ABSTRACT

The research work titled “Robust and Computationally efficient framework for human recognition using Ear Biometrics” is focused on the development of a robust and computationally efficient human recognition system using ear biometrics by extracting robust Unique Mapped Real Transform (UMRT) texture features, Shape features and Histogram features from ear modalities. Human recognition can be successfully performed using several life science metrics in our day-to-day life with the help of recent state-of-art techniques in human recognition. Biometrics deals with human recognition using computational life science measurements and the deployment of biometrics has become the most common and the indispensable part of our diversified day-to-day affairs. Due to the advances in biometrics technology, the inappropriate use of debit or credit cards in commercial applications as well as impersonation at airports, train stations and that at polling stations during elections can be drastically reduced. During few sensitive and challenging scenarios, harmless authenticated users have to claim their identities against malicious, impersonating users. Such difficulties faced by public during invasive acquisition can be reduced by deploying non-invasive acquisition of biometric modalities.

Modern biometric systems have already started deploying non-invasive biometric recognition systems by acquiring biometric modalities such as face, ear, iris etc, in a non-invasive manner. The main reason for developing a non-invasive biometric system is to acquire the biometric modalities without affecting or disturbing the subject. Ear biometric modality can be acquired non-invasively without disturbing the harmless subjects or without the knowledge of suspicious subjects. Also, harmless subjects need not regret about the associated criminal stigma while registering their ear biometric modality. There has been proven research on Ear biometrics which
adds to the realism of this particular biometric for person identification and / or verification.

In the present investigation, a robust and computationally efficient human recognition technique has been proposed for ear biometric modality using a new medley of local and global features called RUSH features – Robust UMRT (Unique Mapped Real Transform) texture features, Shape features and Histogram features. The Unique Mapped Real Transform is an integer–to-integer spatial domain transform operated over sub image blocks of different sizes. The basis images in this transform consist of merely +1,-1 or 0 and the computations in UMRT transform can be regarded as spatial filtering carried out using spatial masks of different sizes where the weights in the spatial mask consists of +1,-1 or 0. UMRT transform has been successfully applied in texture analysis, pattern recognition, image enhancement, segmentation and compression. The directional nature of UMRT texture features is useful in the representation of fingerprint orientations.

UMRT and its variant called Sequency based Mapped Real Transform (SMRT) are already applied for image compression as well for the diagnosis of prostrate cancer diseases. This has led to a motivation to apply UMRT for extracting unique texture features for ear recognition. The UMRT texture features are combined with Shape features and Histogram features in a serial fashion for uniquely representing an ear biometric modality in the form of RUSH features. These features are robust to illumination changes, rotations and are also computationally simple as the UMRT features can be easily computed through integer operations. The dimensionality of the extracted features is determined by the length of UMRT features which in turn depends on the size of sub image block as well as size of the window. Optimum RUSH
features are selected by feature selection algorithm based on Genetic Algorithm and information theory.

First, the acquired ear image is preprocessed to improve its overall visual appearance. The desired ear region is segmented out from the preprocessed image using constrained Delaunay triangulation segmentation technique. Robust and computationally efficient UMRT texture descriptors, shape and histogram features are then extracted as RUSH features which uniquely represent ear images of different persons. These robust feature vectors are extracted from both training (gallery) as well as test (probe) ear images. Optimum RUSH features are selected using feature selection based on Genetic Algorithm and mutual information in such a way that the interclass variance of these features is maximized and intra class variance is minimized.

The performance of the proposed ear recognition methodology is studied by testing the GA optimized RUSH feature vectors of test (probe) ear images using KNN and simple distance based classifiers. The proposed system is tested in both identification and verification modes. Testing is carried out using IIT Delhi ear and an internal ear database images. The proposed ear recognition technique is also compared with Uniform Local Binary Pattern (ULBP), Principal Component Analysis (PCA), Local Phase Quantization (LPQ) and Binarised Statistical Image Features (BSIF) based techniques. It is clearly evident from our experiments that the proposed ear recognition methodology using a new type of features called RUSH features & Cityblock distance classifier outperforms PCA based technique in terms of Rank-one recognition rate and recognition time. Rank-one recognition rate of 94.27 % is obtained for GA optimized RUSH features. Although the GA optimized RUSH features methodology is equally good as LPQ technique in terms of Rank-one recognition rate, the recognition time of proposed
technique is 10 times less than that of ULBP and LPQ techniques. The performance of the investigated ear biometric system is studied by calculating performance measures such as Rank-one recognition rate, Verification rate and by plotting performance curves such as Receiver Operating Characteristic (ROC), Cumulative Match Characteristic (CMC) and Expected Performance Characteristic (EPC) curves.