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Biometric Identification System by Lip Shape

Shokhan M. H.* and Khitam A. M.
University of Al-Anbar, Computer College, Iraq

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Abstract

Biometric authentication techniques are more consistent and efficient than conventional authentication techniques and can be used in monitoring, transaction authentication, information retrieval, access control, forensics, etc. Human-lip shape detection is an important criterion for many automated modern system in present day. Like computerized speech reading, face recognition etc. system can work more precisely if human-lip shape can detect accurately. There are many processes for detecting human-lip. This paper presents an approach for biometric identification system based on lips shapes recognition in low resolution images of human faces. The presented technique uses edge detection for detecting the region of a human-lip shape, we called it lip contour and colour filtering for noise reduction and enhancement of the desired recognition of lips. Also discusses advantages of this method, its use, and future development.

Keywords

Lips Recognition, Biometric Authentication, Lips Detection, Lips Shape.

1. Introduction

Biometrics-based authentication techniques have gained much importance in recent times. The main idea behind this approach is to identify human beings uniquely from their inherent physical traits. Identification from biometric parameters eradicates the problems associated with traditional methods of human identification. Human beings are identified from their physical features and not by some external object which they have to present for the process. Near accurate results are obtained as it is difficult to duplicate one's personal features. Various well known methods have already been implemented in human identification (retina, iris, fingerprint, face etc.) [1, 2, 3, 4, 5]. Although widespread progress has been made in this respect, it has been observed that even established biometric modalities fail to give accurate results in all real-life scenarios.

Thus, novel biometric modalities are being researched on which can be used for identification effectively in real-world environment [6, 7]. Numerous measurements and signals have been proposed and investigated for use in biometric recognition systems. Among the most popular measurements are fingerprint, face and voice. Each of these biometric traits has their pros and cons with respect to accuracy and deployment. The use of lip-region features as a biometric straddles the area between the face and voice biometric.

Although in present days there are lots of high resolution cameras Find scanners, there still can remain pictures (e.g. portions of a high resolution images) with small dimensions which are important for image analysis (e.g. faces in high resolution image) [8]. This problem is usually very hard to solve. This paper describes a method for lips recognition in such low resolution images. Recognized lips would help to improve accuracy of speech recognition algorithms and person identification. Any processed face image is very important to filter before it is possible to find desired features. Noises should be removed by image smoothing and sometimes it is important to convert the image to other colour space from RGB (e.g. grayscale). Finally, image enhancing is applied and such picture is ready for further analysis or recognition [9].

*Author for correspondence

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2. Review Works

Lip shape characteristics have been widely used in forensics by experts and by the law for human identification. While examining human lips characteristics the anatomical patterns on the lips are taken into account. Studies have shown that the grooves in the human lips are unique to each person, and hence can be used in human identification.

Although the study of Chieloscopy has gained much prominence in recent times, the idea was proposed in 1968 by Yasuo Tsuchihasi and Kazuo Suzuki at Tokyo University [10, 11]. They studied the lip prints of people of all ages and concluded that lip characteristics are unique and stable for a human being. Much recently, it has been studied that lip prints can also be used to determine the gender of a human being [12].

The pioneer of Chieloscopy, Professor J. Kasprzak, analysed 23 unique lip patterns [13-14] for finding features of human beings. Such patterns (lines, bifurcations, bridges, pentagons, dots, lakes, crossings, triangles etc.) are very similar to fingerprint, iris or palm print patterns. The statistical characteristics features extracted from the lip prints also account for unique identification.

Michal Choras has re-affirmed the belief in his recent studies [15, 16] that the lip can be used as a primary biometric modality for successful identification purposes. He has shown that geometrical analysis of the anatomical parameters of the human lip can be monitored for successful identification. Lukasz Smacki has also done significant research studying the groove patterns in the human lips for personal identification [17]. He has also proposed a method of lip print identification using DTW algorithm [18].

3. Non-Relevant Parts Removal

As there is only need for lip recognition, all other parts of the face and picture are not important and could cause misclassification. The advantage of low resolution images is the fact, that almost every face feature, including mouth, is edge or consists of very few edges. That's why edge detection can be used for image filtering. SUSAN (Smallest Univalue Segment Assimilating Nucleus) edge operator has been used for edge detection [19]. It is fast and has better results than other edge detection operators as shown in figure 1. Only a part of the SUSAN edge detection operator was used to get the edges enhanced as in this time edge directions and other edge information is not used.

Figure 1: Detected edge and image subtraction

The edge image is considered to be a mask. The original image is masked and only edge parts of the image are considered. The image contains only a few colour pixels on potential edges, which could be desired lips or mouth. From now lips and mouth detection can be performed.

4. Color Extraction

RGB colour scheme of the image is not suitable for immediate processing as it contains a lot of mixed information about lightness etc. Another colour scheme should be used. Very convenient colour scheme is YCbCr as it separates luminance, blue chrominance and red chrominance. These colours are very convenient as the mouth is considered to contain high red and low blue components in comparison with other face regions [20,21]. The YCbCr colours can be computed from the RGB as follows:

$$Y = 0.229*R + 0.587*G + 0.144*B \quad \ldots(1)$$
$$C_B = 0.168*R - 0.3313*G + 0.5*B + 128 \quad \ldots(2)$$
$$C_R = 0.5*R - 0.4187*G - 0.0813*B + 128 \quad \ldots(3)$$

With this colour scheme it is possible to start lip detection. To be more precise the pixels of the lips can be described by the probability, that current pixel is mouth pixel. Because lips pixels contain high red and low blue components (seen below formula) the lips detection can be correlated to the red chrominance (Cr):

$$isLipColor(x,y)=C_R(x,y)2*(C_R(x,y)^2-\eta*(C_R/C_B))^2 \quad \ldots(4)$$
$$\eta = 0.95*(\sum C_R(x,y)^2/(\sum(CR(x,y)/CB(x,y)))) \quad \ldots(5)$$

Is LipColor function returns values in range of <0, 255> where 0 represents values, which are not lip colour similar and 255 for colours very similar to lip colour. In next image, each pixel of the filtered and edge masked picture 2 is computed by isLipColor function (the result as shown in figure 2).

Figure 2: Image generated by is Lip Color function and its thresholded version

G : green
C : cyan
M : magenta
$Rx = 2.0*R+1.715*G+1.13*B$

The Color Adjustment Method:
Y : yellow
ST : skintone
R : red
B : blue
G : green
C : cyan
M : magenta

$Rx = 2.0*R+1.715*G+1.13*B$
$Ry = R+4.5907*G+0.0601*B$
$Rz = 0.0565*G+5.5943*B$
$D = Rx+Ry+Rz$
$Px = Rx/D$
$Py = Ry/D$
$Line_{Y-G}: y=3.36x-0.78588$
$Line_{ST-Y}: y=1.260274x-0.086671$
$Line_{R-ST}: y=0.663317x+0.112116$

5. Lip Detection

Light regions in left image of 5 represent very high probability of lip pixels of the processed image. After thresholding, all pixels with high probability level are presented in the right image of 5. Largest region in the image represents mouth. This can be said thanks to edge filtering, so there will always be only few large regions among which lips would be the largest one. The largest region is recognized by image erosion. After several applications of simple “image erosion” filter, only few pixels remain. These remaining pixels are certainly from the largest region and can be used as a seed for colour filling. Filled area is certainly the largest area, which is lip region and the detection is almost done. The centre of the area is computed, its height, width and also deformation coefficient describing average distance of the pixels from the centre, which can be used to determine mouth shape. Final output of the detected lips to the processed image.

Figure 3: Filled lips and the detected lip position

5.1 Lip Shape Recognition Algorithm

Lip recognition algorithm consists of two necessary steps:

Step 1: Locating the Lips

Original image, Image with Color Adjustment, Color Adjustment Method

Image with Color Adjustment, Binary image Method

Grey scaled image, Image with vertical filter, Binary image

The inversion image of addition

The combined Image, The dilated Image The thinned Image

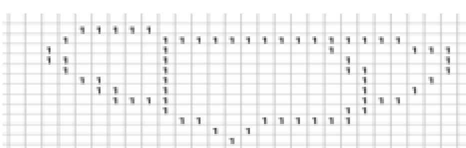
The Image located to matrix, Only lips in the lips area

Step 2: The Criteria to Defining lip Expression

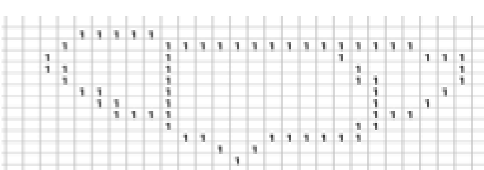
1- The concavity of upper lip
2- The concavity of lower lip
3- The ratio between eyebrow-lips distance and the lips length

In details the Criteria to Defining lip Expression as follow

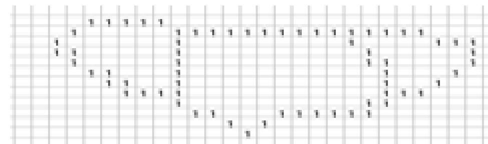
1. The Appointment of Horizontal Minimum Point (Y1): Lip matrix is scanned top-down and left to right. The middle point of first vertical array is appointed to horizontal minimum point (Y1)



2.The Appointment of Horizontal Maximum Point (Y2): Lip matrix is scanned top-down and right to left. The middle point of first vertical array is appointed to horizontal maximum point (Y2)



3.The Appointment of Vertical Minimum Point (X1): Lip matrix is scanned from left to right and top-down. The middle point of first horizontal array which has at least (Lip length /15)+2 , pixels is appointed to vertical minimum point (X1)

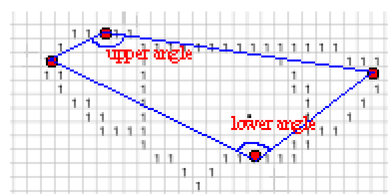


4.The Appointment of Vertical Maximum Point (X2): Lip matrix is scanned from left to right and bottom-up. The middle point of first horizontal array which has at least (Lip length /15)+2 pixels is appointed to vertical maximum point (X2)

X1 is eliminated, if (the row number of X1) < (the row number of Y1 or Y2)

X2 is eliminated, if (the row number of X2) > (the row number of Y1 or Y2)

5.The Concavities of Upper and Lower Lip:

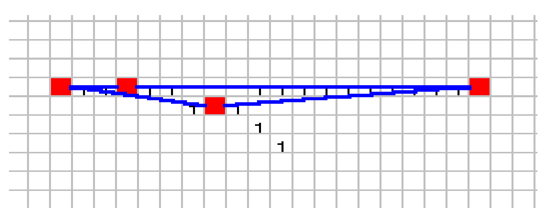


i : row number j : column number

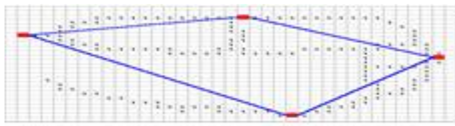
Lower Angle : $ArcTan ((X2_j - Y1_j) / (Y1_i - X2_i)) + ArcTan ((Y2_j - X2_j) / (Y2_i - X2_i))$

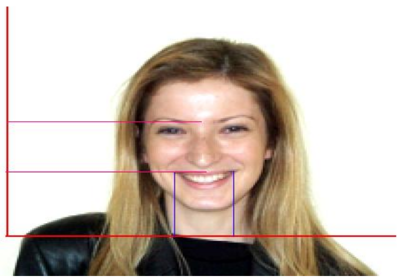
Upper Angle : $ArcTan ((X1_j - Y1_j) / (X1_i - Y1_i)) + ArcTan((Y2_j - X1_j) / (X1_i - Y2_i))$

Examples of maximum and minimum points selection



Examples of maximum and minimum points selection





Y = the distance from eyebrow to upper lip
X = the lips length
Ratio = Y / X

5.2 Experimental Results

In this paper, simulation results are presented which is performed on the human images for lips shapes recognition. Experimental Result of lip shape recognition system as shown in figure (3). The tests correspond to the different human images show a good results when applied on different images with low resolution. After the processing the noise in both images is considerably reduced yet preserving the lip boundaries as shown in the figure 4.

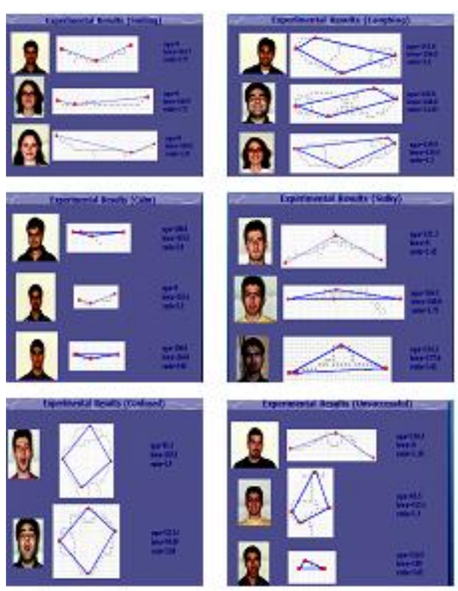


Figure 4: Experimental Results of lip shape recognition system

Table 1 : Results of Samples Test

Total	**laughing smiling confused sulky calm**					
# of samples	50	60	34	33	54	209
# of successful samples	37	45	33	31	50	194
Success ratio (%)	92	92	97	94.8	93.8	93.8

The result of tabel1 show that this algorithm works well on low resolution images. Future work will be focused on better region identification as there can be regions of similar size, which lead in lip misidentification. Also novel approaches using multiple masks based on more features such as hue colour of the face, lip corners etc. should be used.

6. Conclusion and Future Work

Biometrics systems based on lip shape recognition are of great interest, but have received little attention in the scientific literature. This is perhaps due to the belief that they have little discriminative power. However, a careful study shows that the difference between lip outlines is greater than that between shapes at different lip images of the same person. So, biometric identification by lip outline is possible. The presented method is very useful for detecting mouth position and size from the low resolution images. It is also independent on head position. Algorithm is very fast and can be used in real-time applications. The gained information can be used for identification of speakers in the video streams and may improve accuracy in speech recognition algorithms.

In future, the work can be done on an identification system that incorporates the features of both lips and speech. Accuracy can be improved by the use of other feature extraction techniques. Accuracy can also be improvised by incorporating several feature extraction techniques to form a unique one.

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Shokhan M. H. is currently a M.Sc. in the Department of Computer Science at Al-Anber University. I received my master's degree in image processing from the Department of Computer Science, Al-Anbar University, Iraq in 2013. I joined in 1 October 2013 Computer Sciences Department, Al-Anbar University, Iraq, as lecturer. Shokhan M. H. has worked on various problems in computer vision, image processing, 3D visualization, computer graphics, and geometric modeling. His current research interests are in volume image analysis and representation of free-form shapes with parametric curves, surfaces, and volumes.
Email: Project.project88@yahoo.com.

Khitam A. M. has received B.Sc. in Computer Science, A-lAnbar University, Iraq, (2005-2009). I received my master's degree in image processing from the Department of Computer Science, Al-Anbar University, Iraq in 2014. Fields of interest: Adapting of Biometric image and watermark technique. I taught many subjects such as steganography system, computer vision, image processing.