

A Novel Approach for Face Recognition under Varying Illumination Conditions

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ABSTRACT

Face recognition systems are in great demand for domestic and commercial applications. A novel feature extraction approach is proposed based on TanTrigg Lower Edge Directional Patterns for robust face recognition. Histogram of Orientated Gradients is used to detect faces and the facial landmarks are localized using Ensemble of Regression Trees. The detected face is rotated based on facial landmarks using affine transformation followed by cropping and resizing. TanTrigg preprocessor is used to convert the aligned face region into an illumination invariant region for better feature extraction. Eight directional Kirsch compass masks are convolved with the preprocessed face image. Feature descriptor is extracted by dividing the TTLEDP image into several sub-regions and concatenating the histograms of all the sub-regions. Chi-square distance metric is used to match faces from the trained feature space. The experimental results prove that the proposed TTLEDP feature descriptor has better recognition rate than existing methods, overcoming the challenges like varying illumination and noise

KEYWORDS

Face Alignment, Face Detection, Feature Extraction, Feature Matching

1. INTRODUCTION

Biometrics is the key solution for large scale authentication requirements in real time. The commercial usage of video surveillance system has increased with the advent of low cost cameras. This has opened up a huge opportunity to implement complete automation of face-based authentication system. Face Recognition is a challenging task due to variations in the pose, illumination, expression, aging and occlusion. Robust face recognition system depends upon the quality of feature descriptor used in the process of feature extraction. Among all the challenge, illumination is the most important challenge that leads to failure of Face Recognition systems. Hence, a feature descriptor must be more immune to the illumination variations when compared to other challenges which are not of greater significance.

Feature descriptors are used for feature extraction and they can be classified into two categories, global and local feature descriptors. Global feature descriptor such as Principle Component Analysis (PCA), Linear Discrimination Analysis (LDA) and Independent Component Analysis (ICA) considers the entire face region for feature extraction. The use of global feature descriptors affects the face recognition accuracy when there is a change in illumination, scale and pose variation. Global feature descriptor produces better results in a controlled environment.

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Local feature descriptor divides the face region into several sub-regions and the features are extracted from all the sub-regions. The final feature vector is formed by concatenating all the sub-region features. Local Binary Pattern (LBP), Mutli-scale Block Local Binary Pattern (MBLBP), Improved Local Binary Pattern (ILBP), Center Symmetric Local Binary Pattern (CSLBP), Local Ternary Pattern (LTP), Elliptical Local Binary Pattern (ELBP), Scale Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), Local Directional Pattern (LDP), Enhanced Local Directional Pattern (EnLDP), Local Directional Pattern Variance (LDPv), Local Directional Number (LDN), Structured Local Binary Kirsch Pattern (SLBKP), Local Sign Directional Pattern (LSDP), Local Directional Texture Pattern (LDTP) and Local Edge Direction and Texture Descriptor (LEDTD) are some examples for local feature descriptor. Though many feature extraction techniques have been proposed in the last two decades, they fail to achieve better face recognition performance in the uncontrolled environments.

In this paper, a robust and discriminative feature descriptor, Tan-Trigg Lower Edge Directional Pattern (TT-LEDP) for face recognition is proposed. When illumination and noise are considered, the overall gray-scale intensity value changes but orientation of edges remains invariant. The use of edge directional feature makes the proposed TT-LEDP method robust against non-monotonic illumination variations and noise. Apart from edge directional feature, the proposed method uses the Tan-Trigg pre-processing technique for illumination invariant feature representation.

The paper is organized as follows: section 2 reviews the related previous work, section 3 presents TT-LEDP method for face recognition, section 4 compares the performance of proposed method with state of art algorithms and section 5 presents conclusion.

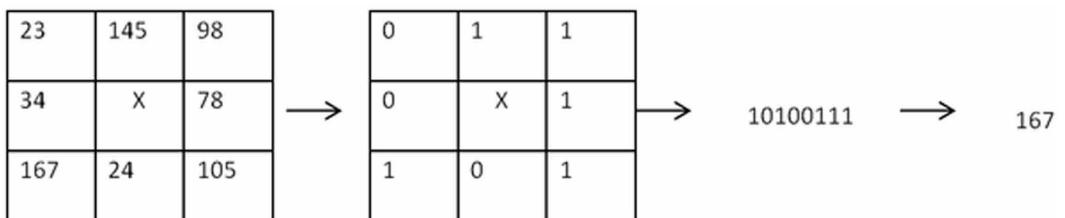
2. RELATED WORKS

The LBP, LTP, ELBP, SIFT, SURF, LDP, EnLDP, LDN methods produce illumination invariant feature representations. Timo Ahonen et al. (2006) proposed LBP algorithm for face recognition. LBP image is obtained by comparing its gray scale value with its neighbouring pixels. If the center pixel value is greater than the neighbouring pixel, then the binary value is set to 1 else 0. This binary pattern is converted to decimal value and it is assigned to LBP image. LBP image is divided into non-overlapped rectangular sub regions of size $m \times n$, feature vectors are formed by concatenating the histograms of all sub regions. The feature vectors of LBP are reduced by considering only uniform patterns. Figure 1 shows the computation LBP for a single pixel and Figure 2 shows the taxonomy of face feature descriptor.

Tan Trigg et al. (2010) proposed a face recognition technique using LTP. LTP is an extension of Local Binary Pattern (LBP) that overcomes noise related issues. In LTP, there are three scenarios which are depicted below.

1. The centre pixel value is added with a threshold (t). If it is greater than the neighbourhood pixel value, then the binary value is set to 1.

Figure 1. Computation of LBP



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