Ear Authentication Using Edge Detection and Feature Extraction

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ABSTRACT

There is an emerging trend in using ear as biometric. This paper proposes an enhanced technique of edge detection of ear, open contour representation, feature extraction and recognition. This work is performed on the ear in random orientation and show a greater accuracy than existing dominant approach. The recognition accuracy is increased by removing the noise in captured ear images and developing new methodologies to work with online images. An active contour algorithm along with canny edge detector to segment the Region Of Interest. The ear contours are then employed for authentication.

KEYWORDS: Ear Authentication, Canny edge detection, Region of Interest (ROI), Ear contours, Active contour algorithm, Feature extraction.

INTRODUCTION

Biometrics refers to metrics related to human characteristics. Biometrics authentication is used in computer as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance [12]. Biometric identifiers are often categorized as physiological versus behavioral characteristics [10]. Examples include, but are not limited to fingerprint, palm veins, face recognition, palm print, geometry, iris recognition, retina and ear. Ear possess a number of inherent characteristics such as it does not vary with facial expressions as well as age. [5, 7]

Human ear images provide rich and stable information and have attracted forensic scientists. The external anatomy of the ear is formed by the outer helix, the anti-helix, the lobule etc. [7]

Typically, a biometric ear analysis system consists of the following process: image acquisition, preprocessing, edge detection, feature extraction and authentication. Image acquisition is the initial step in image processing which gives the entire software details that quickly preserves into a system [1, 2, 13]. Image preprocessing is done to obtain the exact details of the concentrated area taken into analysis. In the edge detection process the amount of data is reasonably reduced in a data set such that the ROI analysis can be performed effectively. By feature extraction process in this case the area of interest considered for analysis results in dimensionality reduction. Generally authentication is introduced in images for reduction of image forgery, which includes removal, insertion, replacement of objects, abnormal color modification, and for identification of the forged area.

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This paper proposes a methodology to recognize online ear images using geometric features. The ear recognition system takes place based on ear height line, reference lines and angles. This process includes curve fitting of the outer ear edge and finding the proper orientation of the ear. Although proposed methodology works weakly in low hysteresis threshold, it recognizes the ear more accurately. Canny edge detection algorithm is used here to find the edges. Ear images are processed according to methodology and then raw images are found as output of the system. Finally, feature vectors are extracted and compared with the database of saved ear images and provide authentication.

![Ear Structure](image.png)

**Fig. 1:** Ear Structure

2. **Related Works:**

In this work, online personal authentication using ear images are presented. The acquired images are then used to extract the region of interest using skin detection, edge detections, and removal of extra edges. Finally, ear contours are extracted using localized region based active contour method. Two feature extraction methods were used here such as log gabor and SIFT. [6] Here an automatic, robust segmentation method using biased normalized cuts combined with a sequence of morphological operations.[4] Here an enhancement of an ear segmentation method using kernel graph cut algorithm was implemented.[3] Here the ear is segmented using active contour algorithm and they are classified based on geometrical shapes such as round, oval, rectangle.

3. **Image Acquisition:**

Image acquisition is initial stage of image processing applications. In order to test and compare the detection or recognition performance of a computer vision system, in general, and a biometric system in particular, Image database of sufficient size must be publicly available. In that we used the datasets. The dataset contains images from the left and the right ear subjects [21]. The images were taken under varying lighting conditions and the subjects were not asked to remove hair, jewelry or head dress before taking the pictures. The images are cropped from video stream, which shows the subject in different poses, such as looking towards the camera, upwards or downwards. Additionally, the ground truth for the ear’s position is provided together with the database, which makes it particularly convenient to obtain the accuracy of ear detection and to study the ear recognition performance independently from any ear detection.

4. **Preprocessing:**

Before using the raw depth scans of the profile face, some preprocessing steps are to be performed. This preprocessing used to improve the visual appearance of an image[14]. If any distortions are present remove this stage. And if any noise scans we apply Gaussian filter and to remove the noise. In this preprocessing are convert the color image into gray scale image.

```matlab
immg11=rgb2gray(imm1);
immg1=histeq(immg11);
immg2=imadjust(immg1);
axes(handles.axes2);imshow(immg11),title('Grayscale');
pause(2)
axes(handles.axes2);imshow(immg2),title('Enhanced image');
```
5. Edge Detection:

Here, the segmentation is performed by edge detection method. The purpose of edge detection in general is significantly reduce the amount of data in an image, while preserving the structural properties[3]. Ear edges can be detected by canny edge operator. The canny edge detection is an edge detection operator that uses a multistage algorithm to detect a wide range of edges in images. The algorithm runs in 5 separate steps [17]. They are smoothing, finding gradients, non-maximum suppression, double thresholding and edge tracking by hysteresis[4].

```matlab
global BW1
global immg1
BW1 = edge(immg1,'canny',0.01,8);
axes(handles.axes2);imshow(BW1)
```

Fig. 2: Preprocessed Image

6. Contour Tracking:

Since the ear has quite a lot of ridges, it seemed like as a suitable choice. We assumed that the longest edge detected would be the outer contour area of the ear. Active Contours are deformable models which operate under internal and external forces to fit object boundaries[8,9]. Since ears have a very strong gradient around the helix. So we can find region properties of edges of image. Then trace the maximum area of contour area i.e., outer edge[11,16]. After detect the outer edge then plotted by line for highlight the outer ear.

```matlab
x1=bwareaopen(BW1,max(a1));
axes(handles.axes2);imshow(x1),title('Outer Edge');
pause(2)
axes(handles.axes2);imshow(imm1),title('Contour Tracing')
hold on
plot(pkt1(:,2),pkt1(:,1),'.y')
hold off
glcm1 = graycomatrix(x1);
e=glcm1;
```

Fig. 3: Edge Detected Image
7. Feature Extraction:

The process next to contour tracking is feature extraction. The main purpose of feature extraction is data reducing by measuring certain features that distinguish objects or their parts. In this feature extraction we use the feature score based on selection of contour line of an ear[8]. In this stage longest distance points was determined. For this distance matrix for all contour point was computed [15]. The two points on the contour which are farthest apart are selected. These two points span the main axis of the ear feature vector following the center point on the line is calculated relative two that line,3 points are calculated. Based on these points the geometric feature value is calculated[18].

8. Authentication:

Each ear recognition system consists of a feature extraction and a feature vector comparison step. A unique features value is generated for each users from the method proposed, which forms a significant for avoiding ambiguity errors[3]. The authorized decision making is based on comparison with users in the enrollment stage.
RESULTS AND DISCUSSION

Initially a color image is taken and then it is converted to gray scale, then it is enhanced in the ROI. In the next step image preprocessing is done followed by edge detection as mentioned in section 5, and then contour tracking for the ROI is obtained. In the next stage feature extraction is obtained and finally authentication for the ROI is obtained as mentioned in figure 5 and 6. During this procedure the identification of contours, and longest edges were little complicated.

Conclusion:
In this paper ear authentication was obtained using Matlab. This process includes curve fitting of the outer ear edge and finding the proper orientation of the ear. Although proposed methodology works weakly in low hysteresis threshold, it recognizes the ear more accurately and accustomed with the real environment [19]. Moving person’s ear can be captured and processed through this methodology and can be traced out with a better accuracy than existing domain approach. This paper proposes a new methodology to recognize ear with a random orientation. This work can be extended for inner curve fitting of the ear and extracting features of the inner portion of the ear edge [20]. Thus by this software implementation for Ear Authentication by the following steps image acquisition, preprocessing, contour tracking, edge detection, feature extraction and authentication is obtained in an effective manner for the ROI.

Future Work:
In future this work may be implemented for any other ROI. Also the software executed can be implemented with any other software other than the implemented one. For Edge Detection any other method other than canny edge detection method can be implemented.

REFERENCES