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Robust Local Features for Remote Face Recognition

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Abstract

In this paper, we propose a robust local descriptor for face recognition. It consists of two components, one based on a shearlet-decomposition and the other on local binary pattern (LBP). Shearlets can completely analyze the singular structures of piecewise smooth images, which is useful since singularities and irregular structures carry useful information in an underlying image. Furthermore, LBP is effective for describing the edges extracted by shearlets even when the images contain high level of noise. Experimental results using the Face Recognition Grand Challenge (FRGC) dataset show that the proposed local descriptor significantly outperforms many widely used features (e.g., Gabor and deep learning based features) when the images are corrupted by random noise, demonstrating the strong noise robustness of our approach. In addition, experimental results show promising results for two challenging datasets which have poor image quality, i.e., a remote face dataset and the Point and Shoot Face Recognition Challenge (PaSC) dataset.

***Index Terms*—robust local feature, remote face recognition**

1. Introduction

Feature descriptor is a key factor in the performance of many computer vision and pattern recognition applications. A plethora of feature descriptors has been developed to improve the performance for these applications. There are several studies that evaluate the performance of these methods, such as [41, 42]. These methods can be divided into two classes: one is learning-based deep features in supervised, weakly supervised or unsupervised way, attempting to model high-level abstractions in data by using architectures composed of multiple non-linear transformations [24]. The other one is traditional local features, nowadays often called hand-crafted features inspired by neuroscience studies, e.g., Weber local descriptor (WLD) [8], Gabor [12], scale-invariant feature transform (SIFT) [38], and local binary pattern (LBP) [43].

For learning-based deep features, a typical approach is deep learning (DL), introduced by Hinton [24]. It performs very well for hand-written digit recognition [25], face recognition [47, 48], human pose estimation [50] and object recognition [30]. The main criticism of deep learning comes from the observation that it requires tons of annotated training data. Despite the power of deep learning methods, they still lack much of the functionality needed for realizing this goal entirely [40].

For the class of hand-crafted local features, typical examples are LBP [43], Gabor [12], and SIFT [38]. These local features achieved very good performance for texture classification, face recognition and object recognition. Specifically, Ojala et al. proposed a simple but very powerful local descriptor, i.e., local binary pattern (LBP). It is one of the best performing texture descriptors and has been widely used in various applications, such as textures classification and face recognition [43]. Chen et al. developed a robust local binary pattern [9]. Zhang et al. proposed to use Gabor and LBP for face recognition [56]. Lowe introduced SIFT, which performs well for matching and recognition tasks [38].

However, one issue of feature descriptors (learning-based deep features and hand-crafted local features) is that they are not robust to the noise present in images. Vincent proposed the denoising Autoencoders (dA) to improve deep learning-based methods [51], which showed good results when the input data to the autoencoders was contaminated with noise. In this paper, we propose a local descriptor robust to noise. It is a hand-crafted local feature, which achieves good performance when the scale of the training set is not sufficient for deep learning (see Section 3 for details.). The proposed local descriptor consists of two components. One is based on the shearlet decomposition and the other on local binary patterns (LBP). Shearlets can detect the edges in images even when they have high level of noise. Furthermore, LBP is effective in describing the edges extracted by shearlets. The proposed descriptor is called LSF since it combines LBP and shearlet and the shearlet transformation is performed in the Fourier domain. Experimental results on the Face Recognition Grand Challenge (FRGC) dataset show that the proposed local descriptor significantly outperforms many widely used features (e.g., Gabor and deep learning based features) when noise is present in the images. In addition, experimental results show promising results for two challenging datasets which have poor image quality, i.e., a