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Human Recognition through Ear Biometrics using Average Ear Approach

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Abstract

Human ear has attracted researcher's attention recently due to its stable biometrics nature. In this paper, we have implemented human recognition system through 2D ear images and proposed a novel algorithm for human recognition by ear based on average ear method. Algorithm is tested on University of Science and Technology Beijing (USTB) data set of 60 subjects on 180 ear images. We have also discussed different sources of freely available data base and finding of various authors in the same direction. This paper is very useful for those who are budding researches in this area

Keywords: - Ear Biometrics, Ear Signature,

Average Ear Image, Feature Extraction.

1 INTRODUCTION

Biometrics deals with recognition of individuals based on their physiological or behavioural characteristics. Researchers have done extensive studies on biometrics such as fingerprint, face, palm print, iris, and gait. Ear, a viable new class of biometrics, has certain advantages over face and fingerprint [1], which are the two most common biometrics in both academic research and industrial applications. For example, the ear is rich in features; it is a stable structure that does not change much with age [2] and it does not change its shape with facial expressions. Furthermore, ear is larger in size compared to fingerprints but smaller as compared to face and it can be easily captured from a distance without a fully

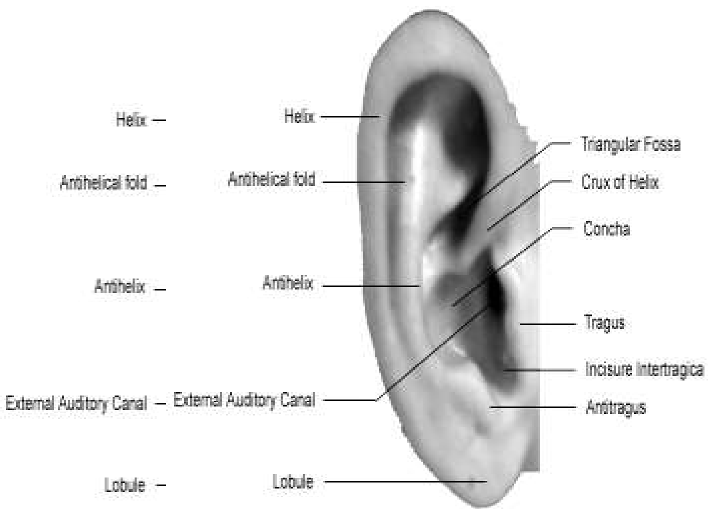

Figure 1: Anatomy of Human Ear

cooperative subject although it can sometimes be hidden with hair, cap, turban, muffler, scarf, and earrings. The anatomical structure of the human ear is shown in Figure 1. The ear is made up of standard features like the face. These include the outer rim (helix) and ridges (antihelix) parallel to the helix, the lobe, the concha (hollow part of ear), and the tragus (the small prominence of cartilage over the meatus).

In this paper, we have used above discussed feature's of ear as a unique signature.

The remainder of the paper is organized as follows. In section 2 background and related work with respect to ear recognition is given. Section 3 complete proposed work is summarised in five steps. Experiments result and conclusion are given in section 4 and 5.

2 BACKGROUNDS AND RELATED WORK

Ear was first used as a human biometric by Iannarelli [4] who compared more than 10,000 ears samples for study and found that, structure of ear does not change radically over time and having the ability to be consider as human biometric like figure print or iris. The medical literature [4] provides information that ear growth is proportional after first four months of birth and changes are not noticeable in the age 8 to 70. We have studied some other author's research work based on two dimensional ear images and summarize them as follows.

Yuan and Mu [11], in this paper, used a normalization method based on the concept of an improved Active Shape Model (ASM). Ear normalization was adjusted for any scaling and rotational variation in image. Then Full-space Linear Discriminant Analysis (FSLDA) was applied to perform ear recognition and achieved a recognition rate of 90%. According to Xie and Mu, multi-pose problem erupts only when the angle between the subject ear and the camera changes, causing the distortion

Chang, Bowyer, Sarkar and Victor, built a recognition system by taking the help of both face and ear. The technique used by them was PCA. They manually pass two coordinates of the triangular fossa and the antitragus. There on PCA was used to extracting features point known as ear-space [10].

Burge and Burger [9], transformed the subject ear into the model of adjacency graph. The graph construct was based on Voronoi diagram which is further derived from the use of Canny extraction based on curve segments. They designed a graph matching logic for authenticating a person.

Zhang and Liu, analyzes the problem of multi view ear recognition. They used B-spline pose manifold construction in a discriminative projection space. This space is formed by the Null Kernel Discriminant Analysis (NKDA) feature extraction scheme. They reported a 97.7% rank-1 recognition rate [13]

Sana and Gupta [20], they extracted the structural features of the ear by using Haar wavelet transforms. The Haar wavelet transform was applied to separate the discovered subject image and to calculate coefficient matrices of the wavelet transforms which are clustered in its feature template. The correctness of their algorithm was 96%.

Nosrati et al. [22], they applied a 2D wavelet on an aligned ear image. Template matching algorithm was used for feature extraction. The features was diverged in various positions (horizontal, vertical, and diagonal). They merged these lost images to create a single feature matrix. They achieved a recognition correctness of 90.5%.

SOURCES OF EAR DATA BASE:

Ear data base are freely available on various universities and organization's sites, to promote research work in the same direction. Some standard data sets as follows.

USTB Ear Database:

It is provided by Ear Recognition Laboratory at University ofvScience & Technology, Beijing [5]. They have created four database - I, II, III and IV.

Database –I Every subjects is photographed three different images. They are normal frontal image, frontal image with trivial angle rotation and image under different lighting condition. Each of them has 256 gray scales. Images had already experienced rotation and shearing.
Database –II The subject's head in right hand view is photographed by CCD camera. The distance between subject and camera is fixed to 2 meters.
Database –III All images are right side profile full images which are photographed with color CCD camera under the white background and constant lighting. The distance between camera and subject is 1.5 meters. The resolution of image is 768*576, 24-bit true color. Define the angle when CCD camera is perpendicular to ear as 0 degree, which we call profile side.

IIT Delhi Ear Database
The IIT Delhi database of an ear image is gathered by taking the snaps of students and staff ear present in the campus. The acquisition of an image was done during Oct 2006 – Jun 2007 using simple imaging set up. The age groups of the subjects are in between 14 – 58 years. The resolution of an image is 272 x 204 pixels in jpeg format.

IIT Kanpur Ear Database
It consist of two set of data i.e. Dataset -1 and Dataset-2. Data Set 1 has 801 side face images acquired from 190 subjects. Data Set 2 has again 801 side face images collected from 89 subjects. It consist of frontal view of the ears captured at three positions, first when a person is looking straight, second when person is looking approximately 20down and third when person is looking approximately20 up.

3. **PROPOSED WORK**

In our work, we have used USTB data base-I, a set of 60 subjects. We took average of three ear images of each subject, as we have used 180 ear images of 60 subjects. Complete method is summarised in following steps.

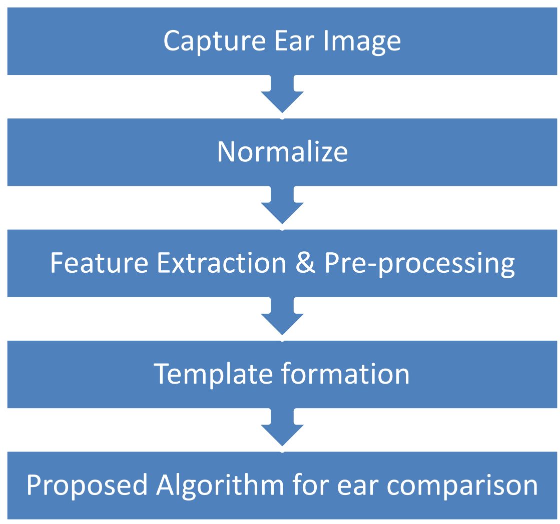

Figure 2: Steps of the propose method

CAPTURE EAR IMAGES:

First step of the work is to collect standard data set. Therefore, either create own data set or used standard dataset, which are available on various universities as discussed above. You can get the data set on special request from the university authority. In order to create own data set, to

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capturing ear images, various factors, we have to be keep in mind like,

- Stability of camera and its height.
- Distance between camera and subject.
- Subject should be stable.
- Constant light ambience.

NORMALIZATION:

Once, data set collected, it should be normalized before processing. Here normalization means that all the images must be equal in dimension. If the images are not equal, then they have to alter in a standard dimension through cropping and resizing. As we have used USTB data set-I for the processing. All the images are equal in dimension of 80×150 pixel.

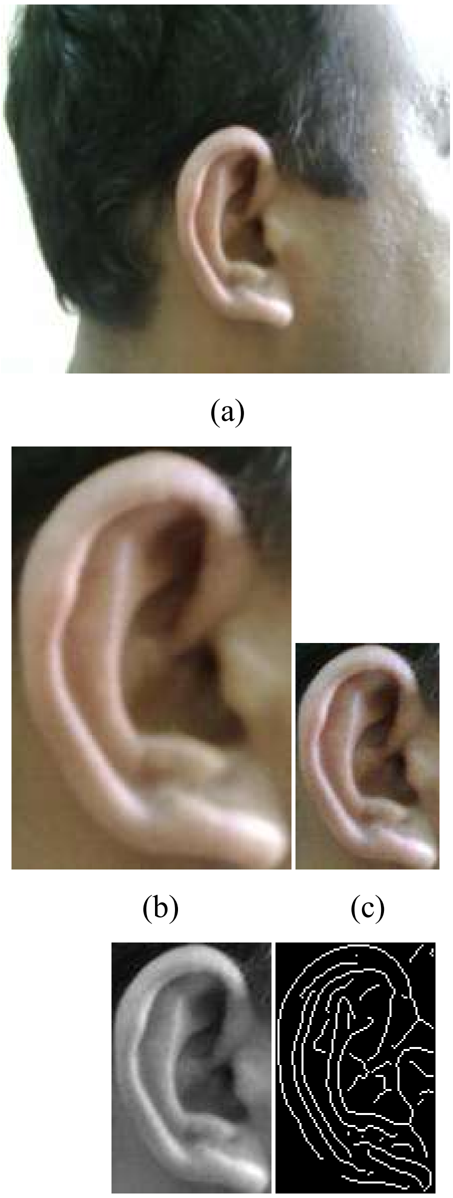
FEATURE EXTRACTION:

The ear is made up of standard features like fingerprints. In biological context, ear includes the outer rim (helix) and ridges (antihelix) parallel to the helix, the lobe, the concha (hollow part of ear), and the tragus (the small prominence of cartilage over the meatus). All these biological features of ear, we have used as a unique signature in the form of edges.

In order to extract ear features in the form of edges, we have used most popular method of edge detection named as Canny Edge Detector. Complete feature extraction method summarise in following steps.

- Change format of ear image, from RGB to Greyscale.
- Set all the parameters of canny edge detector function on specific values.
- Pass greyscale image as a parameter in canny edge detector and get unique ear signature in return and save it as a binary image.

Complete feature extraction method described in Figure 3.



(a) (b) (c) (d) (e)

Figure 3: (a) Original image (b) Cropped image (c) Resized image (d) Greyscale image and (e) Ear Signature with actual features

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CANNY EDGE DETECTOR

Canny edge detector is used for feature extraction, details of the function as follows.

Function:

img = edge(I, 'canny', thresh, sigma)

Assign Thresh and singma parameters sets at value thresh =0.165, singma=1

Conversion procedure

ie=imread('ear11.bmp');

ge=rgb2gray(ie);

q11=edge(ge,'canny',0.165,1);

imwrite(q11,'q11.bmp');

PRE-PROCESSING

The extracted ear features in the ear image are too thin; therefore, to improve accuracy in result, we have to increase thickness of each ear signature. Here, each ear signature is stored in binary matrix of 80×150 pixels. In order to increase thickness of ear signature, dilation operation has been performed. The procedure of the dilation as follows.

Structuring Element for dilation

SE=[0 1 0; 1 1 1; 0 1 0]

Dilation Function
DilEar=imdilate(EarEdge,SE)

Write Dilated Image
imwrite(DilEar,'DilEar.bmp')

Results after dilation shown in figure 4

4(a) 4(b)

Figure 4: (a) Actual Ear Signature (b) Ear Signature after Dilation

TEMPLATE FORMATION:
In order to compare ear signatures, we creates template for entire subjects. Template of each subject has been created by averaging three dilated ear signature together. Each ear signature is stored in binary matrix of **80×150** dimension. Formula of the template formation as follows;

$$\sum_{i=1}^{n=80} \sum_{j=1}^{m=150} \mathrm{EarTemp1}(i,j) = \sum_{i=1}^{n=80} \sum_{j=1}^{m=150} (\mathrm{ear11}[i,j] + \mathrm{ear12}[i,j] + \mathrm{ear13}[i,j])$$

Here, **ear11**, **ear12** and **ear13** are three dilated ear images of the same subject with variation.
EarTamp1 is the first template of the first subject and saved it as binary image as shown in figure 5(b). In this research work 180 ear images of 60 persons (three images of each person) have been used for the template formation. We can add more ear images in respective template for more accuracy in ear recognition.

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Fig. 5(a) three dilated ear signature

Fig 5 (b): Ear Image template

PROPOSED ALGORITHM FOR EAR IDENTIFICATION:

Proposed Algorithm for template comparison with the query ear image is as follows.

Step 1: Count Number of ones in ear template.

Step 2: Read ear signature, which has to be compared and perform bitwise logical OR operation with ear template then count again the number of ones from the result.

Step 3: if the total no of ones count in Step2 are same as counted in step1, then display the message "ear is recognize with the current template" and exit

Step 4: and if total no of ones count in step2 plus threshold value (in this case threshold value is 173) are less than or equal to ones count of ear template in step-1 then query ear image is also recognize with ear template and exit.

Step 5: otherwise go to step1 for other template comparison with query ear image.

Repeat this process until entire templates are not compared or query ear signature is not matched with one of the template.

Step 6: Display the message ear is not recognized and exit.

4 **EXPERIMENTAL RESULTS**

The proposed method is implemented in MATLAB 7.5 on a PC with 2.27 GHz Intel processor and 3 GB RAM. In the experiment, ear data set from the University of Science and Technology Beijing (USTB) Chain has been used.

In figure 5, time analysis shown between time and number of template compared, at 2.27 GHZ Intel 3i processor. Time taking in comparison of one ear query image with one template is 0.108 Second. In this experiment, ear recognition success rate is 100% with 60 templates when applied ear query image out of 180 images of data set, those participated in template formation.

20 ear images are used in testing other than 180 ear images as a query, after testing we found that the maximum variation of 173 pixels in matching with concerned template, therefore we have set this value as a threshold. It is expected that when, number of ear images increases in template formation then recognition rate would be improve.

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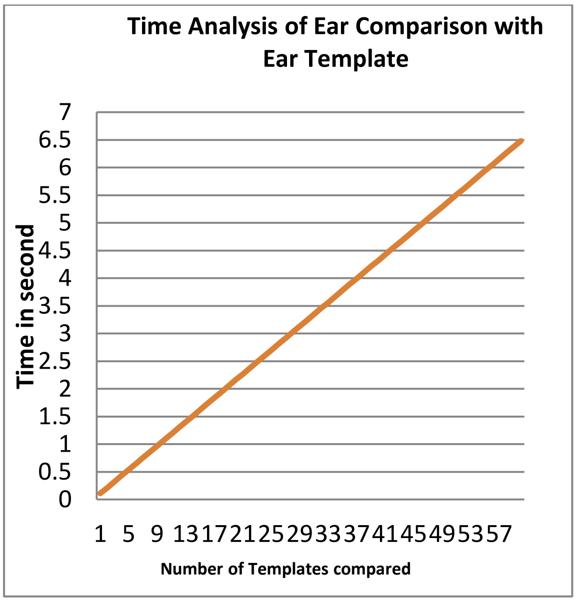

Figure 5: Analysis between time in second and ear Comparison with ear template.

5. CONCLUSIONS& FUTURE ENHANCEMENT:

In this paper, a new method of human recognition is proposed based on average ear images. Ear images are cropped manually and needs to be resized followed by conversion into grayscale image. After that Canny edge detector is used to extract the feature from the image. Database images are trained and stored in the form of average ear image as a template. Results obtained are promising and encouraging with 100% correct recognition rate, when we consider query images from 180 ear data set. We have tested this method on 20 ear images other than 180 images of data set; we found maximum deviation of 173 pixels. Therefore we have set this value as a threshold. Results would be more promising, if the number of ear images increase in template formation. All the ear images which we have considered are completely ideal and free from all the noises like images captured in varying illumination condition, piercing with jewelry and partially visible due to hiding ear with cloths or hair etc.

Although the ear biometrics is rich in characteristics but there are still some problems that need to be worked on to make automatic ear recognition system more effective and efficient in real world applications. Our further research work would be extending up to deal with the noises in ear images like variation in illumination, occlusion due to hair, jewellery and ear symmetry.

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