

## Chapter 9

# Real World Applications: A Literature Survey

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### ABSTRACT

*The analysis of face images has been extensively applied for the recognition of individuals in several application domains. Most notably, faces not only convey information about the identity of the subject, but also a number of ancillary information, which may be equally useful to anonymously determine the characteristics of an individual. Even though the first applications of face recognition have been related to security and access control, nowadays the analysis of human faces is related to several applications including law enforcement, man-machine interaction, and robotics, just to mention a few. This chapter explores the analysis of face images.*

### INTRODUCTION

Visual perception is probably the most important sensing ability for humans to enable social interactions and general communication. As a consequence, face recognition is a fundamental skill that humans acquire early in life and which remains an integral part of our perceptual and social abilities throughout our life span (Allison, Puce, & McCarthy, 2000; Bruce & Young, 1986). Not only faces provide information about the identity of people, but also about their membership in broad demographic categories of humans (including sex, race, and age), and about their current emotional state (Hornak, Rolls, & Wade, 1996;) (Tranel, Damasio, & Damasio, 1988; Calder, Young, Rowland, Perrett, Hodges, & Etcoff, 1996; Humphreys, Donnell, & Riddoch, 1993; Calder & Young, 2005). Humans “sense” these information effortlessly and apply it to the ever-changing demands of cognitive and social interactions.

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This chapter aims to provide an overview of the most interesting applications of human face analysis and recognition. Due to space constraints this overview can not be exhaustive, yet it provides a good starting point for those who are willing to approach this challenging and fascinating technology and research field.

## **Human Face Analysis in “The Real World”**

The difficulties often encountered in the analysis of human faces stems from the high variability of the face as an object. This is due to both intrinsic and extrinsic factors. The former include the plasticity of the face itself, the motion of the facial muscles producing different facial expressions, the feeding conditions changing the fat mass, the skin hydration, the presence of aesthetic products such as facial lotion and make-up, and the pose of the head. The latter include the illumination conditions, the background and the general environment, the imaging sensor and camera, the distance of the subject from the camera.

## **APPLICATIONS RELATED TO SECURITY**

Security is possibly the application domain where face recognition systems have been most often deployed. Yet, these not always have been translated in a direct success.

### **Access Control**

From this view point, real applications can be divided into categories: cooperative and non-cooperative in terms of subject's cooperation; controlled and non-controlled in terms of setting operational environment. Cooperation of subjects is often related to the head pose issue. Cooperative face recognition applications are often designed to operate in a near distance between camera and face. The user is required to look straight to the camera with neutral expression and eyes open in order to be granted a permission or authorization, such as entering to a restricted area, withdrawing money from ATM.

In a controlled operational environment, illumination could be purposely designed and set in such a way that the face is captured with front lighting, the most favorable way for the system to perform well. The control may be designed to also constrain the head pose to be frontal. The worst case is non-cooperative user in an un-controlled setting, in which paramount difficulties and challenges present to face recognition applications systems.

Access control and in a similar operational manner, time attendance, is a near distance type of cooperative and controlled applications of face recognition. Such a system is placed in a convenient location and designed easy to use, and the illumination is set the best way as possible. The user is required to face to the camera and he or she is willing to do so. Technically the least challenging, this is therefore the basic of all types. Such an application can be in either one-to-one verification or one-to-many identification.

Figure 1 illustrates the applications of face verification at the 2008 Beijing Olympic Games. This system verifies the identity of a ticket holder (spectator) at entrances to the National Stadium (Bird's Nest). Each ticket is associated with a unique ID number, and the ticket holder is required to submit his registration form with a two-inch ID/passport photo attached. The face photo is scanned into the system. At the entrance, the ticket is read in by an RFID reader, and the face image is captured using a video camera, which is compared with the enrollment photo scan, and the verification result is produced (Figure 2).

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