Intelligent Biometric System: A Case Study

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ABSTRACT

Biometrics is the field of technology devoted to verification or authentication of individuals using biological traits. A biometric authentication system verifies the identity of a claimant based on the person’s physical attributes, such as voice, face, or fingerprints. Its application areas include security applications, forensic work, law enforcement applications, and so on. Here we have divided the work in four cases: person identification using speech features, using facial features, using fusion of speech and facial features, and finally identification using fusion of optimized speech and facial features. For all these four cases we have simulated an intelligent system using Artificial Neural Networks. The neural network model is trained by back-propagation algorithm.

Keywords: artificial neural networks; biometrics; feature extraction; facial features; fusion; speech features

INTRODUCTION

In today’s electronically wired information society, there are more and more situations which require an individual, as a user, to be verified by an electronic machine as in the case of transaction authentication on physical or virtual access control. Traditionally, these activities have mostly been conducted using ID numbers, such as a token or a password. The main problem with these numbers is that they can be used by unauthorized persons. On the other hand, biometric techniques use unique personal features of the user himself to verify the identity claimed. These techniques employ face, facial thermogram, fingerprint, hand geometry, hand vein,
iris, retinal pattern, signature, or voice print information. All these features have different degrees of uniqueness, permanence, measurability, user acceptability, performance, and robustness against circumvention (Jain & Ross, 2002; Reynolds, 2000).

A large number of commercial biometric systems are using fingerprint, face, or voice. Each modality has its advantages and drawbacks (discriminative power, complexity, robustness, etc.). One of the most important features for commercial applications is the user acceptability. Techniques based on iris or retina scan are very reliable but not well accepted by end-users. Identification through voice and face is natural and easily accepted by end-users. A lot of work has been done in the last years in the field of face and speaker recognition yielding mature techniques that can be used in applications. Automated face recognition has been witnessing a lot of activity during the last years (Bazin & Nixon, 2004; Garcia & Delakis, 2002; Wu & Zhou, 2003).

Speaker recognition is a very natural way for solving identification and verification problems. With largely available telephone networks and cheap microphones on computers, user recognition through speech becomes a natural solution. A lot of work has been done in this field and generated a certain number of applications of access control for telephone companies. Text-dependent and text-independent are the two major speaker verification techniques (de la Terra, Perindo, et al., 2005; Dellar Jr., Hansen, & Proakis, 2000; Lee & Huo, 2000; Martin & Przybocki, 2001; Sun, Liu, & Zhong, 2003; Xiang & Berger, 2003).

It has been shown that combining different biometric modalities enables to achieve better performances than techniques based on single modalities. Combining different modalities allows alleviating problems intrinsic to single modalities. The fusion algorithm, which combines the different modalities, is a very critical part of the recognition system (Fierrez-Aguilar, Ortega-Garcia, Garcia-Romero, & Gonzalez-Rodriguez, 2003; Fox, Gross, Chaza, Cohn, & Reilly, 2003; Fox & Reilly, 2003; Sanderson, 2002; Sanderson & Paliwal, 2000).

Biometric technologies were first proposed for high-security specialist applications but are now emerging as key elements in the developing electronic commerce and online systems revolution as well as for off-line and standalone security systems (Jain, Bolle, & Pankanti, 1999; Kittler, Messer, & Czyz, 2002).

A recent resurgence of interest in neural networks has resulted in a large number of parallel techniques and models for real-world applications. Neural networks are massively parallel arrays of simple processing units that can be used for computationally complex tasks such as image processing, machine vision, and computer vision. Neural network models have been applied in low-level image processing, image segmentation, clustering techniques for