Geometric Ear RecognitionBased on Neural Network

Raid LuaibiLafta
Thi-Qar University

Abstract

In this paper, an approach to recognize human using ear image biometrics using its features has been proposed. Traditional image-based approaches to person identification almost exclusively employ front views of the individual's face. Ear on the other hand, has a more uniform distribution of color, so almost all information are conserved when converting the original color image into gray scales. The human ear is a perfect source of data for passive person identification in many applications. In the growing need for security in various public places, ear biometrics seems to be a good solution, since ears are visible and their images can be easily taken, even without the examined person's knowledge. When employing face or lip as a biometric, changing of their appearance with the expression of the subject creates problem but in case of ear the shape and the appearance are fixed. We extract the features 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. Experimental result reveals that the proposed identification method can achieve almost 95% accuracy.

We used the Artificial Neural Networks (ANN) technique to determine whether or not the query person is recognized.

1. Introduction

There are many possible data sources for human identification systems, but the physiological biometrics have many advantages over methods based on human behavior.

Biometric technology is gaining popularity in this modern era for the purpose of security and other applications. The new feature in biometrics is human ear which is becoming popular. It has several advantages over other biometric technologies such as iris, fingerprints, face and retinal scans. Ear is large as compared to iris and fingerprint and unlike them, the image acquisition of human ear is very easy as it can be captured from a distance without the cooperation of individual [1]. Human ear contains rich and stable features and it is more reliable than face as the structure of ear is not subject to change with the age as the facial expressions [2]. Biometrics systems based on images acquired from cameras are face and ear [2]. Both of these methods contain large volume of unique features that allow identifying humans. Human ears have been used as major feature in forensic science for many years (for example in airplane crashes). Ear prints, found on the crime scene, have been used as a proof in over few hundred cases in the Netherlands and the United State[3].

Nowadays, police and forensic specialists useear prints as a standard proof of identity [4,5,7]. An otoscopic (ear based) forensic opinion has astatus of scientific evidence and, admitted by Polish Courts [8].

The Geometrical methods of open contour representation and feature extraction which can be applied to ear image analysis. Our geometrical contour processing methods dedicated for ear biometrics are motivated by procedures used in police and forensic evidence search applications. In reality, well-established manual procedures of handling ear evidence (ear images or ear prints) are based on geometrical features such as size, width, height and earlobe topology (so called ear otoscopy) [9]. Therefore we measure the geometrical parameters of ear contours extracted from ear images. Such approach gives information about local parts of the image, which is more suitable for ear biometrics than global approach to image feature extraction. Moreover, geometrical features of extracted contours are ear identification than color or texture information, which is not distinctive enough for various ear images. Contours corresponding to earlobes are much diversified and contain enormous amount of information allowing ear identification. Recently ear biometrics has gained attention in computer vision community due to large interest in passive human identification systems. In previous work [10] we overviewed different approaches of 2D ear image analysis. Recently, various approaches towards 3D ear biometrics have been developed and published [11].

2. PROPOSED SYSTEM

The ear biometric base recognition systems can also be divided into five main parts - image acquisition, preprocessing, and feature extraction, extraction of feature vector and classification & comparison(Figure 1).

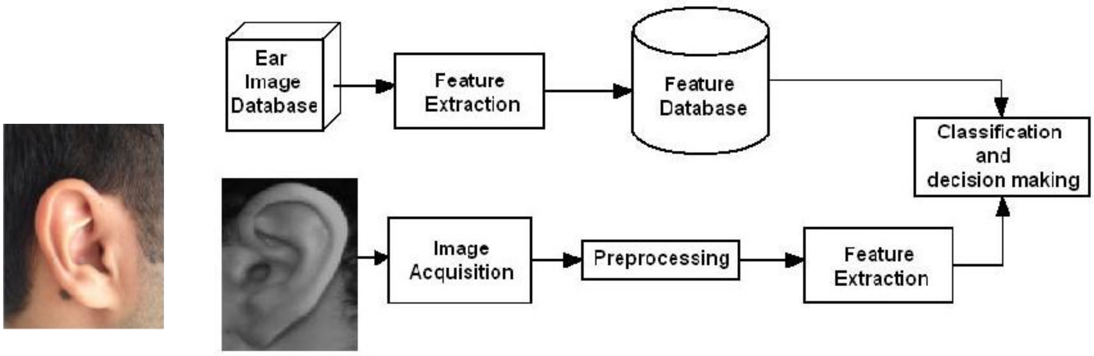

Figure 1:Ear biometric recognition system

The following subsections explain these parts:

2.1 Image Acquisition

The side face images are acquired using Digital camera under the same lightening conditions with no illumination changes (use of flash gives a fairly constant illumination).The images are acquired using 12 Mega pixel digital camera. All the images are taken from the right side of the face with different distances. The images have been stored in JPEG format.

2.2 Preprocessing

In this step 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 result of thepreprocessing stage is the binary image with 7-10longest ear contours (Figure2):

Figure2: Ear Contour Representation

2.3 Feature Extraction

Feature extraction is done in two stages they are the following:
1. Shape & Edge detection.
2. Euclidian distances & Angles of triangle detection.

The proposed approach is able to detect ear of different shapes. The ear shapes areRound, Oval, Triangular and Rectangular in nature. If the shape is get match then other feature vectors like Euclidian distances, angle of a triangle are compared and the maximum feature vector of a person are matched to get human identification.

Figure 3: a) Triangular, b) Round, c) Oval, d) Rectangular

To isolate the important and relevant information from the image this approach uses the following operations :

- Edge Detection
- Dilation
- Thinning

For edge detection the canny edge detection is used with a threshold of 0.3 as canny detection gives the best results under the given illumination conditions. Along with this dilation is used to connect the edges which may be broken by the edge detection process.

Thinning has already been incorporated in the canny detection [6].

2.4 Data Base

Database contains of two parts:

1- Ear Image Database – It contains the ear images, shape of different people taken in advance in Thiqar university. 20 people are taken and stored in a folder with their names as filenames. Each file in the database has five images of the right ear taken from a 12 megapixel camera with different distances at a resolution of 320x240. Five images per person have been taken and stored.

2-Feature Database – It contains the features extracted from the images which have been stored in advance in Ear Image Database. This database is used for comparison between extracted features of the test image and the features of all the pre existing images, to identify the person.

3- The proposed approach:

In practice, geometric ear recognition is difficult problem to solve [1]. First the ear features must identify in the image without identifying the target features, work to compare ear cannot begin. Second, a set of features must be chosen as to provide a robust set of data values for comparison. But what features should be chosen? Choosing the best ear feature set is an important task in designing a geometric ear recognition system.

Multilayer perceptron with one hidden layer is applied successfully to recognize and identify the input ear images by training and testing it. The back-propagation algorithm (supervised manner) used to learn the network. The input layer consists of 5 neurons (node) which represents the Euclidean distances between the chosen feature points on the ear image. The hidden layer consists of 5 neurons (node). The number of neurons at the output layer is depending on the number of different stored persons in the database. For example, when the number of persons is less than or equal to 16, the number of nodes in the output layer must be 4, that is because the resulted value is computed from the binary output vector. This value represents the index of the person in the stored database.

The following figure shows the architecture of used Artificial Neural Networks (ANN):

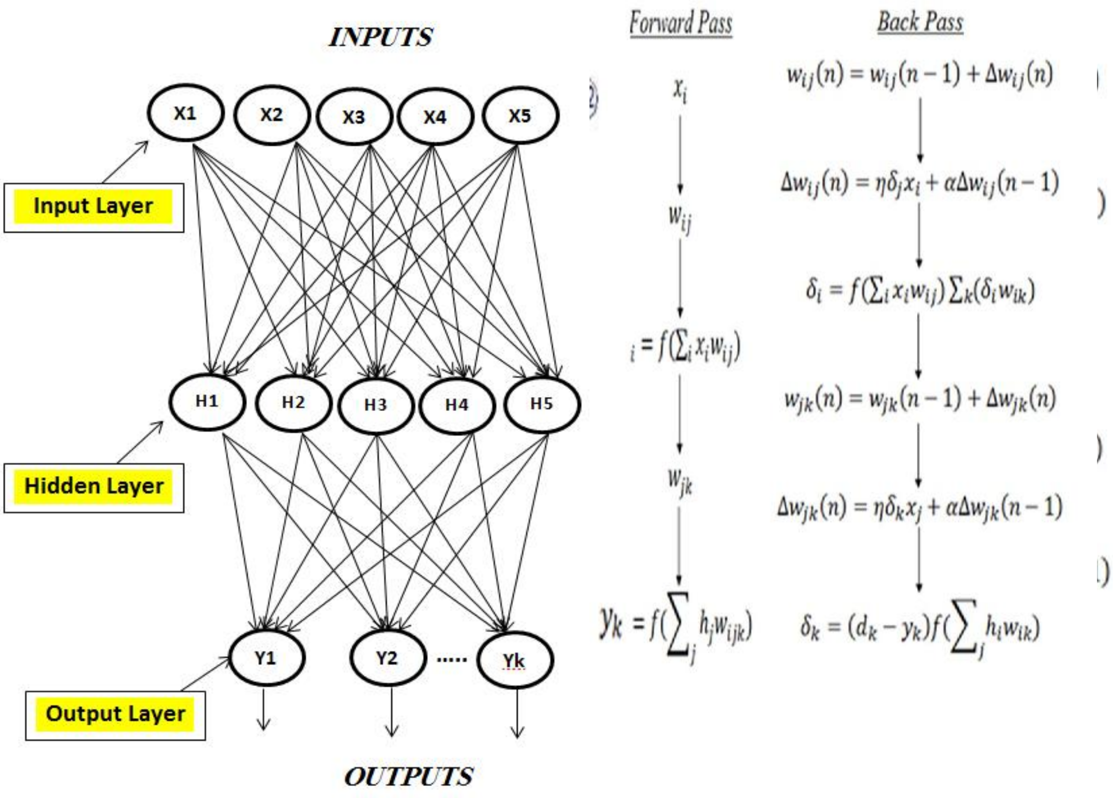

Figure (4): Algorithm Proposed for multilayer perceptron neural network

4-EXPERIMENTAL RESULTS

We have tested our proposed algorithm on Ear database for University Thiqar persons [TUDB]. TUDB consists of 100right ear images, five images per person (20 persons). These images are 8 bit gray scale and under different lighting conditions and with different distances. Figure 5 shows some images which are stored in databases.

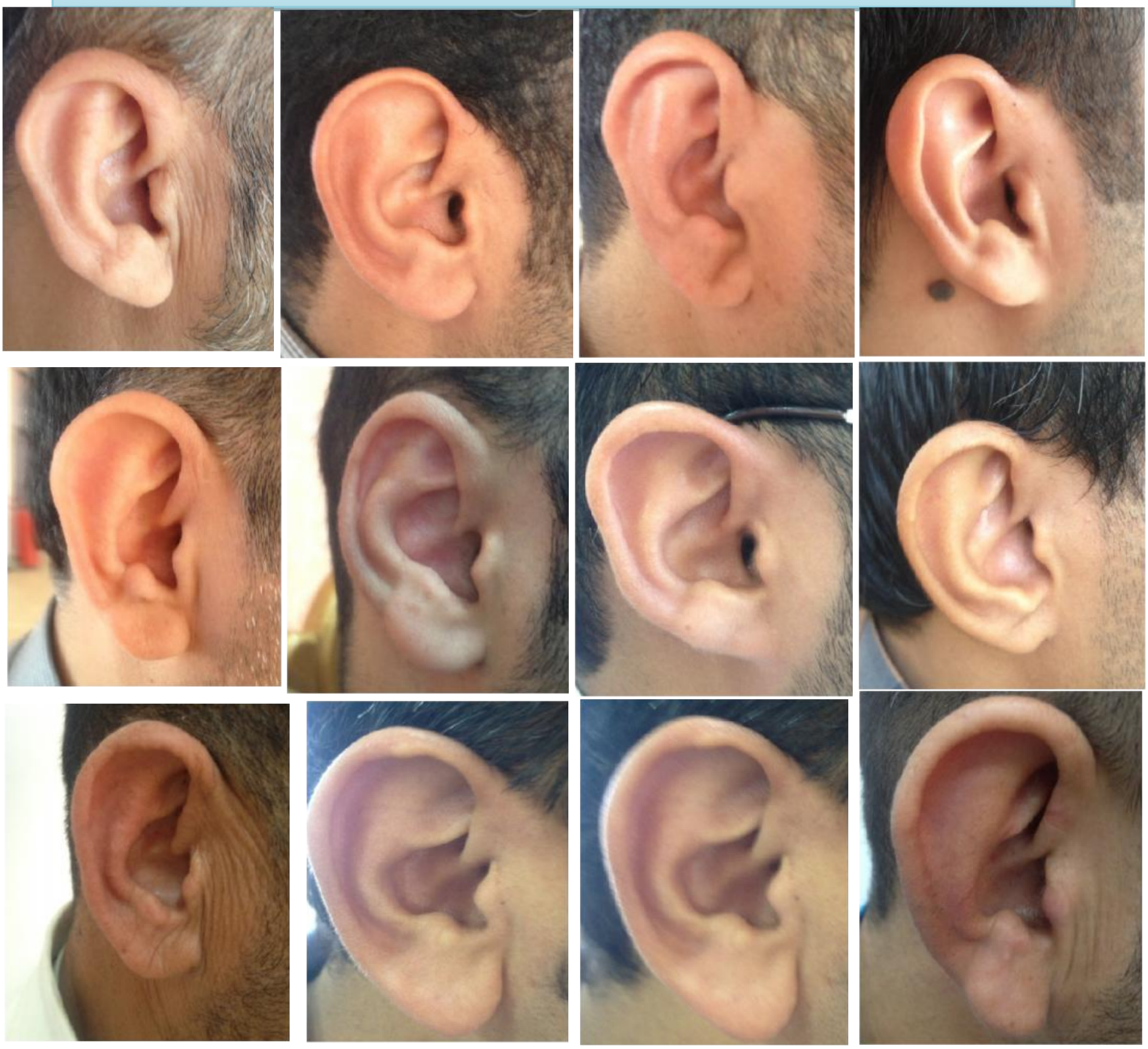

Figure (5): images taken from real database

In fact, we used three images per person (20 person)to train the Artificial Neural Networks (ANN) and the other images used to test the network.The proposed ANN is trained by using the back-propagation algorithm.We use factor for each image to detect the distances in the image,we will divide every distance by the factor, if the image is taking from near or farthe result isthe same, so the problem is solved. Henceall the images are taken from the right side of the face with different distances .We detected five points for each image automaticallyfor this purpose, and we find the distance between the points, then we used ANN.

After that the ANN is tested by any query input image. The obtained results give 95% matches. In comparison with other results, we can say that our approach give optimal and good results in pattern recognition and identification fields. We can certify that the main difficulty through the design of our experiments is the determination of feature position which must be in same order w.r.t. the input information vector. While the training time of the proposed ANN does not represent any difficulty because it is trained only on the ear image. Then the resulted weights are fixed on the links between any two nodes in different layers. So we can recognize rapidly the query person.

5- Conclusions:

1. From the experimental results, we can conclude that geometric features of ear image give good results in the recognition and identification.
2. Choosing the important feature positions for each image will effect on the final recognition results. So it must take carefully.
3. We note that, the using of ANN can give a high accuracy results.
4. Overall efficiency of 95% for this technique of obtaining 2 feature vectors from the same contour.
5. The proposed method used ear biometrics for passive identification of a person.

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