Chapter 1
Face, Image, and Analysis

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ABSTRACT

Face image analysis, consisting of automatic investigation of images of (human) faces, is a hot research topic and a fruitful field. This introductory chapter discusses several aspects of the history and scope of face image analysis and provides an outline of research development publications of this domain. More prominently, different modules and some typical techniques for face image analysis are listed, explained, described, or summarized from a general technical point of view. One picture of the advancements and the front of this complex and prominent field is provided. Finally, several challenges and prominent development directions for the future are identified.

INTRODUCTION

The face is an important part of human body. Face images can be used to identify a person, to assess people’s feeling, to transmit various kinds of information, to communicate with other persons, etc. The information obtained from face images contains abundant meanings, such as the race, gender, age, health, emotion, psychology/mentation, profession, etc. Therefore, it is not surprise that researches and applications centered on face images is one of the hottest topics in information science, and even in social science. For example, face recognition stands as the most appealing biometric modality, since it is the natural mode of identification among humans and is very unobtrusive.

After long time intensive research works, together with the progress in electronic equipments and computational devices, some remarkable accomplishments in face image researches have been reported and some real applications have been accomplished. With the accumulation of the research results and application experiences, it is expected that automatic investigation of face images would be possible under various difficult
conditions in the near future and would allow people to use it in areas such as biometrics, biomedical applications, human computer interaction, human behavior and emotion study, security and surveillance system, etc.

Various image techniques have been developed to treat different images (and videos, the image sequences) these years. These techniques can be collected into three groups, (i.e., image processing (IP), image analysis (IA), and image understanding (IU)). In a structural sense, IP, IA, and IU build up three interconnected layers of image engineering (IE), a new discipline of information science.

The automatic investigation of face images is based on and evolved from a number of image techniques, such as image segmentation, object detection and object tracking, image classification, image pattern recognition, and image matching etc. According to the above classification of image techniques in image engineering, and the current research and application levels, techniques used to treat face images are mainly under the category of image analysis. Therefore, the automatic investigation of face images is often called face image analysis, though before analysis, many image processing techniques have been served in various pre-processing stages; and after analysis, some image understanding techniques might be used to further interpret the original world.

While human beings are quite good in seeing face images and picking out suitable information for making appropriate decision, the ability of automatic analysis of face images in complex scene by computers is still limited. In other words, face image analysis is a difficult problem for a computer but is relatively straightforward for a human being. This is often explained by the “fact” that the computer is quite suitable for low-level image treatments while the human brain is more preferred for high-level interpretations of scene from images. However, with the theoretical progress and the wide applications of face image analysis in the recent years, this field is undergoing great changes. A general sketch for this field and its advancements will be given in this chapter.

**BACKGROUND**

In the following, several aspects of the history and scope of face image analysis are discussed, and an outline of research developments and publications is provided.

**History and Scope**

Face of a person is often the first part perceived by other people. Related researches, especially from psychological and psychophysical point of view, have long been practiced by specialists. Using image analysis techniques to study face images, however, is only considered in recent years with the mature of image techniques. For example, automatic face recognition has been actively studied for over three decades as a means of human identification.

The communication and co-operation between scientists and engineers have put the research and applications in this field forward dramatically. Not only still face images captured in the front, with suitable lighting and without occlusion can be investigated, but also dynamic faces of different ages, different poses, with different lighting conditions, having different expressions can be analyzed.

Getting into 21 century, many techniques have been developed, and more research results have been accumulated. On the other side, the requirements for security, human-machine interaction, etc., are getting more and more attentions. All these greatly contribute to the fast progresses of the field of face image analysis.

Face images consist of large information, and the analysis on these images can provide many cues for various purposes. The scope of face image analysis includes not only face recognition,
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