Effective and Fast Face Recognition System Using Complementary OC-LBP and HOG Feature Descriptors With SVM Classifier

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ABSTRACT

Selection and implementation of a face descriptor that is both discriminative and computationally efficient is crucial. Local Binary Patterns (LBP) and Histogram of Oriented Gradients (HOG) have been proven effective for face recognition. LBPs are fast to compute and are easy to extract the texture features. OC-LBP descriptors have been proposed to reduce the dimensionality of LBP while increasing the discrimination power. HOG features capture the edge features that are invariant to rotation and light. Owing to the fact that both texture and edge information is important for face representation, this article proposes a framework to combine OC-LBP and HOG. First, OC-LBP and HOG features are extracted, normalized and fused together. Next, classification is achieved using a histogram-based chi-square, square-chord and extended-canberra metrics and SVM with a normalized chi-square kernel. Experiments on three benchmark databases: ORL, Yale and FERET show that the proposed method is fast to compute and outperforms other similar state-of-the-art methods.

KEYWORDS

Face Recognition, Histogram of Oriented Gradients, Hybrid Features, Orthogonal Combination of Local Binary Patterns, Support Vector Machine

INTRODUCTION

Face recognition offers numerous applications including authentication, access control, surveillance and human computer interaction. It has been an active research area over the past decades, but is still a challenging problem as the human face can undergo wide variations such as those due to pose, illumination, age and occlusion. Among the three steps in face recognition – face segmentation, feature extraction and classification, feature extraction is considered crucial as it ultimately governs the recognition accuracy. The feature extraction algorithm needs to possess good representative and discriminative capability, should be computationally efficient and also robust to facial variations.

Feature extraction algorithms reported in the literature are either based on global approach or local approach. Global methods extract features from the whole face image and thus, deal with the complete facial information. Some popular global methods include Eigenfaces (Turk & Pentland,
datasets.

aspect.

but exhibit two drawbacks – firstly, these are less comprehensive as they do not focus on precise details which is crucial for face representation and secondly, they are also affected by face variations. In contrast, local methods focus on image sub-regions and possess the capability to represent even the minute facial details. They also exhibit better invariance to light, pose and expression changes and thus, are being intensively explored for face identification. The widely used local face descriptors are Gabor Filters, Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG) and Scale Invariant Feature Transform (SIFT). Gabor Filters can efficiently represent the facial lines or edges and are invariant to scale and orientation (Struc, Gajsek, & Pavešić, 2009; Bhuiyan, & Liu, 2007). The main difficulty is, however, their high computational complexity. SIFT is another prominent descriptor in this category which can extract rotation invariant features but SIFT features are susceptible to light variations (Lowe, 2004; Soyle, & Demirel, 2010). In particular, LBP operator has proved to be the powerful and most successful descriptor and has been applied in numerous state-of-the-art face recognition systems (Ahonen, Hadid, & Pietikainen, 2004). It captures the texture information and represents local regions of the face efficiently by comparing each pixel with its neighboring pixels. The two most important benefits of LBP are its computational simplicity and its tolerance to monotonic illumination changes. However, the downside of the LBP descriptors is that the size of feature vector produced has high dimensionality. To address this issue, several variations of LBPs have been proposed in the literature which significantly reduce the dimensionality of the LBP feature vector (Huan, Shan, Ardebian, Wang, & Chen, 2011). Recently, a variant of LBP, orthogonal combination of local binary patterns (OC-LBP) has been proposed for image description which generates less dimensional LBP features while still maintaining the discrimination power (Zhu, Biichot, & Chen, 2013). This method, in contrast to other LBP variations, has achieved accuracy improvement of up to 5% on standard texture classification datasets.

Although, LBP features are preferred for their performance, they however cannot capture the local shape/edge information and are not robust to geometric transformations. HOGs, on the other hand can effectively represent the edges or the facial contours. These have been well applied for the problem of human detection (Dalal, & Triggs, 2005) and only recently to face recognition where they have provided with competitive results (Tan, Yang, & Ma, 2014; Salhi, Kardouchi, & Belacel, 2012; Deniz, Bueno, Salido, & Torre, 2011; Chang, Xiaoqing, & Chi, 2011; Albiol, Monzo, Martin, & Sastre, 2008). The main characteristic of HOG descriptors is that they are robust to changes in illumination, are computationally simple and invariant to geometric transformations including rotation and small displacements. Although, they can represent the edge information, they cannot capture the texture information. Moreover, their performance degrades in case the edges are noisy. LBPs, however, have the capability to filter out the noises from the image and thus, prove to be complementary in this aspect.

Considering that both texture and edge information is important for image representation, some researchers have combined these features for human detection (Wang, Han, & Yan, 2009), palm tracking (Gao, & Cao, 2012) and object localization (Zhang, Huang, Yu, & Tan, 2011). In the recent past, this fusion strategy has been tried for face recognition (Ghorbani, Targhi, & Dehshibi, 2015). This method has achieved good results but suffers from certain limitations. It is computationally slow because it is based on first detecting the facial regions before extracting the features. It combines the HOG features from different patch sizes which increases the dimensionality of the extracted feature set. Also, classification has been done using only the traditional weighted $\chi^2$-square distance metric. Thus, the study leaves a considerable research space on the detailed application of these descriptors for face recognition.
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