HUMAN EAR IDENTIFICATION BY HAAR AND PCA

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Abstract: This paper deals with the performance analysis of classification methods for human ear identification. Today, the world is full of security oriented problems. Hacking the web account, forging the documents and so many crimes leads to the eradication of passwords, pin codes and number based security system. Now, the security system is highly sophisticated with biometrics. Face recognition, iris recognition, ear recognition, gait recognition, finger print recognition are some of the biometric methods. Human ear has many advantages which outplayed face recognition and iris recognition in the security race. Human ear doesn’t show sharp changes from the age of 8 to 70. Ear recognition is so simple in programming module while iris recognition requires more complex modules which lead to a great drawback in real time applications. It makes the face and iris recognition to stay behind. This paper deals with the recognition of human ear using Principal Component Analysis (PCA) which extracts features to the best representation of object images and Haar Wavelet Transform which extracts feature vector. These feature vectors are used for training the database. Training, Testing and Classification are the major steps involved in these algorithms. The efficiency of each algorithm is analyzed by calculating False Acceptance Ratio (FAR) and False Rejection Ratio (FRR).

Key words: PCA, Haar Wavelet Transform, FAR, FRR

I  INTRODUCTION

Biometrics is the science in which an entity is distinguished on the basis of physiological features or behavioural characteristics [2]. Physiological Characteristics include finger print, iris scan, and retina scan, face, thermo grams of face, palm print, ear etc. whereas behavioural characteristics consist of gait recognition, odour, voice recognition and signature verification. The results are obtained in biometrics by using single or multiple means. The achieved results indicate that biometric techniques are much more precise and accurate than the traditional techniques. Other than precision, there have always been certain problems which remain associated with the existing traditional techniques. As an example consider possession and knowledge. Both can be shared, stolen, forgotten, duplicated, misplaced or taken away. However the danger is minimized in case of biometric means [3]. The role of biometrics is amenable in all types of security systems. With the threats / advances of technologies, there is always need to search new means for using as stand-alone applications or in conjunction with the existing systems. In order to include any new class of biometric, the condition required is that it should be universal, distinct, everlasting and collectable [4] i.e. all individuals must have those features (universal) and these features should be identifiable for each individual (distinct). The features should not vary (everlasting) and it must be easy to get required information from these features (collectable). It is obvious that ears are a prominent feature of all persons making it universally acceptable. Ear biometrics has several advantages over complete face: reduced spatial resolution, a more uniform distribution of colours and less variability with expressions and orientation of the face. In the present paper, a new ear recognition approach using wavelets is applied for human identification and PCA with dimensionality reduction technique. 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 includes pre-processing followed by feature extraction and matching in section 4. In section 5 experimental results and discussion are reported and in final section 6 conclusions are made.

II BACKGROUND AND RELATED WORK

Ear was first used for recognition of human being by Iannarelli [5] who used manual techniques to identify ear images. Samples of over 10,000 ears were studied to prove the distinctiveness of ears. Structure of ear does not change radically over time [5]. The medical literature provides information that ear growth is proportional after first four months of birth and changes are not noticeable in the age 8 to 70. Victor et al [6] and Chang et al[7] used eigen ear for identification. The results obtained were different in both cases. Chang’s results show no difference in ear and face performance while Victor’s results show that ear performance is worse than face. According to Chang views, the difference in result might be due to usage of different image quality.
Moreno et al. [3] used 2D intensity images of ears with three neural net approaches (Borda, Bayesian, Weighted Bayesian combination) for recognition. In his work, 6 images from 28 people were used to evaluate the recognition rate of about 93%. Chen et al. [8] studied two steps iterative closest point algorithm on 30 people with their 3D ear images that were manually extracted.

III PROPOSED METHODOLOGY

The Haar wavelet is a “filter” or equivalently a “convolution kernel” that can be used to extract basic structural information from a signal.

Principal component analysis (PCA) is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to (i.e., uncorrelated with) the preceding components. The principal components are orthogonal because they are the eigenvectors of the covariance matrix, which is symmetric. PCA is sensitive to the relative scaling of the original variables.

3.1 Pre-processing

Images with ear rings, other artifacts and occluded with hairs have not been processed in this research work. Each image is gone through the following steps before feature extraction.

• Ear image is cropped manually from the complete head image of a person.
• Cropped ear image is resized.
• Coloured image is converted to gray scale image.

Manual cropping has been done in the work because automated ear cropping is under process. The sizes of cropped ear image are different. In order to find same number of features from each ear image, resizing the images to unique fixed size of 64*64 pixels is made. Each image was converted from RGB to gray scale (if not in gray scale).

Fig 2 (a) cropped image (b) resized image (c) gray scale image

3.2 Feature Extraction, Training and Matching

After normalizing the ear images, next step is feature extraction. These feature vectors are used for training the database. In training process, the numbers of training images are taken and then feature vector of each image is stored in the training database along with the average of the number of training images. For matching, feature vector of test image is calculated.

Euclidean distance for all the trained feature vectors in the database and the test image is acquired. The image corresponding to the minimum value of Euclidean distance matches with the image under consideration.

Fig 1: Flow Chart of Proposed Work
IV EXPERIMENTAL RESULTS

The proposed method is implemented in MATLAB R2009a on a PC with 1.6 GHz Intel processor and 256 MB RAM. In experiments, images are collected from students. Database contains a total of 158 images with 1200*1600 pixels resolution.

Figure 4 and 5 depicts that the training time and recognition time for PCA algorithm is greater than HAAR wavelet transform, but the efficiency of PCA is better than PCA.

![Sample Data Base](image)

![Number of training image per person Vs training time for Haar wavelet and PCA](image)

![Number of training image per person Vs recognition time for Haar wavelet and PCA](image)

<table>
<thead>
<tr>
<th>ALGORITHM</th>
<th>EFFICIENCY</th>
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<tr>
<td>HAAR</td>
<td>84.23%</td>
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<tr>
<td>PCA</td>
<td>94.73%</td>
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Table 1: Efficiency of Haar wavelet transform and PCA

V. CONCLUSION

Ear biometrics got attention to the research community recently. Ear images are cropped manually and resized to a fixed size followed by conversion to gray scale. Database is trained and classification is based on Euclidean distance metric. Results obtained are promising and encouraging with correct recognition rate as well as time required. Results will improve if the orientation of the images is done in pre-processing phase.

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