Ear Recognition using Feature Fuzzy Matching

Kavitha Jaba Malar R, Joseph Raj V

*Abstract— **This paper proposes a novel method, a Fuzzy Feature Match (FFM) based on a triangle feature set to match the ear. The ear is represented by the fuzzy feature set. The fuzzy features set similarity is used to analyze the similarity among ears. Accordingly, a similarity vector pair is defined to illustrate the similarities between two ears. The FFM method shows the similarity vector pair to a normalized value which quantifies the overall image to image similarity. The algorithm has been evaluated with Computer Education and Training Society (CETS) students and staff members' ear database. Experimental results confirm that the proposed FFM based on the triangle feature set is a reliable and effective algorithm for ear matching.***

Index Terms— Extraction, Ear recognition, Fuzzy features, Matching, Similarities, Triangularization.

I. INTRODUCTION

Ear is a new class of human biometrics for physiological identification with uniqueness and permanence. Ear has information rich anatomical feature and unaffected by ageing. Its location on the side of the head makes extraction easier. Ear biometric is convenient in collecting data comparison to other technologies like retina, iris, fingerprint. The ear features and ear identification were using in forensic for more than 10 years. In the absence of fingerprint, due to lack of expression and less effect of aging, the ear biometric is suggested for the identification. The ear can be split into three parts; external, middle and inner. The external ear can be functionally and structurally split into two sections; the auricle, and the external acoustic meatus.The auricle is an external, lateral paired structure. Its function is to capture and transmit sound to the external acoustic meatus. Most of the auricle has a cartilaganious framework, with the lobule the only part not supported by cartilage. The outer curvature of the ear is called the helix**.** Moving inwards, there is another curved elevation, which is parallel to the helix known as the antihelix. The antihelix divides into two cura – the inferoanterior crus, and the superoposterior crus. In the middle of the auricle is a hollow depression**,** called the concha of auricle. It continues into the skull as the external acoustic meatus. The concha acts to direct sound into the external acoustic meatus. Immediately anterior to the start of the external acoustic meatus is an elevation of tissue – the tragus. Opposite the tragus is the antitragus. Cutaneous innervation to the skin of the auricle comes from the greater auricular, lesser occipital and branches of the facial and vagus nerves.

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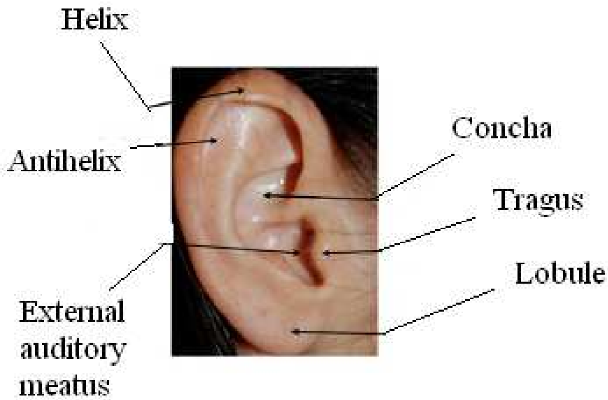

Fig. 1. Structure of an Ear

To improve the performance of biometric system, nowadays researchers prefer the uniqueness and permanence modalities for recognition on the basis of score level as well as feature level. As a permanence biometric aspect, we proposed the new view of biometric that a head based biometric on the basis of the ear.

II. RELATED WORK

Ear recognition is a non-invasive, reliable and passive biometric system used to identify the person based on the physiological characteristics.

Daramola et al [1] presented a new approach for automatic ear recognition system using Wavelet Transform Decomposition and Back Propagation Network (BPN). Texture energy and edge density features are extracted separately from image blocks and fused together to form a feature vector improves a recognition rate of 98% has been achieved.

David J. Hurley et al [2] developed force transformation to extract ear features without field loss of information and a classification rate of 99.2% has been achieved.

Nazmeen Bibi Boodoo et al [3] used Karhunen-Loeve transform to select the more relevant features of face and ear images. The score level fusion done at decision level improves a recognition rate of 96%.

Dattatray V. Jadhav et al [4] proposed Radon transform to capture directional features of face images in different orientations and enhance low frequency components.

Shrikant Tiwari et al [5] for recognition of new born is by fusing ear images with soft biometric data, results in increasing the recognition accuracy.

Changjun Zhou et al [6] have used NMF (Non-negative Matrix Factorization) on original images to obtain the

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residual face space. Fisher Linear Discrimanant analysis (FLDA) is then applied to extract features.
Haiyan Xu [7] has used the Gabor Wavelet to extract the ear features and finally, the features are utilized to train and test Support Vector Machines (SVM) for ear recognition.
Surya Prakash et al [8] presented an efficient and novel method to overcome the effect of illumination, poor contrast by three different image enhancement techniques and extract the local ear features using Speeded-Up Robust Features (SURF). The nearest neighbour classifiers are used to train the ear features. Fusion at score level carried out by weight sum rule significantly improves the recognition accuracy.
Kshirsagar et al [10] explains a methodology for face recognition based on information theory approach of coding and decoding the face image. It uses Principal Component Analysis (PCA) for feature extraction and BPN (Back Propagation Neural Network) for classification.

III. PROPOSED WORK

The proposed technique is able to detect the ear of different size and shape along with the geometrical features from an image of the ear. In the proposed biometric recognition system we extract the features of the ear and match the patterns using fuzzy feature matching. The flow of the proposed system is shown below

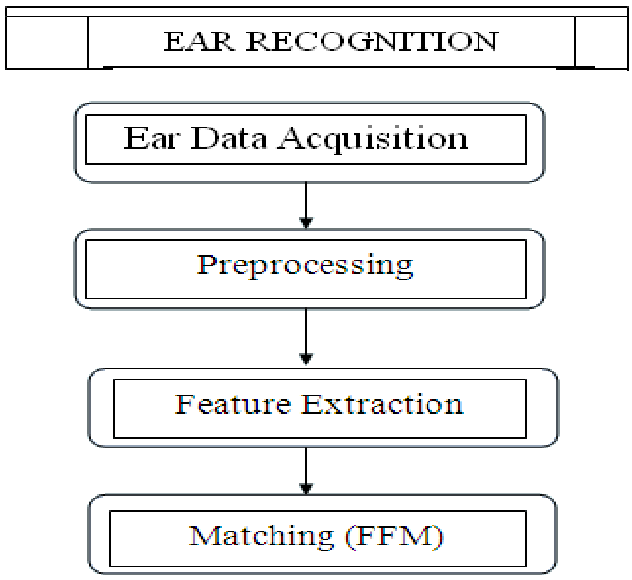

Fig. 2. Flow of proposed system

For data acquisition a personal computer with USB web cam at the distance of 30 cm at a resolution of 320*240 is used. The code written in dotnet is used for data processing and matching.

IV. PREPROCESSING

In this approach the ear part is manually cropped from the side face image and the portions of the image which do not constitute the ear are colored black leaving only the ear. The cropped color image is converted to grayscale image. But due to the noise in the image noisy edges may be detected which are of no use and moreover may reduce the accuracy of the algorithm. The ear shapes are Round, Oval, Triangular and Rectangular in nature. For edge detection the canny edge detection is used with a threshold of 0.5 as canny detection gives the best results under the given illumination conditions.

V. EXTRACTING MINUTIAE

The minutiae can be correctly extracted from a thinned image. There are many approaches to construct triangles in the triangularization method, but there will be three triangles constructed in an ear.

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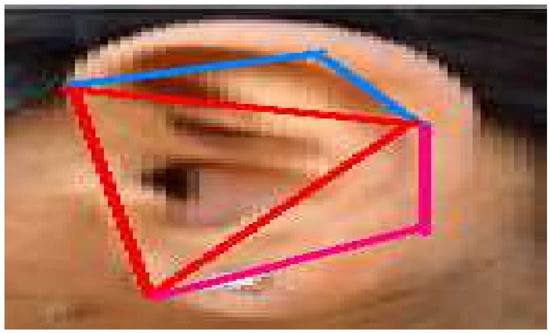

Fig. 3. Triangles Constructed in an Ear

The distance between two minutiae is generally greater than a threshold value. They are often detected at the border of the ear image. The proposed method reduces the complexity.
The first step is to define a triangular feature set in an ear image. The block of the matching is the local triangle feature of the ear. Three triangles are constructed in an ear image .The feature vector of a local triangle structure is defined by the distance between minutiae, the angle between the directions from minutiae, the orientation differences within the region of minutiae.

$FTk=\{d_{ij},d_{jk},d_{ik},\Psi_i,\Psi_j, \Psi_k,OZ_i,OZ_j,OZ_k,\alpha_i, \alpha_j, \alpha_k\}$.

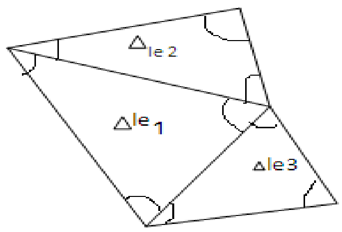

Fig. 4. Triangle Patterns in an Ear

Secondly, we define the pattern parameter space. Four distorted pattern parameters, vectors len_{diff}, Ψ_{diff}, AT_{diff} and PT_{diff} are calculated to construct the deformed pattern feature vector. To learn the genuine distorted pattern parameter, we applied a set of ear images to derive a genuine distorted pattern parameter space. We choose the corresponding training samples for each database.

IV. FUZZY MATCHING AND SIMILARITY

The FFM method maps a similarity vector pair to a normalized quantity, within the interval [0, 1], which quantifies the overall image to image similarity. $FRT_{Tk}= \{ i, j, k, \Psi_i, \Psi_j, \Psi_k, AT, PT\}$ is a controlled local triangle feature in a template ear and $FRT_{IK} = \{ i^l, j^l, k^l ,\Psi^l_i, \Psi^l_j, \Psi^l_k, AT^l, PT^l \}$ is a controlled triangle feature in an input ear, To derive the pattern parameter space we used the training set. The database set contains ear images captured from CETS students and staff ear images. To characterize the similarity

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between ear the fuzzy feature set is used. The image-level similarity is constructed from triangle-level similarities. The FFM measure for template and input ear is defined as

$$\mathbf{Sim} = [\![(1-p)w_A + w_B]\!]\, L^{(T,I)} \quad (1)$$

Here w_A is the normalized area percentage of both template and input ear, w_B is the normalized weight which favours triangle near the image center, p € [0,1] adjusts the significance of w_A and w_B and $L^{(T,I)}$ is the weighted entries of similarity vector of the overall image. The similarity between template and input ear is constructed by triangle similarities. Here, we analyze the matched number of triplets of Minutiae which satisfy the entire criterion in the matching process, and the probability of the local triangle feature set matching model.

V. EXPERIMENTAL RESULTS

We conduct extensive experiments to evaluate the effectiveness and robustness of the proposed system. In order to evaluate the proposed ear identification, an ear database is to be established by collecting the ear images of CETS staff and students. For sampling 25 ear images are collected in the database. This algorithm is compared with the methods described earlier. The system is developed using dotnet. The proposed algorithm considerably reduces the complexity of computation. In the algorithm three controlled three triangles are used for an ear. A better performance of 98.86% accuracy is also obtained. The computation complexity in FFM based method is less.

Table1.Comparison of .FFM with BP

Method	Accuracy
BP	98%
FFM	98.86%

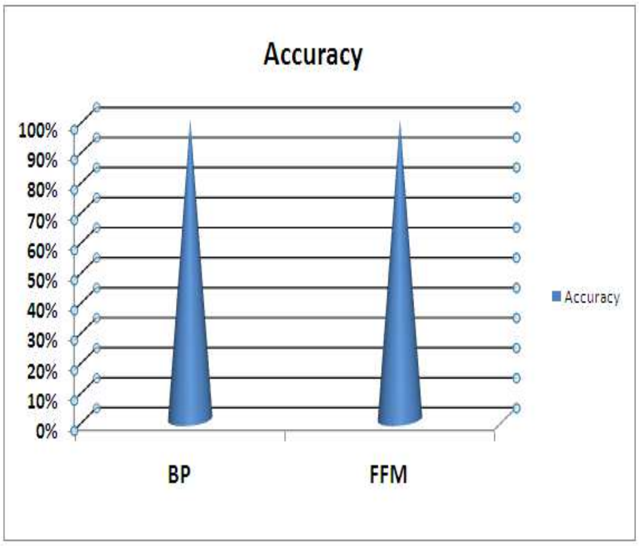

Fig. 5. Comparison of .FFM with conventional methods

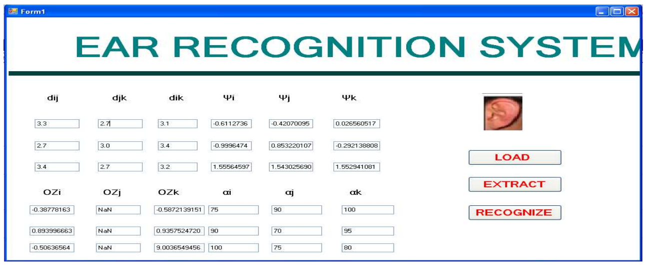

Fig. 6 Input features of Ear

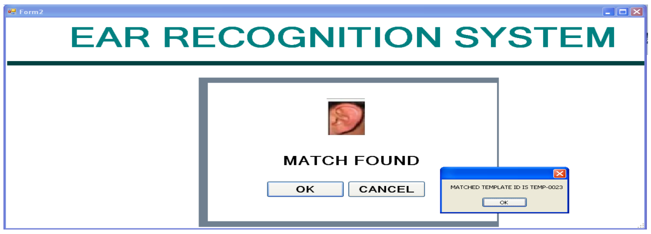

Fig. 7.Result of FFM method on Ear

VI. CONCLUSION

This paper proposes a new method for ear matching. The triangle feature constructed in the ear is represented by the fuzzy feature. These features are used to characterize the similarity between the ears. We introduce a fuzzy similarity measurement for two triangles and extend it to construct a similarity vector including the triangle-level similarity in two ears. The proposed algorithm has been evaluated with ears of CETS students and staff database with 25 ear samples. Experimental results confirm that our algorithm reduces the complexity of the method and produces better accuracy in matching.

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