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Research Article

PROFILE FACE EXTRACTION BASED ON EAR REGION DETECTION

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ABSTRACT
Ear detection from a profile face image is an important step in many applications including biometric recognition. But accurate and rapid detection of the ear for real-time applications is a challenging task, particularly in the presence of occlusions. For identification, first ear region should be detected from profile faces. In this work, we adapted the cascaded profile faces from canons approach to detect ear from a 2D profile face images. Profile face image is getting as input image. In profile face, ear image region is estimated by profile faces canons. And then after review, ear region is specified as a frame. Finally, we extract profile face region based ear region detection. For this aim, we use filtering, edge detection algorithm, closing morphology and noise elimination. Experiments are performed on CVL image database. Also, with increasing number of profile image database we evaluated two important biometric factors that are included False Detection Rate (FDR) and Correct Detection Rate (CDR).

***Keywords**: Biometrics, Profile Face, Ear Detection*

INTRODUCTION

Biometric is measurement of behavioral or physiological characteristics of an individual. Major biometric features involve fingerprints, retina, palm-knowledge, iris, hand and facial structure, voice, teeth, handwriting, keyboard text, walking and speech, ear smell, signature, hand veins shape and DNA. Biometric approaches are commonly divided into two main branches that depend on the features. This is in order to claims verifying and to identification (Nabiyev, 2009) (Nabiyev, 2005).

Face recognition has become one of the most important biometrics authentication technologies in the past few years because of its aptness in various applications and non-intrusive nature.Most of proposed face recognition methods are 2D based and designed to work with images of frontal face. Although the human face has a 3D nature, thus all of information about the face structure is not present in the frontal view. In the other words ,facial profile curve includes different information of the face which is not present in the frontal view. Also in some applications like the situation of a driver entering a gated region (Kakadiaris *et al.*, 2008), the individual surveillance purpose or walking in a corridor, a frontal face image may not be available or hard to acquire. In these status a profile based method is more useable and maybe the only way identifying the individuals. Moreover it is rather easy to analyze, more foolproof (Bhanu and Zhou, 2004) and stronger to illumination variations comparing with the systems of frontal based face recognition. Within the last decade, several algorithms have been proposed for automatic person identification using curve of face profile.

Biometrics is the science of establishing identity of an individual based on the chemical, physical or behavioral attributes of the person. Biometrics relevance in modern society has been reinforced by the need for large-scale identity management systems that functionality relies on the accurate determination of an individual's identity in the context of several different applications. Simple of these applications include granting access to nuclear facilities, sharing networked computer resources, performing remote financial transactions or boarding a commercial flight.

The various biometric that include Ear, Face, Finger prints, vein pattern, voice, Signature, iris, Hand Geometry, Keystroke Pattern, palm print, gait etc.

Face recognition is an unsolved problem under the illumination, conditions of pose; database size etc., attracts significant research efforts yet. The main reasons of ongoing research are its many real world applications such as human/computer interface, authentication, surveillance, perceptual user interfaces and lack of robust features and classification schemes for face recognition task. Principal Component Analysis (PCA) is a typical and successful face based technique. Extracting the basic features such as eyes, nose and mouth exactly, is necessary for most of the feature based approaches. Other Face Recognition approaches based on Discriminate Analysis and Feature Extraction as well as exists but the achievements in the field of automatic face recognition by computer is not as satisfactory as in other region such as fingerprints and pattern recognition etc. Despite of the good results of PCA in database, because of all pixels in the image are essential to obtain the representation used to match the input image with all others in the database (Neerja and Ekta, 2008).

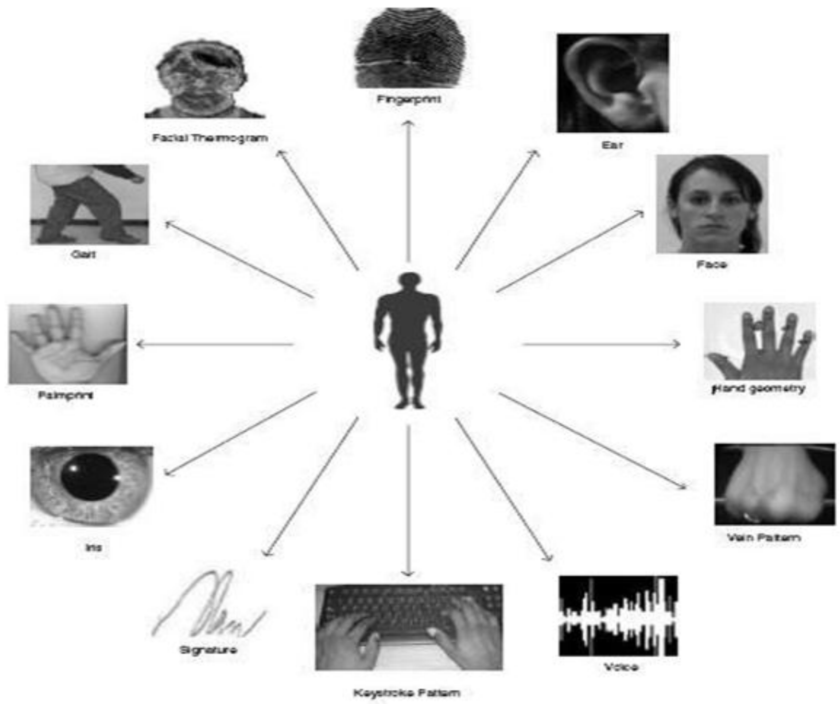


Figure 1: Biometric Parameters of a person

Ear biometrics has received low attention compared to the more popular techniques of face, eye, or fingerprint recognition. Although, ears have played an important role in forensic science for many years, especially in the United States, where a system of ear classification based on manual measurements was developed by Iannarelli, and has been in use for more than 40 years (Jain *et al.,* 2008). Several reasons account for this trend: first, ear recognition does not suffer from some problems associated with other non contact biometrics, as face recognition; second, it is the most promising candidate for combination with the face in the context of multi-pose face recognition; and third, the ear can be used for human recognition in surveillance videos where the face may be occluded completely or in part. Even though, current ear detection and recognition systems have reached a certain level of maturity, their success is limited to controlled indoor conditions. Also to variation in illumination, other open research problems include hair occlusion; ear classification; ear symmetry; ear print forensics; and ear individuality (Pflug, 2012).

In this work, we adapted the cascaded profile faces from canons approach to detect ear from a 2D profile face images. Profile face image is getting as input image. In profile face, ear image region is estimated by profile faces canons. And then after review, ear region is specified as a frame and ear region is cropped. After detection of ear region with help of profile face canons relation, profile face region has been shown by frame. Face profile canons will be explained in next section. Figure 2 shows the process of proposed method for ear detection in profile face image system.

In the following section we review some of ear detection methods. In this section, ear detection method is included several subsection as filtering & Enhancement, edge detection, noise elimination & morphology and profile faces from canons. Profile face extraction process describe in section 3. Experimental results summarized in section 4. Finally, we conclude by Conclusions and some future work direction.

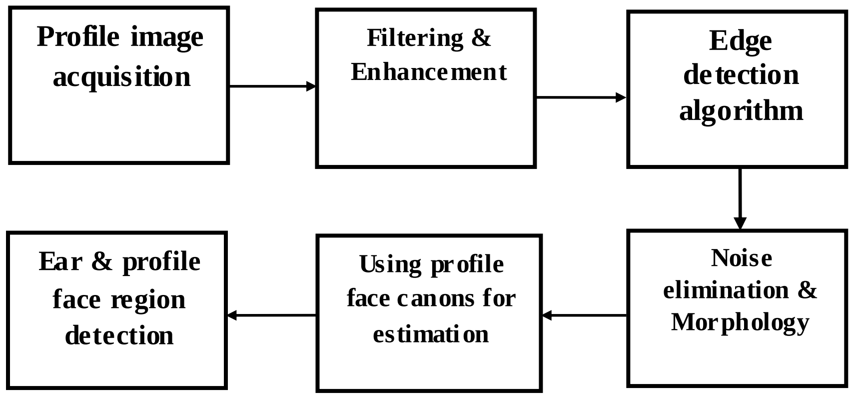


Figure 2: Outline of the method for ear detection in profile face image

MATERIALS AND METHODS

Ear Extraction Process

Most of proposed methods for extracting the ear region is commonly based on skin color segmentation, Shape model, Helix Shape Model, Histograms of Categorized Shapes connectivity graph (Pug and Busch, 2012) (Singh, *et al.,* 2013) (Lei *et al.,* 2013). We adapted the cascaded profile faces from canons (Habiboghli *et al.,* 2014) approach to detect ear from a 2D profile face images. In this work, profile face image or ear region image is getting as input image. In profile face, ear region image is estimated by profile faces canons. And then after review, ear region is specified as a frame. Obtained gray ear registered by mask and then perform recognition processes.

A. Filtering and Optimization

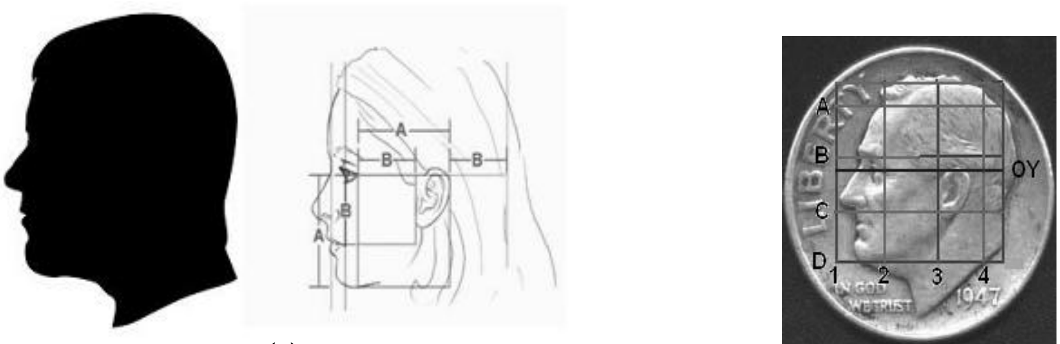
Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel. Linear filtering is filtering in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighborhood.

B. Profile Faces from Canons

For identification first ear region should be detected from profile faces. In general the relation between man and women faces are same. Of course don't forget that these relations may be having difference for various humans. Faces have been seen from profile, the height and length of it is three and half unit. So the human's head from profile are as a square. If draw a straight line from lips to up, this line passes from eye accuracy. Straight line passes from end of nose tangent low lip. Upper lip and small section of brow stand out of line. Chin and nostril state in both side of this vertical line.

If distance between chin to eye is called A, distance between eye to end of ear is same distance too. If distance between lips to eye is called B, distance between eye and first of ear is B too. Distance between eye and outset of ear equal to distance between extremity of ear and end of head; but may be this distance be more than real size. Figure 3 show a profile image of man and women.

If evaluate profile image of human head, is achieved (b).the profile image of human head constitution same selection. Here distance between A-B, B-C, C-D, 1-2, 2-3and 3-4 are same. OY line divides the head of human for two same parts. Of course this division valid for normal human's head. Generally these evaluations don't give a quite right result (Parramon, 1989) (Nabiyev, 2009).



(a) (b)

Figure 3: (a) Profile image of man (b) Profile image from canons

C. Edge Detection Algorithm

First, in preprocessing image transform to gray format. In this transformation red, green and blue portions of each pixel multiply respectively 0.11, 0.59 and 0.3 in order to determine its value. After get the gray images, applied the edges detection algorithms in order to determine edges. For this aim, we use Sobel's edge detection one of sharpening filters types.

Sharpening filter is used to enhance the edges of objects and adjust the contrast of object and background transitions. They are sometimes used as edge detectors by combining with thresholding. Sharpening or high-pass filter allows high-frequency components to pass and delete the low-frequency components. For a kernel to be a high-pass filter, the coefficients near the center must be set positive and in the outer periphery must be set negative. Sharpening filter can be categorized into four types: high-pass filter, Laplacian of Gaussian filter, high-boost filter, and derivative filter.

D. Noise Removal and Morphology

Another common application of image processing is the enhancement of images through the use of sharpening and noise removal operations, which require some kind of neighborhood processing. Traditionally, these kinds of operation were performed using linear filtering.

Mathematical morphology involves geometric analysis of shapes and textures in images. An image can be represented by a set of pixels. Morphological operators work with two images. The image being processed is referred to as the active image, and the other image, being a kernel, is referred to as the structuring element. Each structuring element has a designed shape, which can be thought of as a probe or a filter of the active image. The active image can be modified by probing it with various structuring elements. The elementary operations in mathematical morphology are dilation and erosion, which can be combined in sequence to produce other operations, such as opening and closing.

Profile Face Extraction Process

Most of proposed methods for extracting the face region is commonly based on skin color segmentation (Kakumanu *et al*., 2007) (Hjelmas and Low, 2001) (Yang, 2002). These methods use color components of a known skin model to classify every pixel of image such as skin or non-skin. Although, (Kakumanu *et al*., 2007) shows that using a predefined skin color model to extract the face area is a very challenging task such as the skin color in an image is sensitive to different kind of factors as: ethnicity, camera characteristics, illumination variations, individual characteristics and some other factors.

We propose a new method that matches the skin color model in phase of face extraction. The introduced method, utilizes the skin instance of every individual such as him/her skin color model. Here, we use characterized skin color information for detection of profile face skin and use the boundary of rectangular area for profile face that is proportional with boundary of rectangular region of ear, too. We apply morphological operation and edge detection for profile face image.

Finally, extracted profile face image is obtained by applying pink boundary of rectangular area as shown in figure 4.

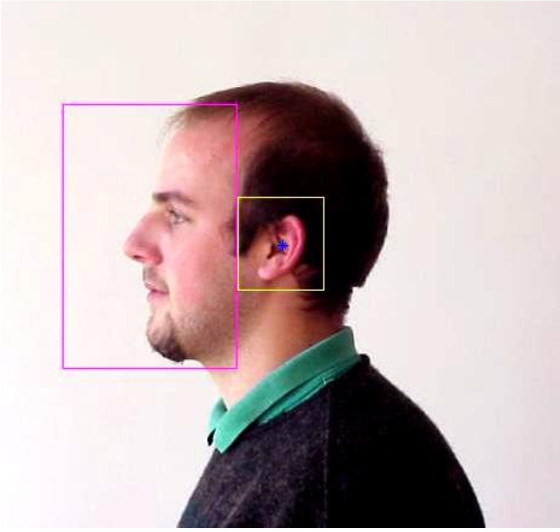


Figure 4: The two rectangular region used in skin face profile segmentation phase

This window is also defines according to the detected size of ear region and location, as is shown in Figure 4 by a pink rectangular window. Classification of every pixel in the green rectangular region as skin or non-skin is based on definition of explicitly (through a number of rules) the boundaries skin cluster in some color space. The Cb and Cr components in YCbCr color space are used to characterize the skin color information. For example
YCbCr is classified as skin if:

Cb>=77 & Cb<=127 & Cr>=133 & Cr<=173

These colors spaces separate RGB (Red-Green-Blue) into luminance and chrominance information and are useful in compression applications although the colors specification is partly unintuitive. The YCbCr color space is generally used in image processing as it separates the luminance, in Y component, form the chrominance described through Cb and Cr components. Several definitions of this transformation exist. In this paper, the luminance Y is constructed as a weighted sum of RGB components, and the Cb and Cr components are obtained by subtracting Y from respectively blue and red RGB components, as (Vezhnevets *et al.*, 2003):

Y=0.299R+0.587G+0.11B
Cb=B-Y
Cr=R-Y
The formulae for converting from RGB to YCbCr are given below.

Y = 0.299R + 0.587G + 0.114B
Cb = -0.169R - 0.332G + 0.500B
Cr = 0.500R - 0.419G - 0.081B

The extracted region may still include some holes in the eye or eyebrow locations. To fill these holes, it needs to apply morphological operations to have perfect segmented binary profile face image. We use a consecutive dilation and erosion with a same kernel window of size 3x3. The kernel size should be selected as small as possible to have minimal effects on the curve of profile boundary. Figure 5 shows the stages of detection and extraction of profile face curve. The final segmented face profile is shown in Figure 5(d).

(a) (b) (c) (d)

Figure 5: The probability image: (a) Raw grayscale mode, (b) after applying morphological operations(c) Edge detection for binary image of pervious stage and (d) Profile extracted applying boundary of rectangular region for profile face

RESULTS AND DISCUSSION

Proposed method has been simulated with MATLAB software on the CVL face database. CVL database have 798 face images for 114 different people and everyone have 7 face images with different angle. Resolutions of images are 640*480 pixels with jpeg format. This face images are included different images of men and women. Figure 6 shows a simple of CVL image database (Peter, 2014).

The simulation was done on the CVL image database. In this simulation we selected profile face images of database. Ear detection method is included several subsection as filtering & optimization, edge detection, noise elimination & morphology and profile faces from canons that Figure 7 show it. Figure 8shows detection of the ear images and profile face extraction by the proposed detector.

Table1and Table 2 Shows results of simulation. As table1 shows, total numbers of experiments on CVL image database is 80.

After performing suggested method by MATLAB software no of false ear detection is 6 and number of correct detection is 74. So false ear detection rate is 0.07 and correct ear detection rate is 0.93. It should be mentioned our suggested method has weakness for the profile face that their ear is hidden or is not recognizable. So in this research, we selected images of CVL database that satisfy this constraint that means the ear was not hidden.

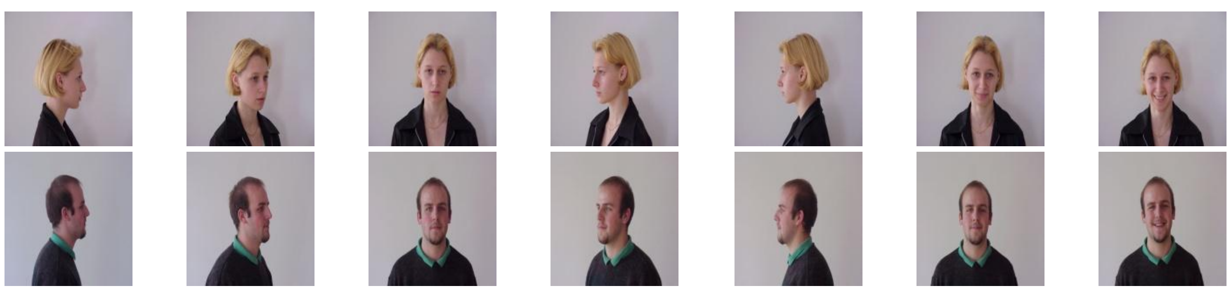


Figure 6: Some image samples of different individual in the CVL face database

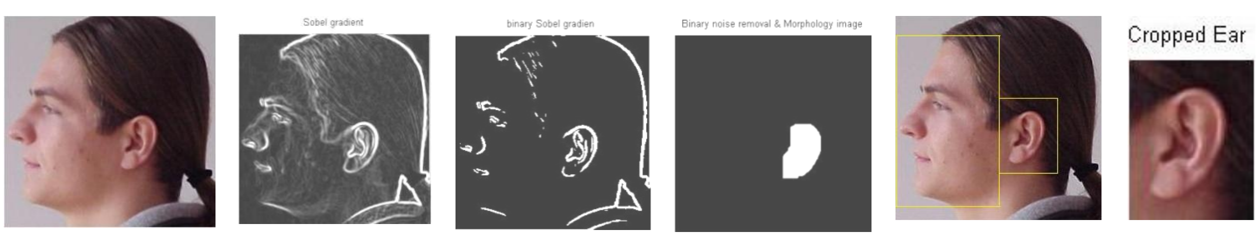


Figure 7: A sample of implemented stapes's images of proposed method for ear detection in MATLAB

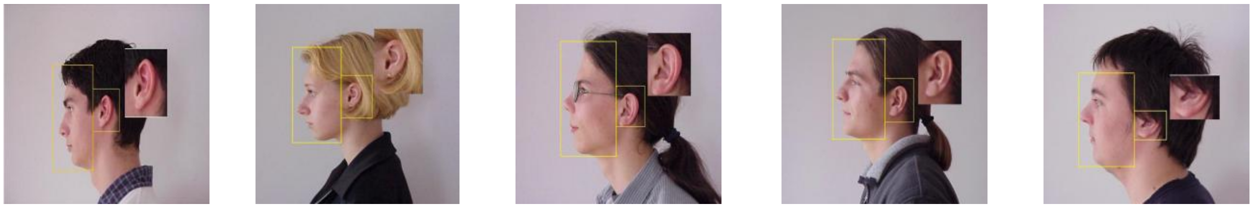


Figure 8: Detection of the ear images and profile face extraction by the proposed detector

Table 1: Detail Results of Testing my Proposed Method on CVL Face Database for Ear Detection

No. of images	No. of False Ear Detection	No. of Correct Ear Detection	False Ear Detection Rate	Correct Ear Detection Rate
80	6	74	0.07	0.93

Table 2: Detail Results of Testing my Proposed Method on CVL Face Database for Profile Extraction

No. of images	No. of false Profile Extraction	No. of Correct Profile Extraction	False Profile Extraction Rate	Correct Profile Extraction Rate
80	3	77	0.04	0.96

Through all of 80 selected images, number of false Profile extraction 3 and number of correct profile extraction has been 77. So false profile extraction rate has been calculated 0.04 and correct profile extraction rate has been calculated 0.96.

Conclusion

Ear detection from a profile face image is an important step in many applications including biometric recognition. But accurate and rapid detection of the ear for real-time applications is a challenging task, particularly in the presence of occlusions. Our method for ear detection based on the Profile faces from canons is fast, accurate and robust.

We adapted the cascaded profile faces from canons approach to detect ear from a 2D profile face images. Profile face image is getting as input image. In profile face, ear image region is estimated by profile faces canons. And then after review, ear region is specified as a frame and ear region is cropped. Finally, we determined profile face region by frame with help of profile face canons and ear region detection. In future, we recognize identity by determining of ear region and profile face extraction with their relation that can be used for identification in driving and entrance.

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