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Ear biometric verification approach based on morphological and geometric invariants

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ABSTRACT

Biometric verification based on ear features is modern filed for scientific research. As known, there are many biometric identifiers that can identify people such as fingerprints, iris and speech. In this paper, the focus is placed on the ear biometric model in order to verifying the identity of persons. The main idea is based on used the moments as ear feature extractors. The proposed approach included some operations as follow: image capturing, edge detection, erosion, feature extraction, and matching. The proposed approach has been tested using many images of the ears with different states. Experimental results using several trails verified that the proposed approach is achieved high accuracy level over a wide variety of ear images. Also, the verification process will be completed by matching query ear image with ear images that kept in database during real time.

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1. INTRODUCTION

Biometric can be described as the set of methodologies that are used to estimate the bodily and behavioral features of a people in order to verification and identification process [1-3]. People verification using biometric models consider an important and common investigation area. One of the biometric models, ear structure is a distinct portion of the people structure with many different properties like form, skin, pose, and other [4-6]. The ear shape is commonly not greatly alteration in the ear shape geometry excluding the ear long is extended with time [7-10]. Ear recognition system is a newest mechanism and upcoming way for people verification. Therefore, the high matching level and false verification degree are big motivating because to the ear image hard structure [11-13]. Due to the rapid technological development, we need new approaches for personal verification. The main contribution of this research are:

- To shed light on a new approach, it is ear verification process.
- Comparing to other biometrics like fingerprint, face and iris, the ear is less popular.

That is because it is a new approach and not supported commercially. This method is helpful in medical field to recognize the identity of dead bodies [14-18]. Through this research we are going to prove the importance of this specific biometric, the ear authentication process in order to be used in other technological fields like in personal security process [19-25]. Ear structure is a distinctive organism of Man's body structure which has many different unique characteristics like form, skin, pose, and others [26-36]. In recent years, a few articles have been published on ear recognition system. Anwar et al. [5] in 2015, proposed a new technique to ear recognition system using geometrical features which are extracted from edge ear image such as mean, distance, shape, centroid, and mean. Akhavansaffar et al. [6] in 2017, presented the way to mixed two biometric models of face and ear to suggest a multimodal biometric framework which is reliable and secure. The idea based on combine the features of face and ear using probability neural

networks. In this paper the ear recognition approach is implemented via many steps, these steps are concentrated on image capturing, transforming color image to grey scale image, image binarization by Laplace operator [7], morphological operations [8], feature extraction [9] and matching [10] to get the final decision [11].

2. THE PROPOSED APPROACH OF EAR VERIFICATION

In this proposed approach, a moments as ear feature extractor is applied to identify the human. The aim is to compute moment's features from the ear image after several operations. Then, the matching process is done in order to decide the final decision. We describe outline of the proposed approach in the Figure 1.

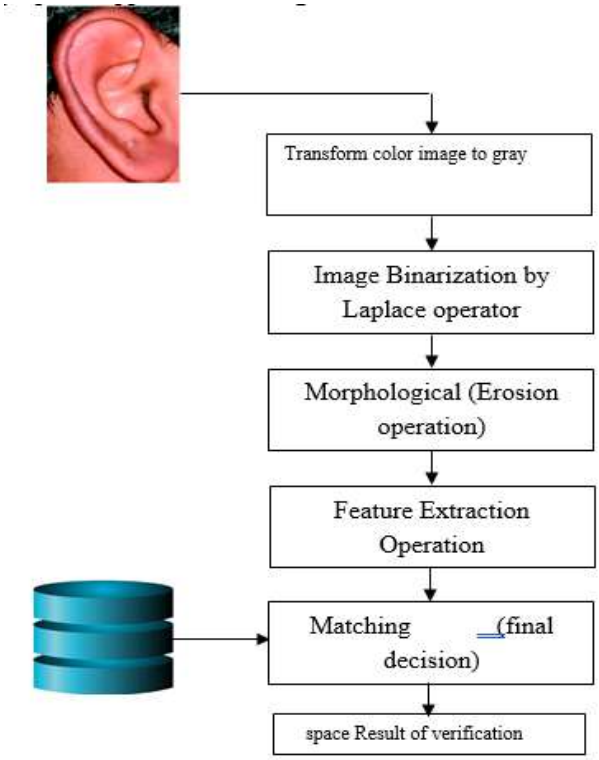

Figure 1. Block diagram of biometric verification approach based on ear image

In the first step, preparation of input image to proposed approach is standup. In second step, the Binarization operation is applied on ear image. In the third step, the erosion operation is done. The feature extraction operation is described in the fourth step. Last step, describe the matching between query ear images with ear images. The main steps of biometric verification approach as shown in the following algorithm:

Input: Ear Image
Output: Result of verification
Begin
Step 1: Load ear image and save pixels intensity to matrix with equal size to the image dimensions.
Step 2:Separate the bands of color ear image to three isolated channels (Red, Blue, and Green).
Step 3: Transform the three color bands to gray scale space G (i,j) and remove the undesired details.
Step 4: Perform the edge detection operation using Laplace filter in order to generate the binary image (Binarization) B (i,j).
Step 5: Apply the morphological technique (erosion) on the binary image which produce during step 5.
Step 6: Compute the moment invariants based on thin (erosional) structure in order to extract the ear features.

Step 7: The matching process between the computed moment invariants with all possible moment invariants that store in database already.
Step 8: Produce the result of verification:
If the similarity ratio satisfy the verification condition then
Print "the person information"; this means the person is verified.
Else Print "the person is not verified".
End.

The input data to the proposed approach is color ear image which is taken by camera Nikon or can be acquired from dataset. It was gotten with size of 460x720in file format of bmp. The colored ear image will transform to one color image (monochrome). It involves the illumination data only, no have color data. This done by using the following formal:

Intensity Relationship (I)=[0.299*R+0.587*G+0.114*B] (1)

where I represent the level of intensity, R, G, and B are the equivalent Red, Green, and Blue bands. Binarization is the procedure that transforms a monochrome image to a black and white image. This enhanced the disparity between the edges and vales in an ear image, and in sequence simplifies the features extraction from ear structures image. In this process the Laplace operator is used.

When the ear image is transformed to binary style, then, morphological operation (erosion) used to determine the actually edges in the ear image based on the structure element. This operation is very important in order to make next step easy and accurate to implement. The goal is shrinks the edge width to single pixel wide. The erosion need to achieve without changing the original edge. Moment's technique is usually used in the pattern resonation during the feature extraction stage. The goal of applying orthogonal moments as ear feature descriptors is encouraged by the theory that basic structures of both pattern and ear are based on tinny structure and the moment can define ears individually regardless other details of local features. This motivated us to use the moment's features to describe the ear boundaries. These features of moments are accomplished to describe geometrical and statistical features comprising edge structure data around ear.

In order to decide whether input ear image is verified or not, the matching process among calculated moment values with each probable moment values is performed. After that, the two sets of moment values are generated to describe the correlation degree of input ear image with ear images in database efficiently. The similarity measure used for both sets of moment values (for input ear image and template ear image) in order to measured the similarity ratio value. To calculate the similarity, correlation coefficient between the two sets moment values is estimated as follows manner:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n\left(\sum x^2\right) - (\sum x)^2}\sqrt{n\left(\sum y^2\right) - (\sum y)^2}} \quad (2)$$

where x and y templates has a robust linear correlation, the ratio is very near to 1. If the result is equal to 1 this mean there is fully fit.

3. EXPERIMENTAL RESULTS

This part describes complete analyses for the achieved results when perform the proposed ear verification approach. During this testing, the several ear images have been tested in order to assess the accuracy of proposed ear verification approach. In this experimental, the results are agreed from four samples of ear images. Figure 2 illustrations the one sample of input ear image with their images which resulting after applied each steps. As recognized in Figure 2, the erosion image more suitable in order to extract the moment's features because has high level of actual ear structure. Table 1 introduces the moment values were calculated for input ear image.

After calculated the moment values for input ear image, these values will compare with each template in database in order to identify the person. The verification process is done through compute the correlation coefficient between calculated moment values and corresponding moment values in database. Table 2 presents the results of correlation coefficient for moment values.

Figure 2. a) Input ear image, b) Monochrome image, c) Edges image, d) Erosion image

Table 1. The moment values of input ear image

Moment	Values
ϕ_1	0.547186
ϕ_2	1.426736
ϕ_3	2.757601
ϕ_4	2.476246
ϕ_5	5.392831
ϕ_6	3.259420
ϕ_7	3.783775

Table 2. The results of correlation coefficient for moment values.

Moment	Values for input ear image	Values for ear image in database
ϕ_1	0.547186	0.528733
ϕ_2	1.426736	0.989907
ϕ_3	2.757601	2.729011
ϕ_4	2.476246	2.629002
ϕ_5	5.392831	5.190923
ϕ_6	3.259420	3.257622
ϕ_7	3.783775	3.6723990
Correlation	0.993066	

4. CONCLUSION

In this paper, ear biometric system for verifying the identity of people has been presented. Seven values of moment invariants are extracted from ear image as features vector. As noted, the erosion morphological operation play very important role in obtained high accurate correlation in matching process and reduce the run time. For test the efficiency of proposed approach set of ear images for different persons are used. The experimental results demonstrated that the ear biometric approach achieves high rate of results

and produced accuracy degree approximately 99.3% on the whole tested ear images. In the future work, more dataset of ear images can used to test the performance of the ear biometric approach with more limitations such as ear covered with hair.

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