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Fusion based Fingerprint Recognition based on CLBP descriptor and DWT

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Abstract : *Biometric recognition presently becoming an important tool for human identification. Fusion based biometric identification is an emerging trend which leads to improved accuracy. In this paper, we propose Fusion based algorithm involving CLBP and DWT which are applied to the fingerprint images separately in order to extract the features. The extracted features are fused by concatenation in order to obtain unique features. These features are compared with the stored database for matching.*
Keywords - *Fusion, DWT, CLBP, Fingerprint, Biometric*

I. INTRODUCTION

The Biometrics is a technique, used to uniquely identify the individual persons, based on the physical characteristics or personal behaviors of individual person. The main application of this biometrics is in security. In order to authenticate the person's identity a number of different behavioral traits have been used. The behavioral characteristics includes signature, keystroke etc. The main aim is to use physical characteristics or personal behaviors traits for identifying the individual persons. The physical characteristics involve face, fingerprint, iris, signature, finger vine etc. A biometric system is a pattern recognition system which involves personal identification by determining the specific physiological or behavioral characteristic possessed by the user. A biometric system can be an identification or verification system, in which identification means determine a person's identity even without his or her knowledge, for example identifying a single person in huge crowd. Verification means confirming a person's identity, for example verifying a person in which he or she belongs to company or not. Biometrics system compares the capture biometric sample with the stored biometric sample in the database, which involves three steps (capture, process, enroll) followed by a verification or identification process. In the first step, sensing device like fingerprint scanner captures the raw biometric. Second step involves extraction and conversion of distinguishing characteristics from the biometric sample into a processed biometric identifier, and in the last phase processing of enrollment can be done. The processed sample is stored in a stored media for further compression during authentication. In fingerprint recognition technique the patterns of friction ridges, edges and valleys of an individual's fingerprints are unique to the individual persons. Fingerprints are unique for each finger of a person including for identical twins. From decades, the law of enforcement has been classifying and determining identity by matching key points of ridge endings and bifurcations. Fingerprint biometrics is one of the most commercially available biometric technologies.

II. LITERATURE SURVEY

The fusion based biometric identification system improves the recognition accuracy and performances that are required for many security applications. There are two different modularties for fingerprint and face and then combined both methods. Therefore it is considered as a multimodal approach. Features based on Gabor Wavelet Networks (GWNs) are used for face trait, and Local Binary Patterns (LBP) is used for fingerprint trait. The outputs of these two methods are fused to get final result.[1] A multimodal biometric system based on the fusion of face and fingerprint biometrics. For face recognition, uniform local binary patters algorithm is used whereas for fingerprint minutiae extraction is used. Both the algorithms are fused in order to enhance the performance and is achieved through product rule. The final identification is then performed using a nearest neighbor classifier which is fast and effective.[4] The texture feature based approach for fingerprint. Discrete wavelet Transform (DWT) is used to identify the low quality fingerprint from inked-printed images on paper. The fingerprint images which are taken from paper is very poor quality and sometimes it is very complex with fabric background. For that purpose firstly, a center point area of the fingerprint is detected and keeping the Core Point as center point, the image of size w x w is cropped. Then Gabor filtering is applied for fingerprint enhancement over the orientation image. Finally, the features of texture are extracted by analyzing the

fingerprint with Discrete Wavelet Transform (DWT) and Euclidean distance metric is used as similarity measure.[5]

An algorithm is used to identify incomplete or partial fingerprints from a large fingerprint database. The algorithm is based on analytical approach for reconstructing the global topology representation from a partial fingerprint, which includes an inverse orientation model for describing the reconstruction problem and then provide a general expression for all valid solutions to the inverse model. This allows preserving data fidelity in the existing segments while exploring missing structures in the unknown parts. Further developed algorithms for estimation the missing orientation structures based on some a priori knowledge of ridge topology features. The statistical experiments show that the model based approach can effectively reduce the number of candidates for pair wised matching of fingerprint. Thus, the model significantly improve the system retrieval performance for partial fingerprint identification.[6]

The multimodal biometrics which will give a better security and accuracy compared to unimodel biometric system. The fingerprint and palmprint images are applied for preprocessing separately in order to remove any noise. The second step is feature extraction. For fingerprint, Minutiae algorithm is used in order to extract the feature and Local Binary pattern for palmprint. In order to fuse the extracted features wavelet fusion is used and Support Vector Machine is used for matching.[9] The Multimodal biometric systems operate on two or more physiological modalities, like face, vein geometry, iris, retina and fingerprint. Multimodal biometric system improves the recognition accuracy when compared to unimodal biometric methods. Decision level is used for fusion. Each biometric result is weighted equally and participate in final decision. The combined results are obtained by using Fuzzy logic algorithm.[10] The multimodal system is used to overcome the problems such as noisy data, intra class variation, non universality, inter class similarities and spoofing which cause the system less accurate and secure. It also increases the level of security. Multimodal system makes use of multiple source of information for personal authentication.[11] A new personal identification framework that is based on the fusion of face and fingerprint biometrics. This system overcomes the limitations of face recognition system as well as fingerprint verification systems. The gray-level co-occurrence matrix and the minutiae extraction are used to represent the features of face and fingerprint image respectively. This framework uses the correlation coefficient as a similarity measure to retrieve the closest face and the corresponding fingerprint images with a query image.[12]

A modified fusion algorithm is extended version of fused based algorithm. This includes Global method and Local binary pattern. Global method gives high FMR, because test fingerprint image are of very low quality which leads to more number of noisy minutiae and noisy minutiae leads to mismatch. LBP captures local pattern of the ridges which also leads results to improve accuracy. The fusion of the Delaunay and LBP operator generates a structure with addition discriminatory features in the comparison for fingerprint matching. One local minutiae matching concept reduces the false rejection due to the triangle formed by the noisy minutiae. So the FMR is reduces but it needs local alignment so method is not fully rotation invariant. When core point is not found due to the degrade quality of fingerprint image, matching decision can be taken only from the triangle method because triangle method is given fully weightage and minutiae matching score is given less weightage.[14] Another method used for authentication purpose, in which the identification is performed using a feature level fusion method which discards the most correlated features. The intra-class correlation for different features sets should be more explored on extended biometric data sets.[17] An indexing technique, primarily for latents, that combines multiple level 1 level 2 features to filter out a large portion of the background database while maintaining the latent matching accuracy. The fusion scheme assigns the same weight to individual indexing modules for every latent. Latent examiners usually consider several features to make exclusions.[18] A fingerprint matching technique using an algorithm called a Hidden Markov Model (HMM). The features of fingerprint are extracted and matching was achieved by HMM parameters. The efficiency of matching was improved since the technique depends on orientation field which is less sensitive to noise.[19]

An algorithm to detect altered fingerprint utilizes orientation field and minutiae distribution. The case studies of incidents for altered fingerprints were investigated and classified into three major categories with possible counter measures. The technique was evaluated on large database of altered fingerprint to prove efficiency.[20] An algorithm for human recognition uses Monogenic Linear Binary Pattern. The rotation invariant measures as local phase and local surface are combined with Linear Binary Pattern Features to improve the performance accuracy.[21] A segmentation of fingerprint based on frame difference during online capturing process. The background of fingerprint is removed by using background frame difference. This technique is further used in automatic fingerprint identification system. The results proved to be effective in dealing with noise background of fingerprint image. The comparison with conventional method shows that it does not require deviation or orientation.[22] A fingerprint based authentication system uses a consecutive fingerprint images are taken, global singularities are located using directional field strength and their local orientation vector is formulated with respect to the base line of the finger. Feature level fusion is carried out and a 32 element feature template is obtained. The polygonal feature vector helps to reduce the size of the feature database from the

present 70-100 minutiae features to just 32 features and also a lower matching threshold can be fixed compared to single finger based identification.[23]A feature level fusion framework for combining features of iris and fingerprint which contain most prominent features. The algorithm uses a single multimodal template by fusing the unimodal templates based on Mohalanobis distance measure. For recognition radial basis function based neural network (RBFNN) is used which is trained using a single fused multimodal template. This algorithm is evaluated using the standard database and real database.[24]

III. PROPOSED METHOD

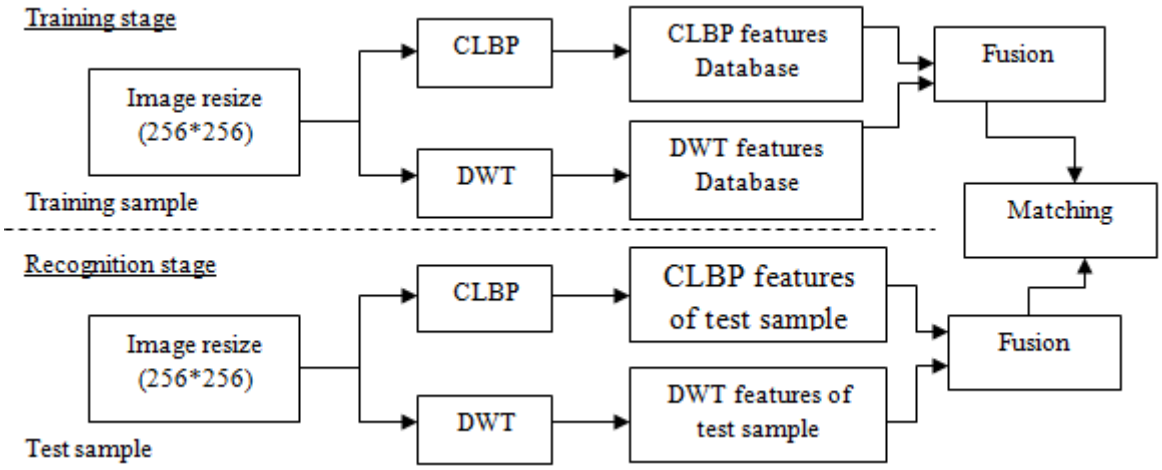

Fig 1 Block diagram for fingerprint recognition using fusion of DWT and CLBP method

The block diagram of fingerprint recognition using fusion of DWT and CLBP [25] is shown in figure 1. There are two stages in fusion based fingerprint recognition system, they are

1. Training Stage: In training stage we are taking fingerprint of 8 persons, for each person we are taking 4 different samples of fingerprint at different duration of time from FVC database. Then we are applying the CLBP and DWT separately, in order to extract the CLBP features and DWT features respectively. The extracted features are fused to increase the number of features.
2. Recognition Stage: In recognition stage we are taking 12 fingerprints of different persons from FVC database expect the 4 fingerprint image of each person which are stored in the database. For each fingerprints the CLBP and DWT algorithm are applied to extract the CLBP and DWT features. The number of features is increased by fusion of CLBP and DWT features of a fingerprint image.

Image resize:

The fingerprint images that we are taken from the FVC database are of size 300*480. These fingerprint images is resize to the size of 256*256 in order to reduce the complexity.

CLBP Algorithm:

The center pixel of every block of the image like 3x3 or 5x5 is simply coded by a binary code after global threshold, and the binary map is named as CLBP_Center (CLBP_C). The purpose is to change the image size with respect to original image of same resolution. The resized component is not so significant when compared to other two components. The operator decomposes the image local structure into two complementary components: the difference signs and the difference magnitudes. Then two operators, CLBP-Sign (CLBP_S) and CLBP-Magnitude (CLBP_M), are coded. All the three code maps, CLBP_C, CLBP_S, and CLBP_M, are in binary format so that they can be readily combined to form the final CLBP histogram. The CLBP could achieve much better rotation invariant texture classification results than conventional LBP-based schemes.

DWT algorithm:

The fingerprint images are segmented into multi resolution representation using DWT. For the verification of fingerprint two level decomposition is applied to the fingerprint image results in LL, LH, HL, and HH sub bands. Most of the fingerprint information is concentrated in the LL band; the vertical information of the fingerprint image is obtained by LH band, the horizontal information of the fingerprint image is obtained by HL band and the diagonal details of the fingerprint image is obtained HH band.

$$\text{If } x = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

$$\text{Then} \quad y = \frac{1}{2}\begin{pmatrix} a+b+c+d & a-b+c-d \\ a+b-c-d & a-b-c+d \end{pmatrix}$$

These operations results to the following filtering processes:

- Top left: a+b+c+d = 4-point average or 2-D low pass (Lo-Lo) filter, which consist the maximum information of the image.
- Top right: a−b+c−d = Average horizontal gradient or horizontal high pass and vertical low pass (Hi-Lo) filter.
- Lower left: a+b−c−d = Average vertical gradient or horizontal low pass and vertical high pass (Lo-Hi) filter.
- Lower right: a−b−c+d = Diagonal curvature or 2-D high pass (Hi-Hi) filter.

Fusion:

The features are concatenated to obtain unique features.

Matching:

The matching is performed by Euclidian distance. 2D Euclidian distance is a measure used for the matching purpose, the Euclidean distance between two point's 'p' and 'q' is defined as the length of the line segment connection the point's 'p' and 'q'. In Cartesian coordinates, if $p = (p_1, p_2, p_3 \ldots p_n)$ and $q = (q_1, q_2, q_3 \ldots q_n)$ are the two points in n-dimension, then the distance 'd' from the point 'p' to 'q' or from 'q' to 'p' is given by

$$d(p, q) = d(q, p) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2}$$

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

IV. RESULTS

The FVC2000 DB1 database is considered with nine persons with six samples per person in database for result analysis and the values of EER and TSR for CLBP, DWT and proposed model. It is observed that the values of EER are less and percentage TSR values are more in case of proposed model compared to CLBP and DWT. The performance of proposed algorithm is improved as texture features are fused with DWT features.

Table 1: Comparison of FRR, FAR and TSR of DWT, CLBP and FUSION based technique.

Technique	FRR	FAR	EER	TSR
DWT	0	1	0.75	55.556
CLBP	0	1	0.5	44.444
Fusion	0	1	0.5	88.889

The percentage EER values of proposed method are compared with existing technique presented Qinghai Gao [26] for FVC2000 DB1 Database is given in Table 2. It is observed that percentage TSR is more compared to existing method.

Table 2: Comparison of TSR between existing and proposed technique

Author	Technique	%TSR
Qinghai Gao	Minutiae based	85.7
Proposed Method	CLBP and DWT	88.89

The proposed method achieves better result compared existing. Since, the fusion of both CLBP and DWT features are considered.

V. CONCLUSION

Biometrics plays a important role in present days. This paper deals with fusion based biometrics for fingerprint image to obtain features using CLBP and DWT algorithm. The fusion method increase the performance and efficiency of biometrics in terms of TSR (Total Success Rate), FRR (False Rejection Ratio), FAR (False Acceptance Rate) .

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