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REVIEW PAPER

FACIAL FEATURE EXTRACTION TECHNIQUES FOR FACE DETECTION: A REVIEW

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Abstract

The researches in the area of face detection have made significant progress in the past few decades. The main challenge in this stage of face detection is to find a suitable effective method for finding facial features. Sub-areas under feature extraction methods are skin color and texture based segmentation, deformable template matching, snake models, feature searching and constellation analysis. In this paper we represented a review on some important contribution in the field of feature extraction for face detection.

Keywords and phrases : face detection, skin color and texture, snake models, constellation analysis.

Introduction

Finding of dominant facial features invariant to rotation, scaling, translation, viewing angle and illumination is, however a challenging problem. Extraction of facial feature is treated as a pre-phase operation in many face related applications. Important review works on detection methods are presented in literatures [16], [29]. Most of the feature extraction algorithms are based on illumination and pose variations [17], [20], [21],[22],[23], demorphable models [19], and geometrical models [18].

In the year 1997 Jeng et al. [1] proposed an efficient face detection approach based on a geometrical face model. The detection approach simply chooses the most possible set of feature blocks and assumes only one face in the image. In 1999, Wang et al. [2] demonstrated the effectiveness of a new face detection algorithm based on shape information [26] in the images with simple or complex background. The algorithm is able to correctly detect mostly all faces in the images with simple backgrounds. Huang e. al.[3] presented a novel genetic algorithm based optimization approach for facial modeling. Terillon et al. [4] presented skin color model based comparative performance of different chrominance spaces for color segmentation. In his approach, if normalized color spaces [25] are selected for segmentation and detection, the efficiency of the segmentation needs further improvement, in order to increase bost the robustness to larger variations of illumination. In 2002 Fan and Sung [5] presented varying pose face detection and facial feature extraction from color images. The skin-color detection method quickly can locate possible face candidates even from a varying pose face model. Cascia et al. [6] proposed a fast, reliable head tracking under varying illumination. The texture map provides a stabilized view of the face that can be used for facial expression recognition. Dass and Jain et al. [7] proposed Markov Random Field Models for face detection and synthesis. Better detection results are obtained for the second-order model compared to the first-order. Bobick and Davis [8] presented a novel representation and recognition technique for identifying movements. Zhu et al. [9] proposed a discriminant analysis and adaptive wavelet feature selection method. In this method, feature selection is directly guided by error reduction. Rowley et al. [10] presented neural network-based face detection. It can detect faces rotated in the image plane by using a router network in combination with an upright face detector. Yilmaz and Gokmen [11] presented a new approach to overcome the problems in face recognition associated with illumination changes. Lai et al. [12] presented a method for holistic face representation, called spectroface. The proposed method works well on images with different facial expressions, translation, scale, occlusion, on-the-plane rotation, small rotation in depth and uniform illumination conditions. The future work can be on developing other possibility to handle like large rotation [27] in depth and non-uniform illumination conditions. Bien et al. [13] presented human face analysis with neural network-based [28] method.

Georghiades et al. [14] presented human faces recognition under variation in lighting and viewpoint. In Table 1. Some important contributions in the field of facial feature extraction methods used in face detection have been discussed.

Table 1. Some contributions in the field of facial feature extraction methods used in face detection

Research Groups	Field of Study	Contributions and Limitations
Jeng et al. [1]	Geometrical face model	Contributions: • Detect facial features, especially the eyes, even in complex backgrounds. • Can efficiently detect human facial features. • Deal with the problems caused by bad lighting condition. Limitations: • Cannot detect all faces from the cluttered images. • Multiple faces in a single image fail to detect
Wang and Tan [2]	Shape information of faces	Contributions: • Correctly detect mostly all faces in the images with simple backgrounds. • More robust to noise and shape variations. Limitations: • Cannot detect faces in very complex backgrounds. • The computational cost is high. • Cannot accurately locate faces with large rotation angles.
Ho and Huang [3]	Facial modeling from an uncalibrated face image.	Contributions: • Robust for various poses of human faces. • Two face images can obtain the better facial model than a single face image. Limitations: • The complexity of facial modeling is high.
Terillon et al. [4]	Skin color model based	Contributions: • Color segmentation based approach used in complex scene images. • Color image segmentation is computationally fast. Limitations: • Dark skin colors pose a problem of discrimination against "non-skin" colors. • The NN based model should be trained to detect also side views of faces.
Fan and Sung [5]	Varying pose face detection from color	Contributions: • Can achieve reliable face detection and feature selection under various different poses, face appearances, and lighting conditions.

	images.	Limitations: • Skin-color detectors other non face objects like hand , not only faces
Cascia and Sclaoff [6]	Head tracking under varying Illumination	Contributions: • Robust algorithm of planar face tracker Limitations: • The performance of the tracker is low in presence of high rotations.
Dass and Jain et al. [7]	Markov Random Field Models	Contributions: • Able to simulate face images from the training samples in both the face and non-face data bases. • Do not use facial features for the purpose of face detection. Limitations: • Do not significantly reduce detection error rates.
Bobick and Davis [8]	Recognition of human movement	Contributions: • Computationally feasible. Limitations: • An alternative view of a different movement projects into a temporal template with similar statistics. • Would fail when two people are in the field of view • Condition is worse when one person partially occludes another, making separation difficult.
Zhu et al. [9]	Wavelet based Feature Selection.	Contributions: • Optimize the computational complexity of the classifier. Limitations: • Processing features is relatively expensive.
Rowley et al. [10]	Neural network-based face detection	Contributions: • The system employs a router network and then uses “detector” networks. • Efficiently detects frontal faces which can be arbitrarily rotated within the image plane. • Significantly faster procedure. Limitations: • There are still a significant number of false detections and missed faces.
Yilmaz and Gokmen [11]	Eigenhill, eigenface and eigenedge	Contributions: • The goal is to describe maximum variation among faces while reducing the high-dimensional face space to a low-dimensional eigenspace. • Eigenhill has better performance compared to eigenedges, and eigenfaces. Limitations: • Edges are very sensitive to pose and orientation changes in the face. • Any change in facial expression and small rotation of the face will degrade performance.

Lai et al. [12]	Holistic face representation	Contributions: • Does not require detecting any facial features, such as eyes and mouth. • Spectroface representation does not require detecting any facial landmarks for alignment. Limitations: • Not suitable for non-uniform illumination conditions.
Park and Bien [13]	Neural network based fuzzy observer	Contributions: • A supervised learning algorithm with fuzzy observer • Simple features can be used for fuzzy measurement Limitations: • Difficulty involved in the machine implementation
Georghiades et al. [14]	Detection of faces under variation in lighting and viewpoint	Contributions: • Recognizing faces under large variations in viewpoint. Limitations: • Variable illumination but fixed pose. • Eigenfaces methods fail under extreme illumination conditions.
Turk and Pentland [15]	Detection and identification of faces using eigenfaces	Contributions: • Has high speed and simple. • Ability to adapt over time. Limitations: • Noisy image and partially occluded face causes recognition performance to degrade.

Concluding Remarks:

A brief study on the facial feature extraction used as a prephase of face detection methods have been presented in this paper. In table 1 along with the contributions in different algorithms, several limitations can also be observed.

Several difficulties still exist in case of proper selection of facial features. To distinguish faces in very complex backgrounds make the false detection rate is higher. The aim of the future algorithm needs to reduce the computational cost. Another limitation mostly observed in several detection systems is that, it cannot accurately locate faces with large rotation angles. However, if candidate regions can be identified, the angle could be included. In order to improve the rate of detection on complex backgrounds, a verification step should be added. In the future work goal of the researchers should be on reducing the complexity of facial modeling along with the facial features incorporated in model definition and fitting. The NN models should also be trained to detect also side views of faces, and its generalization ability should be increased. It is to be noted remarked that symbolic fuzzy subsets can be employed for the fuzzy observer in characterizing and representing facial features. In the coming years, we shall look forward for research publications which can overcome all limitations in the field of facial feature extraction and detection.

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