Non-Cooperative Facial Biometric Identification Systems

Carlos M. Travieso González
University of Las Palmas de Gran Canaria, Spain

Aythami Morales Moreno
University of Las Palmas de Gran Canaria, Spain

INTRODUCTION

The verification of identity is becoming a crucial factor in our hugely interconnected society. Questions such as "Is she really who she claims to be?", "Is this person authorized to use this facility?" are routinely being posed in a variety of scenarios ranging from issuing a driver's license to gaining entry into a country. The necessity for reliable user authentication techniques has increased in the wake of heightened concerns about security and rapid advancements in networking, communication, and mobility. Biometric systems, described as the science in order to recognize an individual based on his or her physical or behavioural traits, is beginning to get acceptance as a legitimate method in order to determine an individual's identity. Nowadays, biometric systems have been deployed in various commercial, civilian, and forensic applications as a means of establishing identity.

In particular, this work presents a non-cooperative identification system based on facial biometric.

BACKGROUND

How do biological measurements qualify as being biometric? Any human physiological and/or behavioural characteristic can be used as a biometric characteristic as long as it satisfies the following requirements (Jain, Ross & Prabhakar, 2004): universality, distinctiveness, permanence, collectability.

The choice of biometric identifiers has a major impact on the performance of the system. This choice depends greatly on the intended application of the system. Currently, some of the most widely used biometrics identifiers include fingerprints (Jain, Ross & Prabhakar, 2004, pp. 43-64), hand geometry (Sanchez-Reillo, Sanchez-Avila, Gonzalez-Marcos, 2000), iris (Jain, Ross & Prabhakar, 2004, pp. 103-121), face (Jain, Ross & Prabhakar, 2004, pp. 65-86), etc...

Most biometric systems require co-operation on the part of the users in order to acquire their biometric data. Face identification, however, does not require this condition for its use, although it can be used. This is therefore its principal advantage over other biometric systems. Human face identification is an extensively studied field since the computational cost has not been turned out to be a drawback, due to the increasing importance of this kind of biometric identification in the access security to places such as airports, metros, train and bus stations. The process of facial identification incorporates two significant methods: detection (an individual from among a set) and identification (whether an individual is whom s/he claims to be).

Face detection (Young-Bum Sun, Jin-Tae Kim & Won-Hyung Lee, 2002) involves locating the human face within an image captured by a video camera and taking that face and isolating it from the other objects captured within the image.

Identification is comparing the captured face with other faces that have been saved and stored in a database. The basic underlying identification technology of facial feature identification involves either eigenfeatures (facial metrics) or eigenfaces. Within this type of study a great variety of references can be found (Discrete Cosine Transform (DCT), Karhunen-Loeve (KL) Transform, Independent Component Analysis (ICA), Principal Component Analysis (PCA), etc). The greatest advantage of a facial identification system is its non-cooperative nature as it is a system which can work independently of user co-operation.

FACIAL IDENTIFICATION SYSTEM

This article presents the two principal processes associated with face identification: face detection and face identification. However, there also exist other aspects of facial identification system to be taken into account. In the face detection module the face capturing is shown, just when the camera takes a picture or frame. The image acquisition can be carried out using RGB images, Infrared (IR) images among other formats; recently thermal images are also being used. The choice of the image format depends on its applications, lighting conditions, location (indoor or outdoor system), and the degree of security.

In the face identification module, a database can be found with the user information that must be located; therefore a supervised classification must be carried out. The parametrization submodule extracts the user features, and the classification system generates a model in order to difference our user/users versus the remainder of persons (see figure 1).

Face Detection

The challenges associated with face detection can be attributed to the following factors: Pose, presence or absence of structural components, facial expression, occlusion, image orientation, imaging conditions.

There are many closely related problems with respect to face detection. Face localization aims to determine the image position of a single face; this is a simplified detection problem with the assumption that an input image contains only one face (Lam & Yan, 1994). The goal of facial feature detection is the detection of the presence and location of features, such as eyes, nose, nostrils, eyebrow, mouth, lips, ears, etc., with the assumption that there is only one face in an image (Zhiwei, & Qiang, 2006). Face recognition or face identification compares an input image against a database and reports a match, if found (Darrell, Gordon, Harville & Woodfill, 2000). The purpose of face authentication is to verify the claim of the individual's identity in an input image (Crowley & Berard, 1997), while face tracking methods continuously estimate the location and possibly the orientation of a face in an image sequence in real time (Darrell, Gordon, Harville, & Woodfill, 2000, Zhiwei, & Qiang, 2006) (see figure 2).

Several face detection systems have been introduced (Ming-Hsuan Yang, David Kriegman & Narendra Ahuja, 2002) (Yang, Ahuja, &Kriegman, 2000). There are many existing techniques to detect faces based on a single image. The techniques for face detection with a single image were classified into three categories.

- **Knowledge Based System:** This approach depends on using rules about human facial features to detect faces. Human facial features such as two eyes that are symmetric to each other, a nose and mouth, and other distance features represent this feature set. After detecting features, a verification process is carried out to reduce false detection. This approach is good for frontal images, as is shown in figure 3. The difficulty lies in translating human knowledge into known rules and to detect faces in different poses.
  Furthermore, the surrounding environment can also pose a problem. For example, changes in light sources can add or remove shadows from a face. Therefore, many variables should be considered when designing a face detection system.

Figure 1. Block diagram for a non-cooperative facial identification