition:

- Three features array are needed, one for each color.
- Each feature array is big in size (256 elements).
- The architecture of artificial neural network needed to recognize the image is sophisticated and has an input layer with 768 neurons (256*3) [13, 14, and 15].
- High time for feature extraction, and high time for image recognition [16], and this will lead to poor efficiency of the recognition system.

Another method is now used for image feature extraction, this method is called local binary pattern (LBP), [7, 9], which is based on calculating LBP operators as shown in figure (3) (for each pixel).

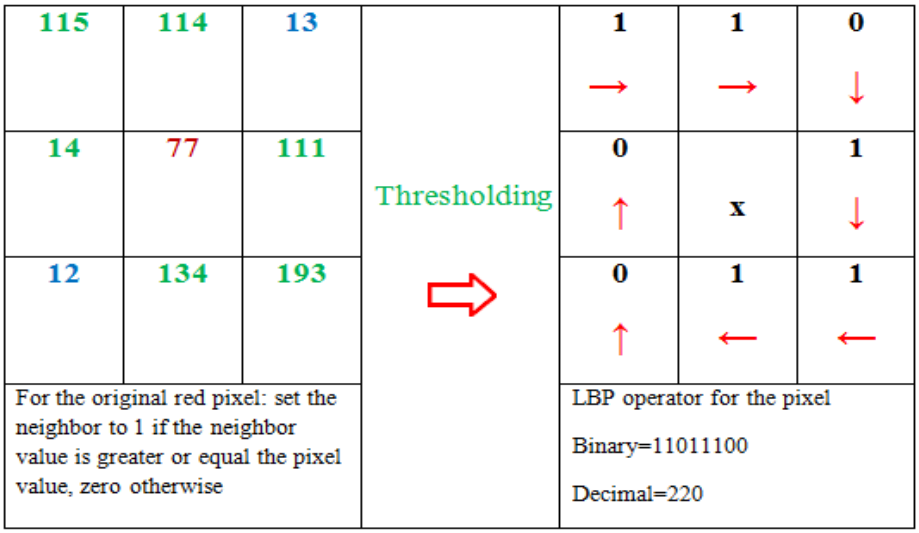

Figure (3): Calculating LBP operator

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LBP method creates a 256 entry feature array for each color and suffer from the same mentioned above disadvantages, thus we cannot recommend this method for color image recognition.

A version of LBP method is Centre-symmetric local binary patterns (CSLBP), which creates a feature array of 16 elements [10, 11, and 12] (see figure (4)). Using this method can minimize the negative effects of the above mentioned disadvantages, but the feature array size still not small, so we have to seek a better method for color image feature extraction.

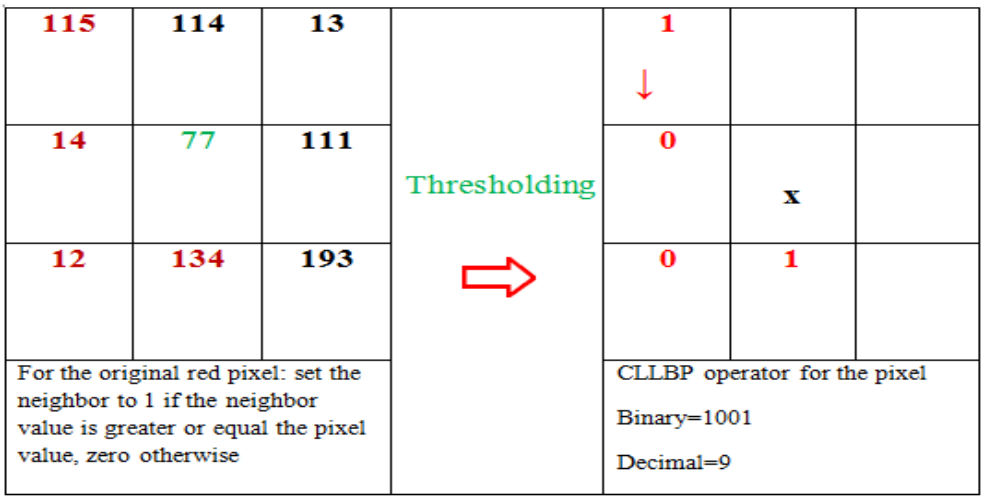

Figure (4): Calculating CSLBP operator

2- Proposed Methods

Method 1: Reduced LBP (RLBP) method

This method uses the idea used in LBP and CSLBP methods and based on the neighbor pixels to calculate the feature, but it reduces the number of entries in the color image feature array to 4 and it can be implemented applying the following steps:

1) Get the color image.

2) Reshape the 3D color image to 2D image.

3) Initialize the feature array to zero(F(1:4)-0).

4) For each pixel (P(i, j)) in the 2D image do the following:

   A. Calculate a threshold value T as follows:

$$T = (P(i,j+1) + P(i+1, j)+P(i,j-1)+P(i-1,j)+P(i+1,j+1)+P(i+1,j-1)+ P(i-1, j-1)+P(i-1,j+1)-8*P(i,j))/9;$$

   B. Calculate the logical variables a and b as follows:

$$a = ((P(i,j+1) + P(i+1, j)-P(i,j-1)-P(i-1,j) > T));$$
$$b = ((P(i+1,j+1)+P(i+1,j-1) - P(i-1, j-1)-P(i-1,j+1) > T));$$

   C. Find the index of F(I=a+b*2).

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D. Increment the array index by 1(F(I)=F(I)+1)

5) Save F in an input data set which can be passed to ANN.

Method 2: Extreme points method (EPM)

This proposed method is based on finding the edges of the image (local extremes), and it uses the magnitude of the gradient to calculate the extremes, which are used here to create the image features [17].
Local extreme for each pixel can be calculated as shown in figure (5):

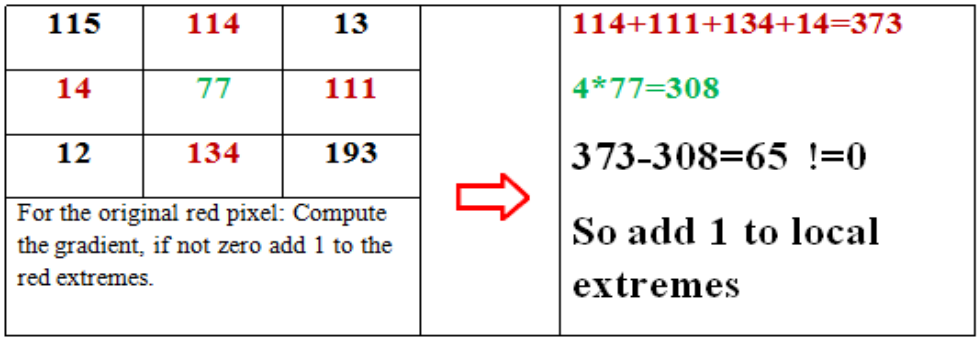

Figure (5): Calculating local extreme

For each color, summation the local extremes gives the color feature, thus we reduce the color image features to 3.

This method can be implemented applying the following steps:

1) Get the color image.
2) Extract the red, green, and blue components.
3) For each component initializes extreme counter to zero.
4) For each pixel in each component calculate the gradient as shown in figure (5).
5) If the gradient not equal zero add 1 to the local extreme.
6) Save the local extremes as a color image features.

3- Implementation and Results Discussion

The suggested above two methods were implemented using different color images.

The results of implementing the proposed EPM method are shown in table (2), while the results of implementing RLBP method using the same images are shown in table (3).

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Table (2): EPM results

Image #	Size	Features			Extraction time(sec)
1	384 x 512x3	17523	61386	56601	0.044843
2	770 x 1026x3	694	3219	3080	0.098481
3	168x 300x3	18904	9864	17804	0.009357
4	183x 275x3	10896	9751	14424	0.007565
5	172x 293x3	7633	3015	7589	0.006089
6	1200 x1800x3	43042	53641	67571	0.290760
7	183x275x3	12617	11661	23666	0.008232
8	1600x 2560x3	410846	424635	1263057	0.589395
9	183x275x3	15832	7805	23059	0.008587
10	1200x 800 x3	6686	13070	24840	0.120215

Table (3): RLBP method results

Image #	Features				Extraction time(sec)
1	286620	101054	96197	102629	0.100056
2	2322715	10516	9298	20863	0.338388
3	69369	24446	25023	30758	0.030078
4	66505	26886	27968	27972	0.030672
5	82765	19710	20334	26765	0.028529
6	5823396	241199	198214	206395	0.939946
7	59984	30797	28648	28648	0.030710
8	7885652	1529238	1447643	1410751	1.953460
9	51668	35708	31996	31996	0.030955
10	2713482	56928	50849	49945	0.418782

From the obtained results we can see that each method creates a unique feature array for each color image, thus this array cab be used as a signature or a key to recognize the image.

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EPM has and advantages comparing with RLBP method and these advantages can be summarized in:

- ✓ Feature array size equal 3 instead of 4 for RLBP method
- ✓ EPM is more efficient in extracting color image features and has a speed up always greater than 1 as shown in table (4).

Table (4): Speed up of EPM

Image #	EPM extraction time	RLBP extraction time	Speedup
1	0.044843	0.100056	2.2313
2	0.098481	0.338388	3.4361
3	0.009357	0.030078	3.2145
4	0.007565	0.030672	4.0545
5	0.006089	0.028529	4.6853
6	0.290760	0.939946	3.2327
7	0.008232	0.030710	3.7306
8	0.589395	1.953460	3.3143
9	0.008587	0.030955	3.6049
10	0.120215	0.418782	3.4836

Conclusion

Color image recognition systems require an efficient method of color image feature extraction method. EPM and RLBP methods for color image features extraction were proposed, tested and implemented, both methods gave a unique feature array for each color image. EPM method can be used reduce the feature array element and enhance the recognition cycle by minimizing the extraction time and minimizing ANN architecture by minimizing the number of input layer neuron to 3.

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