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A Fusion Technique for the Multimodal Biometric System

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Abstract - Biometric recognition is the challenging area because security and user authentication is necessary for any login purpose. To identify a person, physiological characteristics are most widely used. This paper proposed a new fusion technique for the integration of finger knuckle print, palmprint and face biometrics. The present study concentrated on the multimodal biometric system due to its benefits. Initially the region of interest was obtained for the biometric traits. Then the features are extracted using Speeded Up Robust Features (SURF). Fusion of finger knuckle print, palmprint and face are done at score level using MeRank fusion rule. The MeRank technique uses classification result as well as matching scores of each trait. The performance of the proposed technique is evaluated and experimental results demonstrated that the fusion technique achieved 98.84% of accuracy for the multimodal biometric system.

Key words - Feature extraction, score level fusion, SURF, Multimodal system and MeRank.

I. INTRODUCTION

Biometric recognition is the reliable way to authenticate the identity of a person. Biometrics is considered as a currently ongoing research topic with many applications, regarding safety and convenience [1]. Recognizing a person with high confidence is a critical issue in various applications such as passenger clearance; e-banking, access control etc. Actually biometric recognition is based on the authenticity of a specific anatomical or behavioural characteristic possessed by the user.

In the biometric system, recognition can be done based on unimodal or multimodal. Unimodal refers to biometric authentication by means of single biometric trait. Multimodal refers to biometric authentication by means of multiple biometric traits. To recognize a user in the biometric system, initially a user should be enrolled in the system. During this process, the user biometric template or reference data can be captured. Actually biometric template means feature set of the individual user which is securely stored in the database .The template is used for matching biometrics features when an individual needs to be identified. The need for reliable user authentication techniques has significantly improved in the wake of heightened concerns about security and rapid advancement in mobility, communication and networking [2].

The fusion of multimodal biometric system can be performed at four different levels sensor level, feature level, matching score level and decision level. The fusion at match score level is the most widely used method because it easily facilitates the combination of scores from different matching systems such as face and fingerprint recognition systems [3]. Thus, we concentrate the fusion at the matching score level to integrate matching scores for the finger knuckle print, palmprint and face.

The remainder of this paper is organized as follows: Section I contains the introduction of the biometric system and the score level fusion for the multimodal system, Section II contains the related work of multimodal system, Section III contains the methodology of fusion technique and multimodal recognition system, Section IV contains the experimental results and discussion of the results and conclude the paper, by stating the conclusions, in the last section.

II. RELATED WORKS:

Geetha and Radhakrishnan [4] developed the multimodal biometric system which uses multiple biometrics and integrates information for identification. The traits used for multimodal biometric system are fingerprint and palmprint. The features were extracted from the fingerprint and palmprint using Coiflet wavelets. They employed SVM with

RBF kernel and achieved the best classification of 97.53% and a low root mean square error of 0.0524.

Aravind and Valarmathy [5] focused on score level fusion which they carried out using three categories of classifiers like, rule classifier (fuzzy classifier), lazy classifier (Naïve Bayes) and learning classifiers (ABC-NN). From the observed results, the new technique had achieved a maximum accuracy of 95%.

Archana and Bhalke [6] developed a multibiometric system with fingerprint, plamprint and iris traits. Different feature extraction algorithms were applied for every trait to obtain the features. Matching score of extracted features were calculated separately for each trait. These Matching scores of individual trait were combined together by using weighted fusion technique. The observation resulted in 95.23 % accuracy.

Kazi and Rody [7] presented a multimodal biometric system using face and signature with score level fusion. The results showed that face and signature based bimodal biometric system can improve the accuracy rate about 10%, higher than single face or signature based biometric system.

From the knowledge of related works it is understood that the multimodal will enhance the accuracy of the system and it also helps to reduce the error rate. Now a days most of the authentication system preferred to use multimodal biometric system than the unimodal system. So in this work, we are eager to introduce a new fusion technique for the multimodal biometric system.

III. PROPOSED METHOD

III.I. Multimodal Recognition System

In the proposed work, the multimodal biometric system uses face, FKP and palmprint for recognition. The block diagram of the Multimodal system is shown in Fig. 1. Initially pre-processing is needed to extract region of interest (ROI) from the images. For the feature extraction, each of these images requires localization of region of interest.

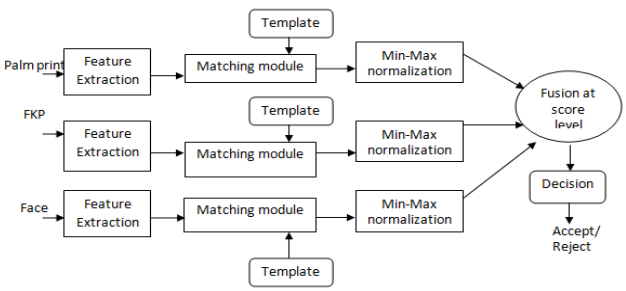

Fig. 1: The block diagram of the proposed Multimodal recognition system

Speeded up robust feature(SURF) is used to extract the local features of face, FKP and palmprint. According to Bay [8] SURF is highly distinctive invariant features. Thus, the extracted feature vectors are found to be robust to scale, distinct, robust to rotation and partially invariant to illumination. At first, SURF key-points are detected at distinctive locations in the image by Hessian matrix approximation. The second order Gaussian derivatives for Hessian matrix are approximated using box filters. Next, Key-points are localized in scale and image space by applying a non-maximum suppression in a 3x3x3 neighbourhood. Final step describes the key-points descriptor. It fixes a dominant orientation from a circular region around the interest point based on information present within that region. From the oriented square local image region around keypoint, feature vector of 64 values is computed.

In Matching process, the feature set of the query image is matched with the corresponding features of all the images in the database. The matching scores between feature vector of images is calculated by Euclidean distance. Then min-max normalization is used to normalize the matching score between the range 0 and 1. After normalization, score level fusion was made by integrating the matching score of three biometric traits. From the result of fusion technique, final decision is made to accept or to reject.

III.II METHODOLOGY OF FUSION TECHNIQUE

The designed fusion MeRank technique is shown in Fig. 2. This technique considers the result of unimodal system. The following steps are carried out for the Fusion module.

Step 1: First find the individual match score for face, FKP and palmprint respectively by using the formula

$$\text{Matching score (MS)} = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

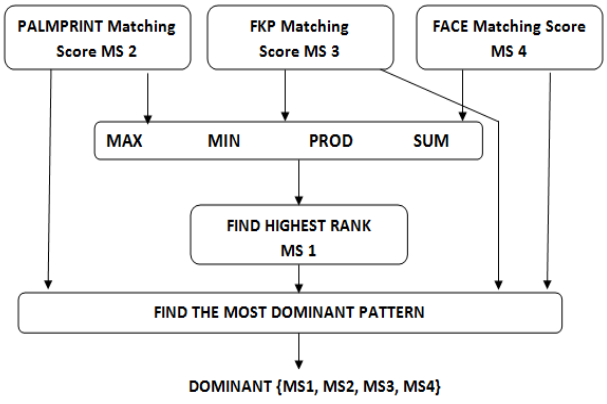

Fig. 2. Proposed MeRank technique

Step 2: Then apply any one of the fusion type (MAX , MIN, PROD and SUM) on these three match score to find the matching person based on highest rank method. The matching result obtained as M1 by using the below formula

$M1 = MAX (Palmprint_{MS}, FKP_{MS}, Face_{MS})$
$M1 = MIN (Palmprint_{MS}, FKP_{MS}, Face_{MS})$
$M1 = PROD (Palmprint_{MS}, FKP_{MS}, Face_{MS})$
$M1 = SUM (Palmprint_{MS}, FKP_{MS}, Face_{MS})$

Step 3: Based on the training and testing feature, apply SVM classifier to find the matching person based on minimum distance value for each biometric face, FKP and palmprint and obtain the matching result as M2, M3, M4 respectively.

$M2 = SVM (Palmprint_i, TPalmprint_i)$
$M3 = SVM (FKP_i, TFKP_i)$
$M4 = SVM (Face_i, TFace_i)$

Where $Palmprint_i$ – indicates trained dataset features of palmprint.
$TPalmprint_i$– indicates test dataset features of palmprint

Step 4: Then form the matrix by combining M1 and M2, M3, M4.

$$M = [M1\ M2\ M3\ M4]$$

Step 5 : Further, find the matching person based on the most dominating pattern.

$$MP = MaxVote (M)$$

IV. RESULTS AND DISCUSSION

The objective of this section was to investigate the integration of the three biometric modalities: FKP, palmprint and Face in the biometric recognition system in order to achieve a better performance that may not be achievable by using single biometric modalities.

To estimate the performance of the proposed multimodal biometric system, a database containing Face, FKP and palmprint images has been collected from the Hong Kong Polytechnic University (PolyU database [9], [10],[11]). The biometric database consists of 10 images per person for 100 persons. Accuracy is measured in terms of error rates namely false acceptance rate (FAR) and false rejection rate (FRR).

$$Accuracy (\%) = 100 - (FAR+FRR) / 2$$
$$GAR (\%) = 100 – FRR$$

The table 1 shows the performance of the fusion technique. The results illustrates that the equal error rate of MeRank-SUM achieves less value than the other fusion technique. Both False acceptance rate and false rejection rate average indicates the equal error rate.

Table 1: Performance of the fusion technique

Fusion Rule	FAR	FRR	EER
MeRank MAX	0.01	0.0179	0.0139
MeRank MIN	0.02	0.0179	0.0189
MeRank PROD	0.02	0.0119	0.0159
MeRank SUM	0.01	0.0132	0.0115

The MeRankSUM fusion obtains FAR of 0.01 and FRR of 0.0132 for 98.84% of accuracy. The error rate of MeRank fusion technique is displayed in Fig. 3. The MeRank-SUM fusion rule shows less error rate of 1.15% when compared with other technique. MeRank-MAX rule achieves 1.39% of equal error rate.

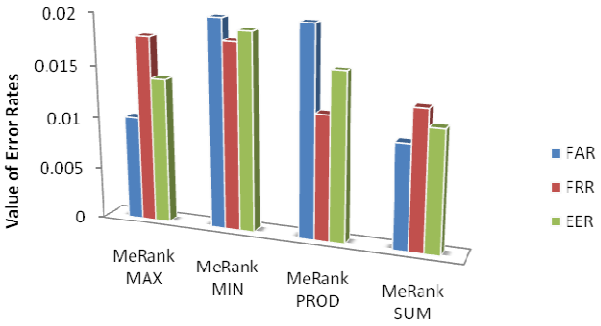

Fig 3: The error rate of MeRank fusion technique

The accuracy rate of MeRank fusion with SURF feature extraction was illustrated in Fig. 4. Among the rules studied, the SUM rule of the MeRank fusion displays 98.8421% high percentage of accuracy. MeRank-MAX rule achieves 98.60% of accuracy for the multimodal system.

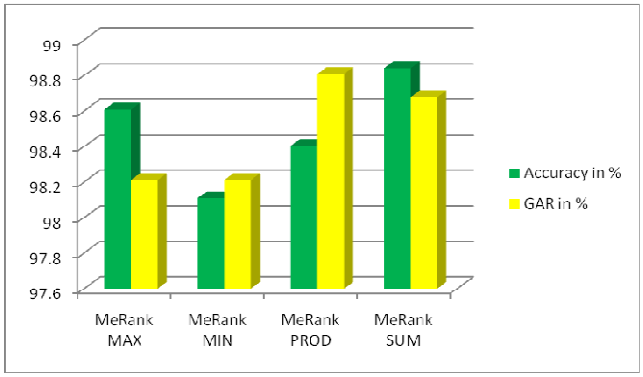

Fig 4:Accuracy and GAR of fusion Technique

The performance of the proposed system is compared with the existing system results. Geetha and Radhakrishnan [4] developed the multimodal biometric system for the integration of palmprint and fingerprint. They employed SVM with RBF kernel and achieved 97.53% of accuracy and a low root mean square error of 0.0524. Archana and Bhalke [6] developed a multibiometric system with

fingerprint, plamprint and iris traits. The matching scores of individual trait were combined together by weighted fusion technique. The result showed 95.23% of accuracy. Nageshkumar *et al.* [12] achieved accuracy of 98% for multimodal system (face and palm print).

Kazi *et al.*, [13] implemented bimodal biometric (face and signature) system and showed the accuracy rate of about 97%. Chaudhary and Nath [14] observed the GAR 92% with FAR 2% for the combination of iris, face and voice recognition.

The result of the MeRank-SUM achieved 98.8421% of accuracy and 98.68% of GAR for multimodal recognition system. The result of the MeRank fusion is better than previous work. This fusion technique improves the accuracy by 0.6% and reduces the error rate of the multimodal recognition system when compared with the result obtained by the SURF algorithm using simple fusion rules.

V. CONCLUSION

In this proposed work, we have designed a multimodal recognition system based on the fusion of FKP, palmprint and Face modalities. The Speeded up robust feature was employed for feature extraction and SVM classifier for matching process. The MeRank-SUM fusion technique improves the performance to the maximum of 98.8421% accuracy. The experimental results showed that information fusion at the matching score level improves the results of the recognition. The result of the MeRank system clearly explains the significance of multimodal biometric recognition and has the capacities to be utilised in the environments that require a high security.

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Y. Jacob Vetha Raj has been working as Associate Professor in the Department of Computer science, N.M. Christian College, Marthandam, South India., since 1990. He has completed B. E. (CS) in 1989 at National Engineering College, Tamil Nadu , Obtained M. Tech (C & IT) in 2007 and has completed Ph.D in Computer Science and Engineering in Manonmaniam Sundaranar University, Tirunelveli. He has involved in various academic activities. He has attended many national and international seminars, conferences and presented few research papers. He is a member of curriculum development committees of autonomous colleges of Tamilnadu and his area of research specialization is Image Processing.

