Chapter 56
Facial Image Processing in Computer Vision

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ABSTRACT

The application of computer vision in face processing remains an important research field. The aim of this chapter is to provide an up-to-date review of research efforts of computer vision scientist in facial image processing, especially in the areas of entertainment industry, surveillance, and other human computer interaction applications. To be more specific, this chapter reviews and demonstrates the techniques of visible facial analysis, regardless of specific application areas. First, the chapter makes a thorough survey and comparison of face detection techniques. It provides some demonstrations on the effect of computer vision algorithms and colour segmentation on face images. Then, it reviews the facial expression recognition from the psychological aspect (Facial Action Coding System, FACS) and from the computer animation aspect (MPEG-4 Standard). The chapter also discusses two popular existing facial feature detection techniques: Gabor feature based boosted classifiers and Active Appearance Models, and demonstrate the performance on our in-house dataset. Finally, the chapter concludes with the future challenges and future research direction of facial image processing.

INTRODUCTION

Face offers the most natural way of authenticating a person and has become a popular biometrics technique available for security (Zhang, 2000). By following the norm of the biometrics techniques, face recognition and facial expression recognition has emerged from manual process to automatic process. The evolving technology has motivated the computer vision scientists' involvement in facial analysis.

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puter vision techniques applied to facial image processing and analysis. In addition, we discuss the recent advances in facial image processing in computer vision.

First we outline some reliable face detection techniques and provide the best recommendation. For the last decade, Haar cascades technique is known as a popular face detection technique especially in real-time application. We illustrate the performance of Haar cascades and enhance its performance by pre-processed the images with skin colour segmentation. Additionally, we provide some demonstration on the effect of computer vision algorithms on face images, which exemplify but not typify the algorithms.

Secondly, we review the existing computer vision techniques in facial feature detection. To recognise the facial expression, it is crucial to detect the changes in facial features. Unlike face recognition, facial expression recognition aims to classify the expressions by finding a model for non-rigid patterns of facial expression and it is expected to perform better by using a set of image sequences. Besides, psychological points of view are well-known as important approach in facial expression analysis. Hence, computer animation scientists define the facial feature points based on MPEG-4 Standard, which is inspired by Facial Action Coding System (FACS). In computer vision, most of the researchers define a reasonable set of facial feature points in tracking the facial feature changes based on FACS or MPEG-4 Standard. Scale Invariant Feature Transform (SIFT) has gained popularity in image matching, but how well it works on face images is a question for which we need an answer. Two important benchmarks in facial feature point detection are also discussed in this chapter i.e. Gabor Feature based Boosted Classifiers and Active Appearance Models.

Finally, we conclude the chapter with some discussions in the future challenges of facial analysis and future direction of facial image processing in computer vision.

BACKGROUND

The study in facial expression has been conducted in last century (Darwin, 1872; P. Ekman, 1973), and within the past 12 years considerable progress has been made in automatic analysis of facial expression from digital video input (J.F Cohn, 2007; J.F. Cohn & Kanade, 2007; Fasel & Luettin, 2003; Tian, Cohn, & Kanade, 2005). In early research, Ekman et al (P. Ekman & Friesen, 1976) reported a new method of describing facial movement based on an anatomical analysis of facial action. To capture subtlety of human emotion and para-linguistic communication, automated recognition of fine-grained changes in facial expression is needed (Tian, Kanade, & Cohn, 2001).

Early researches in automatic analysis and recognition of facial actions from input video focused on the relatively tractable problem of posed facial actions acquired under well-controlled conditions. Recent work has progressed to spontaneous facial actions, subtle facial actions, variation in illumination and merging with synthesis faces (i.e. avatar separate identity from facial behaviour) (J.F Cohn, 2007). Computer facial expression analysis systems need to analyze the facial actions regardless of context, culture, gender, and so on. The accomplishments in psychological studies, human movement analysis, face detection, face tracking, and recognition motivate the automatic facial expression analysis (Tian, et al., 2005).

FACE DETECTION

Research in face detection generally means to detect human faces and putting them into ellipsoid or rectangle boxes. Face detection algorithms are quite reliable in or near real-time condition, however, there is much works that need to be done for detailed description of external and internal facial features (Ding & Martinez, 2008). Over the past years, researchers have developed various face detection techniques. These include:

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