ABSTRACT

Biometric system is essentially a pattern recognition system that verifies a person based on the features extracted from his/her physiological or behavioral characteristics. Generally a biometric system performs four distinct tasks, namely preprocessing of sensor images, feature extraction, feature matching and decision making to provide person authentication. Any biometric should possess characteristics such as universality, uniqueness, permanence, collectability and acceptability to persons involved. However all these characteristics put together may not be present in every biometric. This fact has led to significant research in multi biometric systems, which rely on fusing information from multiple biometric scores (similar or diverse biometrics) resulting in higher reliability. Nowadays, these biometric systems play a significant role in a lot of security related applications. Combined with technological advances, the increased concern towards security has created a boost to intelligent person authentication systems.

In this regard, this research work first proposes procedural improvements for feature extraction in unimodal biometric authentication systems based on iris, retina and ear. Secondly, different score normalization and fusion schemes by making use of multiple snapshots / multiple units / multiple biometries are implemented which are expected to contribute further towards improved intelligent authentication systems. Five different multimodal biometric systems are developed based on the fusion of various combinations of the traits iris, retina, ear, palm print
and fingerprint. Images of these traits are obtained from publicly available biometric databases and performance of the proposed biometric systems are evaluated using measures like Genuine Acceptance Rate (GAR), False Acceptance Rate (FAR), False Rejection Rate (FRR) and Equal Error Rate (EER).

The proposed iris based authentication system first performs localization of iris region by masking eyelids, eyelashes and reflections. The features are extracted by making use of the consistent bits from middle portion of the iris code, excluding the inconsistent bits at the two ends (referring to pupil and limbic boundaries). The selected iris region is normalized into a rectangular block with constant dimensions to account for any imaging inconsistencies. Finally, Hamming distance between the encoded iris templates is computed and based on the scores obtained, persons are either authenticated or rejected. As this method uses only 2/3 of the bits of the original iris code, the computation time (matching of irises) is found to be reduced by 50%, and hence it can be a good choice for applications requiring faster response. In order to enhance the system performance further, a multi-unit iris recognition system is proposed that uses left and right irises of users. Score level fusion of hamming distances obtained from both irises show good enhancement in the recognition rate compared to that of either left or right iris alone.

Next, authentication based on retina is considered which is relatively a new approach compared to other biometrics and it involves blood vessel segmentation, feature points generation and matching of these points. Sometimes
retinal blood vessels may suffer from deformations like translational and rotational displacements that may occur due to eye movement or strain during image acquisition. Hence a new feature extraction method is proposed to deal with above problems arising out of retinal pattern changes. Initially, the blood vessel pattern is segmented from a retina image and then the unique features called bifurcation points are extracted from the blood vessels. Finally, the number of matched bifurcation points between two retina patterns is used to quantify the degree of matching. The experimental results obtained show 100% recognition with images of DRIVE database.

A suitable way of finding the feature points from ear images under partial occlusion is also proposed here. This is based on a geometric approach that is both scale and rotation-invariant. As occlusion due to hair and ear rings significantly affect the top and bottom portions of ear, only the middle portion is considered in this work. The method involves two stages of feature extraction from the cropped mid portion of ear, first by using outer edges and then inner edges. The pattern distance scores computed from the two stages are then combined into a final score by using weighted sum fusion. Results show an increase in the recognition rate that signifies the presence of highly unique features in the middle part of ear. In addition, the computation time reduces by 40% as size of the ear image used is 2/3 of the original size.
Five different multimodal biometric systems are implemented by employing existing and proposed score normalization and fusion techniques and their relative performance is compared with respect to accuracy and error rate. In order to perform score fusion effectively, normalization is required as the scores obtained from different biometrics may be in different numerical ranges. It is found that fusion of more traits in one system increases recognition rate and decreases error rate, but this raises the complexity of the biometric system. It is found possible to strike at an optimal number of traits maximizing the performance of a system while keeping its complexity within limits. It has been observed that the combination of normalization and fusion methods chosen has a significant impact on the resulting performance, irrespective of the number of traits involved. In addition, the selection of right threshold plays a crucial role in a biometric system. An optimization approach based on PSO is proposed for the proper selection of this threshold and it has been tried out in a multimodal system based on iris and palm print. The experimental results obtained show that threshold optimization improves accuracy of the system. Overall, this research work develops the basis for efficient biometric systems for providing secured access to resources.