

Ear Identification System Based on Hybrid Techniques

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Abstract - In this paper, an efficient ear identification system is presented for human recognition based on Curvelet Transform and Fractal Dimension (FD). In the proposed system, the ear images are cropped manually from the side head images. After that curvelet Transform and FD are used as a hybrid features extraction technique. The proposed system aims to reduce the dimensionality that reduce the required computational power and memory size so that, the mean and standard deviation (STD) are computed from the learning and testing samples and used as input to classification phase to recognize different ears. The proposed system have been tested and compared with other systems using two different databases the first one is a constructed ear database named as Ear_Images database, which is consist of 200 images. The second database is the USTB database. The experimental results show that the achieved recognition rates by the proposed system are up to 92.7% and 93.4, respectively.

Keywords - Biometrics, Ear Recognition, Ear Identification, Curvelet Transform, Fractal Dimension.

I. INTRODUCTION

Biometrics is the science in which an entity is distinguished on the basis of physiological features or behavioral characteristics. Physiological characteristics include finger print, iris scan, retina scan, face, palm print, ear and etc. Whereas behavioral characteristics consist of gait recognition, odor, voice recognition and signature verification [1]. Automatic person identity recognition based on biometric ear image is relatively a new research area, it is an image processing technique of transforming ear image to feature vector for personal identification. Human ear contain rich and stable features, it is more reliable than face because the structure of the ear does not change in proportional to increase in age. It has been found that no two ears are exactly the same even that of identical twins [2]. The potential for using the ear's appearance as a means of personal identification was recognized and advocated as early as 1890 by the French criminologist Alphonse Bertillon [3]. Ear features have been used for many years in task of forensic science for personal identification.

This is because ear is a stable biometric and invariant with age change. Moreover, it has all the properties trait should have, i.e. uniqueness, universality, permanence and collectability. Unlike face structure, ear has no expression changes, makeup effects and the color is constant trough out the ear [4]. Ear was first used for recognition of human being by Iannarelli, who used manual techniques to identify ear images. Samples of over 10,000 ears were studied to prove the distinctiveness of ear. Structure of ear does not change radically over time. The medical literature provides information that ear growth is proportional after first four months of birth and changes are not noticeable in

the age group from 8 to 70. Thus, this ensures that the ear will occupy a special place in conditions requiring a high degree of perfection [5]. In this paper an efficient ear identification system is presented for human recognition based on the Curvelet Transform and FD. In the proposed system the ear images are cropped manually from the side head images. After that Curvele Transform and FD are used as a hybrid features extraction technique. The proposed system aims to reduce the dimensionality that reduce the required computational power and memory size so that, the mean and standard deviation (STD) are computed from the learning and testing samples and used as input to classification phase to recognize different ears. The experimental results have shown the effectiveness of the proposed system in comparison with other previous ear recognition systems. The research paper is organized into the following sections. Overview of the related work is given in section 2. The proposed ear identification system is presented in section 3. The experimental results are reported in section 4. The paper is concluded in section 5.

II. LITERATURE SURVEY

Ear recognition has received considerably less attention than many alternative biometrics, including face, fingerprint, iris, and gait recognition. However, in recent years a few researchers have begun to consider the problem of developing a computational approach for ear recognition [6]. some of them are:

Md. Mahbubur , Md. Rashedul and et al [7] proposed a method to recognize human using ear biometrics. The features are extracted from an ear image by measuring geometric relations between predetermined points (lengths, angles). Here, the geometrical structures observed from pixel value distances are used for the successful recognition of objects. Recognition of objects is based on these geometrical structures.

ZhaoxiaXie and Zhichun Mu [8] present ear recognition system based on the locally linear embedding (LLE) and an improved locally linear embedding algorithm (IDLLE) to avoid the disadvantage of the standard LLE algorithm.

Surya Prakash, Umarani J. and et al [9] presented a distance transform and template based technique for automatic ear localization from a side face image. This technique first segments skin and non-skin regions in a face and then uses template based approach to find the ear location within the skin regions.

Rajesh M Bodade and Sanjay N. [5] proposed a novel approach of feature extraction of iris image using 2D Dual Tree Complex Wavelet Transform (2D-DT-CWT) which provides six sub-bands in 06 different orientations, as against three orientations in DWT. DT-CWT being complex, exhibits the property of shift invariance. Ear feature vectors are obtained by computing mean, standard

deviation, energy and entropy of these six sub-bands of DT-CWT and three sub-bands of DWT. Canberra distance and Euclidian distance are used for matching.

III. THE PROPOSED SYSTEM

The proposed ear identification system consists of the following stages: Image Acquisition, (Preprocessing & Edge detection), Features Extraction and (Enrollment & Classification). The proposed system for person identification by ear biometrics is shown in Fig. 1.

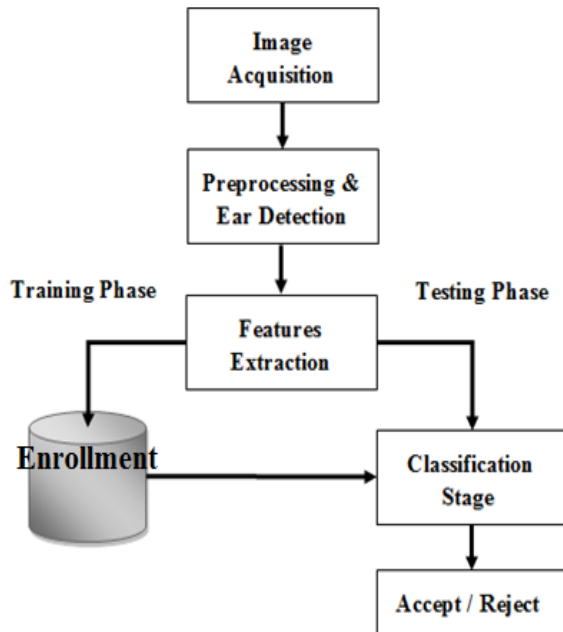


Fig.1. Stages of the proposed ear classification system

IV. IMAGE ACQUISITION

One of the challenges in this research of color ear recognition has been the lack of available database in color. Often, those databases that are available are of poor quality, with over compression of the images or wide variations in the illumination. For this purpose the colored ear database has been constructed named as Ear_Images database. This database currently contains colored profile face images of 50 persons in Joint Photographic Experts Group (JPEG) format with the image size of 256x256. Each person is photographed against a uniform of white background using a single camera and identical settings. For each person, 4 photographs have been taken so that 4 images for each one (Two in the right side and two in the left side). The total number is 200 images. Fig. 2 shows an example image for two persons.



Fig.2. An example of personal image in the constructed database

V. PREPROCESSING & EAR DETECTION

Firstly, the ear part is manually cropped from the side face image (from right & left sides) to get the different sizes of images. In the second step, these images are resized to have images in the same size as explained in the Fig.3. The RGB images are converted into grayscale images in the third step by using Eq.1.

$$I_g = 0.2989 * I(R) + 0.5870 * I(G) + 0.1140 * I(B) \quad (1)$$

Where I(R), I(G) and I(B) are the Red, Green and Blue channel values of RGB image, respectively,. I_g is an intensity image with integer value ranging from a minimum of zero to a maximum of 255.



Fig.3 The captured ear images

VI. FEATURES EXTRACTION

The feature extraction is an inevitable step in the classification of high dimensional data. In this work, the feature extractor based on the hybrid method named as curvelet-fractal technique. The details for each technique can be summarized as follow:

A. Curvelet Transform

There are two generations of the discrete curvelet transform. In the proposed work, the curvelet via wrapping is adapted. The curvelet transform is a multi-scale transform. This make it better than other traditional multi-scale transforms, such as wavelet transform in the edges

representation and other singularities along curves. Applying the curvelet via wrapping can be summarized in the following steps:

1. Take FFT of the image by Eq.2 and Eq.3.

$$f(n) = \sum_{x=0}^{k-1} f(2x)WK^{ux} + \sum_{x=0}^{k-1} f(2x+1)WK^{ux} \times W2K^u \quad (2)$$

$$F(u+K) = f(2x)WK^{ux} + f(2x+1)WK^{ux} \times -W2K^u \quad (3)$$

2. Divide FFT into collection of Digital Corona Tiles.
3. For each scale j and angle l do
 - Translate the tile to the origin.
 - Wrap the parallelogram shaped support of the tile around a rectangle centered at the origin.
 - Take the Inverse FFT of the wrapped support is given by Eq.4.

$$f(n) = \frac{1}{N} \sum_{k=1}^N F(K) \times \exp(i2\pi k \times (k-1) \times (n-1)/N) \quad (4)$$

- Add the curvelet array to the collection of curvelet coefficients.

End for

B. Fractal Dimension

In the proposed system, Box Counting Method (BCM) is adapted for fractal computation. Assume that the ear image of size $N \times N$ pixels has been scaled down to a size $m \times m$ where m is an integer. Feature extraction is implemented by using BCM for all samples in the database.

The FD values are computed over the whole pixels of a block. In order to calculate the box-counting dimension, any structure should be located on square grid with the mesh dimension s , and afterwards, all meshes that contain even the smallest part of the ear structure are summed up. In this way, the number of filled meshes N is calculated, which is related to the mesh and image dimension, then, the number is registered as $N(s)$. Next, each mesh is divided into four equal ones and the FD calculation is repeated. In practice, the algorithm can be continued until reaching the lowest (i.e., pixel) resolution level. The fractal dimension is obtained using the following equation:

$$FD = \frac{\sum_{s=0}^{k-2} \log(A(s)) * \log(N(s))}{\sum_{s=0}^{k-2} \log(A(s))^2} \quad (5)$$

Where FD is slope show Fig.4, $A(s)$ is total number of boxes to all block, $N(s)$ is number of box cover the structure, k is highest box size and s is box size.

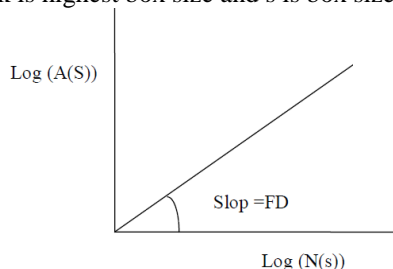


Fig.4. Dependence between $A(s)$ and $N(s)$

VII. CLASSIFICATION STAGE

In this phase, the mean and standard deviation for feature are extracted from the learning samples using the proposed feature extraction algorithm, respectively. and then comparison between the extracted set of features with those extracted from the testing sample, where the corresponding mean and standard deviation of all the samples stored in a database. The matching decision is take using distance Eq.6.

$$Dist(K) = \sum_{i=0}^T \frac{mean(i) - FD(i)}{STD(i)} \quad (6)$$

Where T is the number of training samples, mean and STD is the mean and standard deviation for training sample and FD is fractal dimension for test image. The identification of testing image with the same class k in database is represented by selecting the smallest value of $Dist(k)$.

VIII. EXPERIMENTAL RESULTS

To evaluate the performance of the proposed system an extensive experiments are carried out on two different databases. The first experiment is performed on a constructed database by us and named as Ear_Images database. This database currently contains 4 ear images for each one (Two in the right side and two in the left side). The total number is 200 images. The evaluation of proposed system and comparative results are based mainly on calculating the Accuracy Rate (AR) and False Negative Rate (FNR) as explained in the Fig.5. Considering the number of the training and testing images to be 2 for each person.

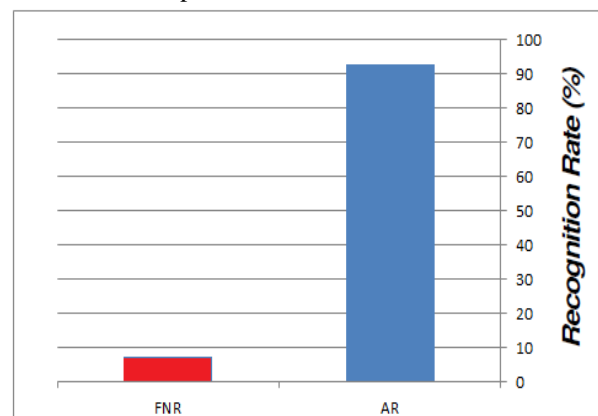


Fig.5. Recognition accuracy on the Ear Images database

In the second experiment, the proposed system is testing on the USTB ear database that contains 308 images of 77 subjects. The original images, with a resolution of 300×400 , are cropped to grayscale images with a resolution of 270×360 . In this experiment, three images of one person are used in the training phase and the remaining in the testing phase. The performance of the proposed approaches is evaluated by comparing it with some widely used approaches:

Local binary pattern, LGPDP, Fisher Discriminant Analysis and Principal Components Analysis (PCA) for ear recognition. The average accuracy rates (in %) are summarized in Table 1.

Table 1: Recognition accuracy on the USTB database

The Approaches	Accuracy Rate %
LBP [10]	89.79
LGPDP [11]	89.53
FDA [12]	85.71
PCA [13]	78.68
The proposed approaches	93.4

IX. CONCLUSIONS

In this paper, a reliable and efficient ear identification system is proposed. The proposed system can be summarized in to four stages: Image Acquisition, Preprocessing & Ear Detection, Features Extraction and Classification stage. The proposed system based on Curvelet Transform and Fractal Dimension (FD). In this work, the ear images are cropped manually from the side head images. After that curvelet Transform and FD are used as a hybrid features extraction technique. The proposed technique aims to reduce the dimensionality that reduce the required computational power and memory size so that, the mean and standard deviation (STD) are computed from the learning and testing samples and used as input to classification phase to recognize different ears. The proposed system have been tested and compared with other systems using two different databases the first one is a constructed ear database named as Ear_Images database, which is consist of 200 images. The second database is the USTB database. The experimental results show that the achieved recognition rates by the proposed system are up to 92.7% and 93.4, respectively.

REFERENCES

- [1] M. Ali, M. Y. Javed, A. Basit, 'Ear Recognition Using Wavelets', Proceedings of Image and Vision Computing New Zealand 2007, pp. 83-86, Hamilton, New Zealand, December 2007.
- [2] Samuel Adebayo D. and Oladejo Daniel O. "Automatic Ear Recognition System using Back Propagation Neural Network", International Journal of Video & Image Processing and Network Security IJVIPNS-IJENS Vol: 11 No: 01, February 2011 IJENS.
- [3] Mohamed Saleh, SherifFadel and Lynn Abbott, "Using Ears as a Biometric for Human Recognition", ICCTA 2006, 5-7 September 2006, Alexandria, Egypt.
- [4] RerkchaiFoopratesiri and WerasakKurutach, "Ear Based Personal Identification Approach Forensic Science Tasks", Chiang Mai J. Sci. 2011; 38(2) : 166-175.
- [5] Rajesh M Bodade and Sanjay N Talbar, " Ear Recognition using Dual Tree Complex Wavelet Transform", (IJACSA) International Journal of Advanced Computer Science and Applications, Special Issue on Image Processing and Analysis.
- [6] Mohamed Saleh, SherifFadel and Lynn Abbott, "Using Ears as a Biometric for Human Recognition", ICCTA 2006, 5-7 September 2006, Alexandria, Egypt 311.
- [7] Md. Mahbubur , Md. Rashedul and et al, " Person Identification Using Ear Biometrics", International Journal of The Computer, the Internet and Management Vol. 15#2 (May - August, 2007) pp 1 - 8.
- [8] ZhaoxiaXie and Zhichun Mu, "Ear Recognition Using LLE and IDLLE Algorithm", 978-1-4244-2175-6/08/\$25.00 ©2008 IEEE.

- [9] Surya Prakash, UmaraniJayaraman and Phalguni Gupta, "Ear Localization from Side Face Images using Distance Transform and Template Matching", Proc. IEEE Int'l Workshop on Image Processing Theory, Tools and Applications, (IPTA 2008), Sousse, Tunisia, Nov 2008 pp. 1-8.
- [10] Ahonen, T., Hadid, A., Pietikäinen, M.: Face Description with Local Binary Pattern. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 28, pp. 2037--2041 (2006).
- [11] Guo, Y., Xu, Z.: Local Gabor Phase Difference Pattern for Face Recognition. In: International Conference on Pattern Recognition, pp. 1-4 (2008).
- [12] Liu, Y., Mu, Z., Yuan, L.: Application of Kernel Function Based Fisher Discriminant Analysis Algorithm in Ear Recognition. Measurements and Control, pp. 304--306 (2006).
- [13] Chang, K., Bowyer, K., Sarkar, S., Victor, B.: Comparison and Combination of Ear and Face Images in Appearance-Based Biometrics. IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 9, pp. 1160--1165 (2003).

AUTHOR'S PROFILE



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