ISSN 1746-7659, England, UK
Journal of Information and Computing Science
Vol. 12, No. 1, 2017, *pp*. 041-051

Multi-scale logarithmic difference face recognition based on local binary pattern

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(Received November 14, 2016, accepted December 17, 2016)

Abstract. In order to solve the problem that face recognition is sensitive to illumination variation and local binary pattern has small spatial support region. A novel face recognition approach which is multi-scale logarithmic difference face recognition based on local binary pattern is proposed. Firstly, LBP operator is used to extract the texture feature of the face. Secondly, the LBP feature is used to extract the light invariant based on the Lambertian reflection model. Then, the light invariant is used to obtain the multi-scale features according to the different distances, and the refined feature-map is obtained by the linear combination of multi-scale features. Finally, face recognition is performed using refined feature-map. Extension experiments on four data sets (Yale, FERET, ORL and MUI PIE) show that the proposed method which compares to LBP, MSLDE and Gradientface in different illumination conditions can improve the recognition performance.

Keywords: Local binary pattern (LBP); feature extract; face recognition; multiple scales; logarithm transform; difference.

1. Introduction

Face recognition is one of the most fundamental problems in computer vision and pattern recognition. In the past decades, it has been extensively studied because of its wide range of applications, such as automatic access control system, e-passport, criminal recognition, to name just a few [1]. In face recognition, a key problem is to find a valid description operator of face appearance. Some classical methods, such as principal component analysis and linear discriminant analysis, which are based on the whole face feature. Such methods are effective under controlled conditions. However, illumination variation is usually mixed with other complicated uncontrolled variations, such as expression, pose, occlusion, blurring, etc., which will lead to poor performance in face recognition.

In recent years, local feature descriptors attract much attention from researchers. Local binary patterns (LBP) [2-7] are considered among the most computationally efficient high-performance texture features and have made significant achievements in face recognition applications. LBP [8] has emerged as one of the most prominent texture descriptors, attracting significant attention in the field of computer vision and image analysis due to their outstanding advantages: 1) ease of implementation, 2) invariance to monotonic illumination changes, and 3) low computational complexity. Although the LBP method has achieved good results in earlier experiments, it can't obtain the detailed scale and direction information, it is sensitive to the noise at the uniform region. Under the bad illumination condition, the classification performance will decrease sharply. In order to improve the performance of the LBP operator, extending LBP to local ternary mode (LTP) [9], which is more robust to illumination variation and noise. In reference [10], Center Symmetric LBP (CS-LBP) is proposed [10]. It has low dimension and strong anti-noise ability.

Although the LBP method has achieved good performance in earlier experiments, it can't obtain the detailed scale and direction information. Under the influence of strong illumination, the classification performance will decrease sharply. Studies have shown that the effects of illumination are greater than those caused by individual differences [11-12]. Lambertian reflection model is used to extract the illumination invariant, there is no complex modeling process, which is easy to achieve in real-time processing requirements. The basic idea of the Lambertian reflection model is to separate out the light components of the image and obtain the illumination invariant.

The LBP [13-15] method is very sensitive to image noise and is unable to capture macrostructure information. To best address these disadvantages, in this paper, multi-scale logarithmic difference face

recognition method based on local binary pattern is proposed. Firstly, LBP operator is used to extract the texture feature of the face. Secondly, we use logarithm difference to obtain the illumination invariant. Logarithm transform can expand the values of dark pixels and simulate the response of retina cells. In math, it can change a multiplication into an additive model, so that the difference between two neighboring pixels can eliminate light intensity. Thirdly, by dividing a neighborhood into sub-regions according to their distances to the current pixel, multiple feature-maps of different scales can be obtained. They can be modified and combined to form a robust holistic feature-map. A weight is assigned to each feature-map, controlling the importance and influence of this feature-map. A combination of all the weighted feature-maps forms the refined feature-map. Finally, the KNN classifier is used for face recognition of the refined feature map.

2. Related work

2.1. Local binary pattern

Local binary pattern (LBP) is a texture description method in gray scale. It uses the idea of structural method to analyze the characteristics of fixed window, and uses statistical method to extract the whole feature. It was proposed by Ojala et al originally. It is used to measure the local contrast of an image. The basic principle of the algorithm is to characterize the spatial structure of a local image patch by encoding the differences between the pixel value of the central point and those of its neighbors, considering only the signs to form a binary pattern. The resulting decimal value of the generated binary pattern is then used to label the given pixel. Formally, as illustrated in Fig.1.

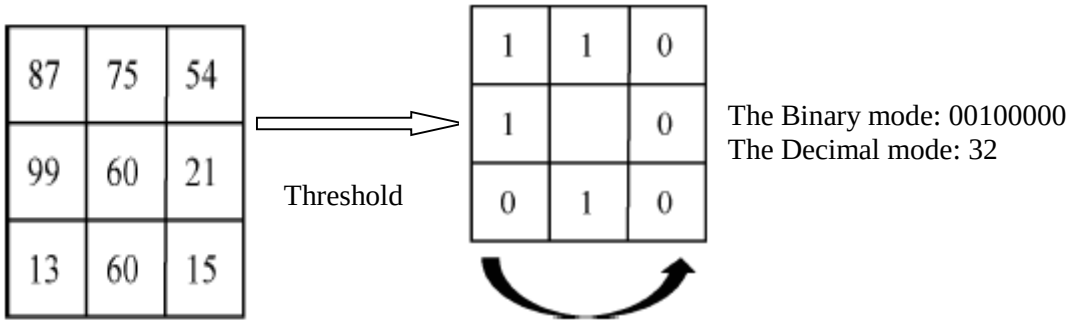

Fig.1. Examples of Raw LBP Operator Calculations

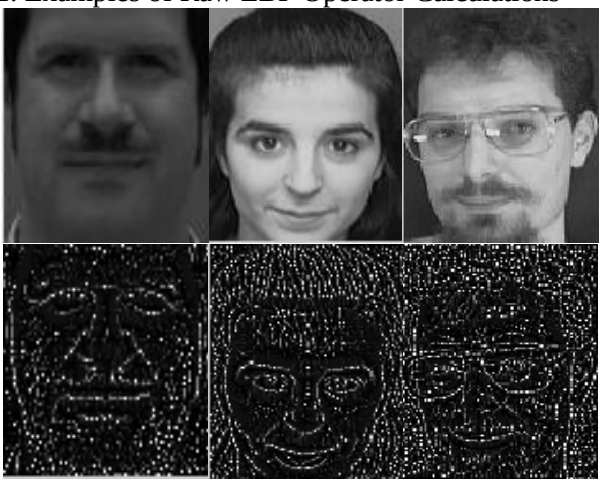

Fig.2. The first line is the original images,
the second line is LBP after transformation of the image

Consider a 3×3 window centering on point c, let the gray value of the corresponding center point is and the gray value of the neighborhood point are . Then the local binary pattern corresponding to the center on as:

$$\mathrm{LBP}(g_c) = \sum_{i=0}^{7} s(g_i - g_c)2^i. \quad (1)$$