Abstract

Biometrics is a fast emerging technology in the recent security arena and has been employed in a number of public and private sector applications either by replacing or by supplementing the conventional knowledge and token-based mechanisms. In multibiometric system, biometric information from multiple sources is consolidated to make decision and can address certain limitations of biometric system. The goal of this thesis was to investigate the design issues of multibiometric systems, and to develop a frame work for multibiometric template protection.

The biometric modalities can be physiological characteristics (e.g. fingerprint, iris, face, palmprint etc.) and behavioral characteristics (e.g. gait, signature etc.). Presently, iris is one of the most accurate and reliable biometric used in a biometric system. In the present work, iris image is used as one of the biometric trait. Iris images are segmented using different segmentation methods. The segmented iris images are then normalized. Subsequently, features are extracted using different statistical methods *viz*. Single Value Decomposition (SVD), Principal Component Analysis (PCA), Automatic Feature Extraction (AFE) and Independent Component Analysis (ICA) and a Discrete Wavelet Transform (DWT). The extracted iris patterns are classified using a Feedforward Backpropagation Neural Network (BPNN) and Support Vector Machines (SVM) with Radial Basis Function (RBF) kernel and, a comparative study of the performance of the feature extraction methods and classifiers is made over the CASIA-IrisVI database. The study demonstrates that ICA is the most appropriate feature extraction method, and running time of SVM with RBF is less than that of BPNN for the considered CASIA-IrisVI dataset. The iris patterns obtained with the ICA feature extraction method are employed in the multibiometrics experimentations.

In multibiometrics, information from the multiple sources is combined at various levels and fusion at score level is the most commonly employed fusion method. A new match scores fusion approach based on interval type-2 fuzzy integral (IT2-FI) in multibiometric system is proposed. The performance of the proposed approach is evaluated in multiple classifier biometric system and multimodal biometric system.

In the multiple classifier biometric system, the iris patterns are classified using three different classifiers *viz*. fuzzy k-NN and two neural networks, BPNN-1 and BPNN-2, with *logsig* and *tansig* transfer functions respectively, and match scores are combined using the proposed IT2-FI fusion approach. In the multimodal biometric system, match scores of three biometric systems i.e. fingerprint and signature match scores are taken from the MCYT-score database, and iris match scores are the match scores generated by the BPNN-1 classifier for the iris patterns. The match scores of the biometric systems are combined using the proposed IT2-FI fusion approach. The experimental results demonstrate that the proposed IT2-FI outperforms the other fusion methods *viz*. sum rule, max-rule, product-rule and type-1 fuzzy integral in terms of EER and FRR in the multiple classifier biometric system as well as the multimodal biometric system.

To address the security issue of biometric template in multibiometric systems, a cancelable multibiometric with tokenized random number is proposed. Multibiometric templates are generated by combining iris and fingerprint patterns at feature level. The proposed cancelable multibiometric (CMB) is formed by transforming multibiometric template using tokenized pseudo-random number. The cancelable multibiometric templates are classified using SVM with RBF kernel and its performance is compared with base BioHashing in terms of EER and FRR at zero FAR. The study is extended in stolen-biometric and stolen-key scenarios. From the experimental result, it is observed that the proposed CMB outperforms the base BioHashing in the multi-algorithm approach as well as the multimodal approach.

The investigation and experimentations carried out in this thesis demonstrate that the proposed interval type-2 fuzzy integral (IT2-FI) can be successfully applied as score fusion method in multibiometric systems and may further be applied to multibiometric systems with different kinds of biometric representations, thus increasing the general applicability of the techniques presented in this thesis. A framework for cancelable multibiometric template security has been proposed in order to overcome some privacy issues about the management of biometric data, aiming to use a biometric trait to identify individuals.

Keywords: Multibiometric, Fuzzy Integral, Score Fusion, Cancelable Multibiometrics, BioHashing