

# Chapter 14

## Intelligent Biometric System Using Soft Computing Tools

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### ABSTRACT

*Biometric Systems verify 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 etc. This work presents a novel concept of applying Soft Computing Tools, namely Artificial Neural Networks and Neuro-Fuzzy System, for person identification using speech and facial features. The work is divided in four cases, which are Person Identification using speech biometrics, facial biometrics, fusion of speech and facial biometrics and finally fusion of optimized speech and facial biometrics.*

### INTRODUCTION

Soft computing is a fusion of computational techniques in computer science, machine learning and other engineering disciplines, dedicated to system solutions. It encourages the integration of soft computing techniques and tools into both everyday and

advanced applications. Techniques in soft computing are Neural networks (NN); Fuzzy systems (FS); Evolutionary computation (EC); Swarm intelligence; Ideas about probability including: Bayesian network and Chaos theory. (Frank Hoffmann et.al., 2005; R. A. Aliev et.al., 2001).

In today's electronically wired information society, it requires that an individual/user to be verified by an electronic machine as in the case of transac-

tion authentication on physical or virtual access control. ID numbers, such as a token or a password are a thing of past now as they can be used by unauthorized persons. Biometric techniques use unique personal features of the user himself/herself to verify the identity claimed. These techniques include face, facial thermogram, fingerprint, hand geometry, hand vein, gait features, iris, retinal pattern, DNA, signature, speech etc. (D.A.Reynolds, 2002; Jain & A. Ross, 2002). Initially Biometric technologies were 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. (J. Kittler et.al., 2002; Jain, R. Bolle et.al., 1999).

Many commercial biometric systems use fingerprint, face, or voice. Each modality has its advantages and drawbacks (discriminative power, complexity, robustness, etc.). User acceptability is an important criterion for commercial applications. Techniques based on iris or retina scan are very reliable but not well accepted by end-users on the other hand voice and face is natural and easily accepted by end-users. Automated face recognition has been witnessing a lot of activity during the last years. (A.I.Bazin & M.S.Nixon, 2004; C.Garcia & M.Delakis, 2002; Jianxin Wu & Zhi-Hua Zhou, 2003).

Speaker recognition is a very natural way for solving identification and verification problems. 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. (A. Martin & M.Przybocki, 2001; Angel de la Terra, Antonio M.Perindo et. al., 2005; B.Sun et.al., 2003; B.Xiang & T.berger, 2003; C.H.Lee & Q.Huo, 2000; J.R.Dellar et.al., 2000).

It has been shown that combining different biometric modalities enables to achieve better performances than techniques based on single

modalities. The *fusion* algorithm, which combines the different modalities, is a very critical part of the recognition system. (C.Sanderson & K.K.Paliwal, 2000; Conrad Sanderson, 2002; Fox et.al., 2003; Fox.N & Reilly,R.B, 2003; J. Fierrez-Aguilar et.al., 2003).

Artificial Neural Networks (ANNs) has resulted in a large number of parallel techniques and models for real-world applications. They 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 (A. P. Paplinski, 2004; B.Fasal, 2002; M.A.Arbib, 2003).

A neuro-fuzzy system is a fuzzy system that uses a learning algorithm derived from or inspired by neural network theory to determine its parameters (fuzzy sets and fuzzy rules) by processing data samples. These systems combine the advantages of fuzzy logic system, which deal with explicit knowledge that can be explained and understood, and neural networks, which deal with implicit knowledge, which can be acquired by learning (Rutkowski & Leszek, (2004); Abraham A, 2001; Jeen-Shing Wang & C. S. George Lee, 2002).

Figure 1 shows the block diagram of the complete model.

## SIMULATION MODEL

We have divided the complete simulation model in four cases:

### Speaker Identification Using Speech Features

The analog speech signal is digitized at a frequency of 16 KHz. For the accurate estimation of the speech features the sampling frequency is kept twice of the bandwidth. The spectrogram of the speech signal is shown in the Figure 2. The individual 36 words from the Hindi sentence namely

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