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Adjacent Local Binary Patterns Based on Color Space Fusion for Color Image Classification ⋆

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Abstract

In this paper, we propose an improved image feature descriptor based on Local Binary Pattern, which is called Adjacent Local Binary Patterns based on Color Space Fusion (ALBPCSF). The proposed method fuses color feature and spatial relations. ALBPCSF uses the channel values of RGB and HSV color spaces to calculate the color feature. Then the proposed method considers the spatial relations which will be combined with the color feature. Finally, an image classification system framework based on ALBPCSF is given. In order to validate the performance, our method is compared with previous methods on Corel 1000 and MIT Vision Texture datasets. The results show that our approach is superior than other methods in color image classification.

Keywords: Local Binary Pattern; Color Texture; KNN; Image Classification

1 Introduction

With the development of information technology, image has become an important information carrier on the Internet. The rapid growth of image resources has produced a need for efficient image classification techniques. Image classification is a basic problem of computer vision, which is one of the most popular research topics. The core of image classification is feature extraction, there are many algorithms for extracting features, such as gray level co-occurrence matrix [1] and Scale-invariant Feature Transform (SIFT) [2].

In recent years, an operator called Local Binary Pattern (LBP) [3] has become popular. It was initially proposed by Ojala et al. for feature extraction. As LBP operator computes simply and rapidly, it is widely used in texture classification, image retrieval, scene classification and face recognition. The original LBP operator only compares the difference between the center pixel and its neighbor pixels. The texture features extracted by original LBP is simple, as such, some

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discriminative information is lost. Therefore, we need to consider other discriminative information to improve the classification accuracy. With the development and wide application of LBP, a lot of improvements have been proposed. Ojala et al. proposed rotation invariant pattern on the basis of LBP [4]. Marko Heikkila et al. released Center Symmetric LBP (CS-LBP) [5] and reduced the dimension of LBP. Guo et al. proposed completed LBP (CLBP) [6] for texture classification. Tan et al. devised Local Ternary Pattern (LTP) [7], which is a robust method for illumination and has a great effect in face recognition. Tang et al. applied LBP to 3D face recognition [8]. Since the original LBP produces a single histogram and ignores the spatial information, R. Nosaka et al. invented Co-occurrence of Adjacent Local Binary Patterns (COALBP) [9], which considered the global structural information that may be contained in the image between the LBP pairs.

Most LBP variants focus on describing the texture feature on gray scale image, but color features are more discriminative than gray features. Using color features can be expected to effectively improve the classification results. Despite several methods have been proposed to embed color information in texture feature extraction, most of them have not considered the spatial structure of the image. But this spatial structure information provides crucial feedback in disambiguating image texture. This subsequently leads to improved classification performance.

To this end, this paper presents an improved LBP operator called Adjacent Local Binary Patterns based on Color Space Fusion (ALBPCSF) and then presents a framework for image classification. For an image, ALBPCSF uses two color spaces: RGB and HSV. It extracts the texture feature when the color feature and spatial structure relations are not separate. First, the proposed method extracts color feature from different channels of RGB and HSV spaces, then fuses them to get the $R * V$, $G * V$ and $B * V$ feature. Furthermore, on the basis of an adjacent LBP pair, ALBPCSF adds the spatial structure relations to the feature vectors. Compared with the existing improvements of LBP, ALBPCSF successfully combines color feature and spatial structure relations which makes the feature information more abundant.

The rest of this paper is arranged as follows: Section 2 introduces Local Binary Pattern. Section 3 shows the proposed method ALBPCSF. Section 4 describes the system framework of image classification based on ALBPCSF. Section 5 shows experiments and results. Then the conclusion is presented in Section 6.

2 Brief Review of LBP

Local binary pattern is a gray-scale texture operator. For an image, the LBP code is computed by comparing a pixel with its neighborhood pixels and considering the results as binary numbers. The LBP is defined as follows:

$$LBP_{P,R} = \sum_{i=0}^{P-1} s(g_i - g_c)2^i, s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \tag{1}$$

where g_c is the gray value of the center pixel, g_i is the gray value of its neighbor, P is the number of neighboring pixels, R is the radius of the neighborhood. If the coordinates of g_c are (0, 0), through the radius R, then, we can get the coordinates of g_i by $(-Rsin(2\pi i/P), Rcos(2\pi i/P))$.

For an image with the size of $N_1 \times N_2$ pixels, the dimension is 2^P and the histogram can be