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Research Article

EAR SEGMENTATION USING DIFFERENTIAL BOX COUNTING APPROACH

Geetha Prem P[1*], Manikandaprabu N[2], Dhivya P[3], Deepa A[4]

[1]PG Scholar, AVS Engineering College, TN, India
[2]Lecturer, Senthur Polytechnic College, TN, India
[3]Asso. Prof/ECE, AVS Engineering College, Salem
[4]ME (Communication Systems), Sona College of Technology, Salem

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*Corresponding Author: **P. Prem Geetha,** PG Scholar, AVS Engineering College, TN, India Email: suryanila333@yahoo.com

ABSTRACT

Biometrics systems based on ear are still in need of more investigation to make it robust and accurate. The most critical step in ear recognition is segmentation as all subsequent steps will depend on the accuracy of segmentation. In this paper, Box counting segmentation method is suggested. The proposed method consists of a sequence of steps. First, a Normalized Cuts method is applied to initiate the ear image segmentation process. Then, the segmentation process is perfected by performing the following functions gray-level slicing, entropy, thresholding, skeletonization, image filling and opening. Finally, a substitution process is applied. Our proposed algorithms are tested on ear images captured produced encouraging result. A 95 percent accuracy rate is achieved at an average of 10 seconds processing time.

Keywords: Component; Ear segmentation, Ear database, Biased normalized cuts entropy, Thresholding, Morphological operations.

INTRODUCTION

Biometrics deal with recognition of individuals based on their physiological or behavioral characteristics. Researchers has done extensive studies on biometrics such as finger print, face, palm print, iris, and gait. Ear, a viable new class of biometrics, has certain advantages over face and finger print. The ear is rich in features; it is a stable structure that does not change much with age and it does not change its shape with facial expressions. 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 use the helix/antihelix for ear recognition. The system has two key components: ear detection and ear recognition.For ear detection, we propose a two-step approach using the registered color and range images by locating the ear helix and the antihelix parts. In the first step, a skin color classifier is used to isolate the side face in an image by modeling the skin color and nonskid color distributions as a mixture of Gaussians. The edges from the color image are combined with the step edges from the range image to locate regions-of-interest (ROIs) which may contain an ear. In the second step, to locate the ear accurately, the reference ear shape model, which is represented by a set of dis cretevertices on the ear helix and the antihelix parts. This is followed by the local deformation process where it is necessary to preserve the structure of the reference ear shape model since neighboring points cannot move independently under the deformation due to physical constraints. The optimization procedure drives the initial global registration toward the ear helix and the antihelix parts, which antihelix between the reference ear shape model and the input image[1-3].

SEGMENTATION

In performing ear recognition, segmentation is usually considered as a vital step because recognition rate will depend on how accurate this step is. Our proposed ear recognition method consists of five basic modules leading to a decision[4].

A. Biased Normalized Cuts

This method was proposed by Maji et al. as a modification of "normalized cuts" approach, in order to incorporate priors which can be used for constrained image segmentation. This approach is considered as a summary of two graph techniques: 1) Bottom-up which look for contours corresponding to significant changes in brightness, color and texture. 2) Up-down technique which looks for strong activation that might be inadequate and the output is not sharply localized[5].

We applied biased normalized cuts to our collection of ear images and a sample result is shown in Fig. 1. Before biased normalized cut is applied, we must determine the number of cuts to divide the ear image into. Upon experimentation, we have determined that the most suitable number of cuts for our database ear images is 12cuts.

B. Intensity Slicing

In order to extract the ear part and ignore the other parts of the face, we need to determine the ear location. This can be done by using the ear boundary acquire from the result of biased normalized cuts. In this step we applied intensity slicing method to eliminate the ear image background and keep only the ear boundaries. The main objective of intensity slicing is to highlight a specific range of gray-level intensities, r_1 and r_2 in image, I and mapped to new intensity values, $s_1$and s_2 in image, In this paper we used a low-value input range, r_1 as 0.001 and the high value input range,r_2 as 0.2. . For output range, we applied 0 as low-value output, s_1 and 1 as high-value output, s_2. Intensity slicing is applied to all ear images in our collection and it successfully highlighted the ear boundary that is needed for the next process.

C. Entropy

Even though intensity slicing managed to high light all ear boundaries satisfactorily, some edge pixels are not fully connected which may cause a defect in isolating the ear segment.

D. Thresholding

The main purpose of thresholding is to segment the ear part by converting the gray scale image into a binary image. In addition, we need to enhance the ear edges so that detail information of the ear boundaries is preserved.

E. Skeletonization

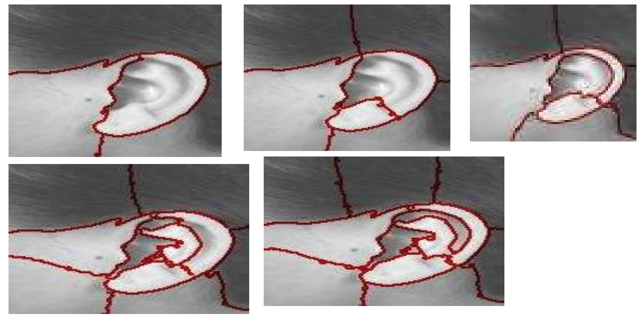
The edges of the ear images are thick and that the intricate details of the ear information are unapparent. In order to overcome this problem the morphology operation skeletonization is applied. Usually, skeletonization operation is used to remove pixels on the boundaries of objects but does not allow objects to break apart [12].The remaining pixels make up the image skeleton

F. Image Substitution

The main purpose of this step is to implement mapping function between the original ear image and image the resulting image of opening operation.

RESULTS AND DISCUSSION

The proposed segmentation method is tested on our own database of ear images which is available for public use. It consists of 200 ear images taken from the left sideof50 subjects. The images were acquired using simple imaging setup that employed a digital camera in an indoor and outdoor environment. The images were acquired over a periodof6 months in variant environments and illumination. Allthe subjects in the database are in the age group of 17-50years and each of them provided 4 ear images taken from slightly different angles.Samples of Biased Normalized cuts with 4, 6, 8, 10 and 12 cuts. Table 1 shows the segmentation rate for 4, 6, 8, 10 and 12 cuts. As can be seen from Table I, the segmentation rate increases as the number of cuts increases. We, however have to consider the segmentation processing time as the number of cuts increased. At 12 cuts, the highest segmentation accuracy rate achieved a commendable 95 percent.



EAR SEGMENTATION RESULTS OF MULTIPLE CUTS

Cuts	Accepted	Rejected	Segmentation Ratio
4	128	72	64%
6	152	48	76%
8	168	32	84%
10	177	23	88.5%
12	190	10	95%

CONCLUSION

We have proposed an automatic, robust segmentation method using biased normalized cuts combined with a sequence of morphological operations. Unlike previous ear segmentation methods that employed ear images captured under controlled environment and illumination, our proposed method managed to achieve a high accuracy rate of 95% for segmentation of ears captured under variant illumination. Using 12 cuts, the segmentation process took an average time of 10 seconds per image. The segmentation method will later be used in an ear recognition system.

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