Gender Classification from Hand Shape

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***Abstract*—Gender classification is important in identify the gender of a criminals and also minimize the list of suspects search from hand shape. It is also useful for of female security purpose. Using a small dataset of 50-hand shape images for 25 persons of different ages and genders is analyzed. By considering some geometry, region & boundary features it is possible to distinguish male and female. Features extraction can be done by using three methods Gabor filter, Zernike moment and Fourier descriptor. The features of each hand is represented by using higher order ZM (Zernike moment), FD (Fourier descriptor) and GF (gabbro filter). Finally, comparison is done by using feature level fusion techniques. The proposed system is implemented in MATLAB and has achieved accuracy of 91.99 % average.**

***Keywords*—ZM, FD, GF, classification, fusion.**

I. INTRODUCTION

Today gender classification is mainly used in social interactions and Services. Biometric systems such as face authentication and recognition can be check or improve with the help of gender classification [1]. Most of gender classification studies are based on face. There is very little research over hand base. In this paper investigation of a problem of gender classification by using hand shape is done. Considering some geometry, region and boundary features it is possible to distinguish male and female. This system divides the hand silhouette into six different parts corresponding to the palm and fingers. To express the geometry of each part Gabor filter, Zernike moments and Fourier descriptors are used. Classification is done with minimum distance classifier, this study have experimented using each part of the hand separately and fusing information from different parts of the hand. Using a small database containing 25 males and 25 females, the proposed system is implemented in MATLAB and has achieved accuracy of 91.99% average.

Various studies have been found on face based gender classification and fewer researches on hand bases. The first study addresses the issue of gender classification from hand images in computer vision. However, for a long time in the fields of anthropology and psychology extraction of gender information from human hands has been studied. several studies have found that, hand dimensions of males and females have significant difference. Ecker [12] (1875) have found three relations of relative finger length in a human hand. The index finger is shorter than the ring finger, the index finger is equal in length to the ring finger and the index finger is longer than ring finger. Mantegazza[13] (1877) found that, all three relations may be occur in both sexes. Relatively index finger is found long more frequently in females than in males. George [8] (1930) have observed that, fingers length is more in a human hand in males. While, the index finger is shorter than the ring finger, when it is studied for Canadian population it is predominant in females. Similar results have been reported in more recent studies. Mcfadden and Shubel [16] discussed all six possible ratios between the index, middle, ring and little fingers in male and female gender. He concludes that, the ratio exhibiting the largest gender difference was the relative lengths of the index and ring fingers. In another study, Agnihotri [17] found that, the average breadth and length of hand are about 1 cm and 1.5 cm. it is correspondingly greater in males than in females. Hand index is the ratio of hand breadth to hand length, he found that, in males the average hand index was more than 44% while, in females the average hand index was less than 44%. Based on these results, he suggested using this value as a threshold for determining gender by hand dimensions. However, till today there is no conclusive study to which features determine gender classification. It proved that gender cannot be determined using a single feature, but it needs the combination of number of features. we have studied the problem of gender classification by extracting more powerful hand features from hand images. Our aim is to build a system that can distinguish between male and female subjects using hand shape information.

II. METHODS AND EXPERIMENTS

A new system is proposed for gender classification by using hand shape. Fig.1 shows, the block diagram of the proposed gender classification by using hand shape. In next paragraphs few steps are explained.

A. Image Acquisition and Preprocessing

Input image

Here the input image is hand shape in bmp format. In our system we acquired the image by using CCD camera, and lighting table. The captured image size is 250×250. Each captured image is goes through preprocessing stages. The acquired image is free from noise and shadow, that's why this set up, is of very high quality.

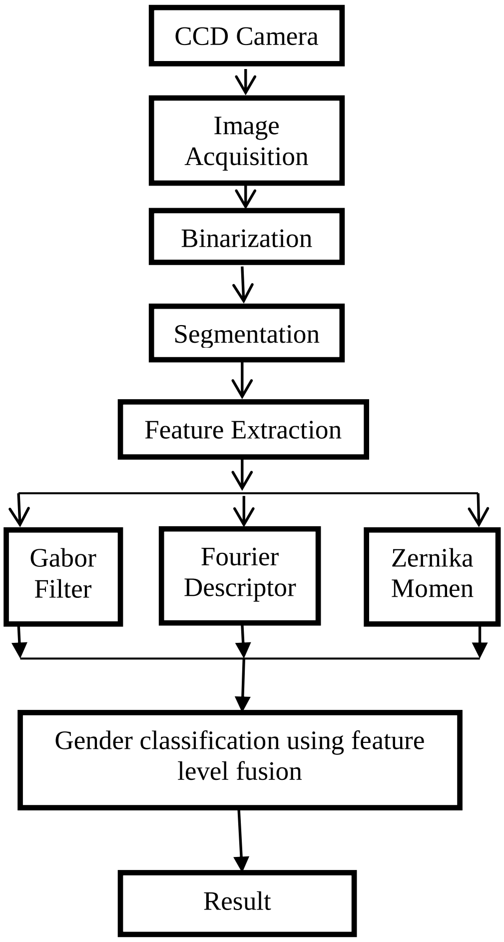

Fig.1: Block diagram of the Gender classification system

Fig.2: input image

Filtering

The input image is in RGB format. So it is first converted into gray scale image, since most of the image processing is done on gray scale images. Generally, [3] images are corrupted with noise and due to body movements, Thus filtering(top hat and bottom hat) is done to remove noise.

Fig.3: Filter image

Segmentation: The goal of segmentation is to separate black part and white part. Segmentation is to cluster pixels into salient image regions that are regions corresponding to individual surfaces, objects, or natural parts of objects. Segmentation could be used for object detection, medical imaging, video surveillance, traffic control system, compression of image.

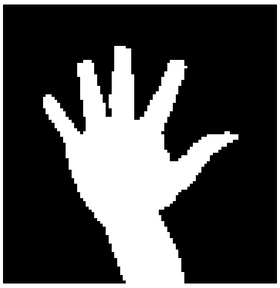

Fig.4: Segmented Image

Feature extraction

After the segmentation of hand, each region represents a set of feature. In the proposed system we used here two mpg-7 shape descriptor for representing the geometry of palm and finger. The work of mpg-7 is to divides shape descriptors in two categories, first contour-based and second region-based. Contour based shape descriptors use the shape's boundary to extract shape information, while region-based shape descriptors exploit the shape's region to represent shape information. In this work, three feature extraction methods are used. First method is Gabor filter, second method is Zernike moment and third method is Fourier descriptor.

Gabor filter

Gabor-filter based methods have been successfully applied for a variety of machine vision applications, such as texture segmentation, edge detection, object detection, image representation, and recognition of handwritten numerals. A one-dimensional Gabor filter is defined as the multiplication of cosine/sin wave with a Gaussian window. Gabor filters are used because they have orientation-selective properties and frequency [4]. Therefore, a properly tuned Gabor filter can be used to effectively preserve the ridge structures while reducing noise [5]

- Gabor Transformation :
- Orientation φ
- Frequency f
- Sigma (standard deviation of gaussian distribution)
- Selection of sigma involves a tradeoff
- Larger values: more robust to noise
- Smaller values: less effective in removing noise

Steps for Gabor Implementation

- Creation of gabor filters with orientations and different frequencies.
- Convolution operations with filters.
- Rotation from 0 to 180 degrees.
- Assemble output images.

$$G(x,y;\theta,f) = \exp\{-\frac{1}{2}[\frac{x^2\theta}{\sigma^2 x} + \frac{y^2\theta}{\sigma^2 y}]\}\text{Cos}(2\pi f x\theta),$$

$$X\theta = x\cos\theta + y\sin\theta$$

$$Y\theta = -x\sin\theta + y\cos\theta,$$

Where θ is orientation of the Gabor filter, f is the frequency of the cosine wave, σx and σy are the standard deviations of the Gaussian envelope along the *x* and *y* axes, XΘ and YΘ define the *x* and *y* axes of the filter coordinate frame.fig.5 shows the result of Gabor filter.

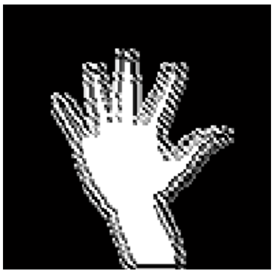

Fig.5: Gabor Filter

Fourier descriptor

The Fourier descriptor is very efficient and effective Way to record and compress a closed boundary as well as non-closed boundary. A few Low-frequency coefficients are also sufficient to reconstruct the the original boundary. Based on this scheme, the high-frequency components near the two ends are much reduced, and a more accurate reconstructed segment with the exact end-point location scan is achieved. Furthermore, the proposed scheme could also be applied on closed boundaries with a pre-segmentation process: segmenting the closed boundary at sharp corners and generating several smooth non-closed segments. According to the simulation results under the same compression rates, FD has better reconstruction quality than directly extracting the Fourier descriptor on closed boundaries. In image processing and pattern recognition, boundary or Edge description plays A VERY important role not only for shape feature extraction, but also for reconstruction and efficient contour recording. A Fourier descriptor having some important property like translation, rotational, and scaling property, As compared to other existing boundary description methods, The Fourier descriptor is widely used method because of its rotation, Scaling and translation invariant (RST-invariant) properties and its compressibility. A low frequency component is also sufficient to describe a boundary [6].

The Fourier descriptor scheme could also be applied on closed boundaries to achieve better reconstruction quality. In the general usage of Fourier descriptors, the discrete Fourier transform (DFT) is directly applied on the whole Boundary sequence. In our method, a closed boundary is first divided into several non-closed means smooth segments according to its image corners and sharp angles. The Fourier descriptor scheme is then applied to record these non-closed segments. Simulation results show that our method could give more detail structures than the general method on closed boundaries. Fourier descriptors have two main purposes: One is to extract a compact shape descriptor for matching and retrieval and the other is to efficiently record and Compress the boundaries which are more important for this paper. By using the proposed Fourier descriptor method we observed Sharpe boundary otherwise by using conventional Fourier descriptor method, the boundary of resultant image is not Sharpe.

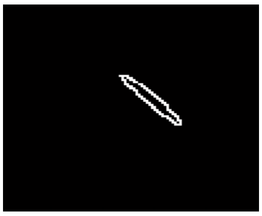

Fig.6: Fourier descriptor

Zernike moment

The improved high order Zernike moment has not only rotation invariance, but also has scale invariance property. The various results show that the improved high order Zernike moment has better invariant properties. The Zernike moment descriptor has such desirable properties like noise removal, rotation invariance, expression efficiency, multi-level representation for describing the various shapes of pattern and fast computation. Zernike moments are based on a set of complex polynomials that form a complete orthogonal set over the interior of the unit circle [7]. They are defined as the projection of the image on these orthogonal basis functions. Specifically, the basic functions $Vn,m(x,y)$ is given by, [8]

$$Vn,m(x,y) = Vn,m(\rho,\theta) = Rn,m(\rho)e^{jm\theta}$$

Where *n* is a non-negative integer, *m* is a non-zero integer subject to the constraints *n-lml* is even and *lml<n*, ρ is the length of the vector from origin to (*x; y*), θ is the angle between the vector ρ and the *x*-axis in a counter clockwise direction, and $Rn,m(\rho)$ is the Zernike radial polynomial [7, 8].

$Rn,m(\rho)$ is defined as follows,

$$Rn,m(\rho) = \sum_{k=lml,n-k=even}^{n} \frac{(-1)\frac{n-k}{2}\frac{n+k}{2}!}{\frac{n-k}{2}!\frac{n+k}{2}!\frac{n-k}{2}!} pk$$

$$= \sum_{k=lml,n-k=even}^{n} \beta n,m,kpk$$

The Zernike moment of order *n* with repetition *m* for a digital image function f(x; y) is given by,

$$Zn,m = \frac{n+1}{\pi} \Sigma \sum_{x2+y2\leq 1} f(x,y)V * n,m(x,y)$$

Where *V*n,m(x;y)* is the complex conjugate of *Vn,m*(*x; y*). To compute the Zernike moments of a given image, the image center of mass is taken to be the origin. A method to improve the speed of Zernike moments computation involves using a quantized polar coordinate system. Following are the steps for implementation of Zernike moment [9].

(1) Get the order (0, 0) geometric moment m_{00} of the image.

$$m_{00} = \iint f(x,y)dxdy$$

From physics viewpoint, *moo* is the expression of mass.

(2) Compute the various order Zernike moments of an image.

$$Z'_{nm} = \frac{n+1}{\pi} \iint_{D^2} f(x,y)[V_{nm}(x,y)]^* dxdy$$

Where

$$D^2 : x^2 + y^2 \leq 1$$

3) Normalize the Zernike moments where, *Z mn* is the improved Zernike moments we presented.

4) *Z* is Complex, we often use the Zernike moments modules |*Zmn*| *as* the features of shape in the recognition of pattern.

The improved Zernike moment descriptor not only has better rotation invariance, but also has better scale invariance is shown in fig.7.

Fig.7: Zernike moment

D. Feature level fusion method

The fast development of digital image processing leads to the growth of feature extraction of images which leads to the development of Image fusion [10]. Image fusion is defined as the process of combining two or more different images into a new single image retaining important features from each image with extended information content. There are two approaches to image fusion, namely Spatial Fusion and Transform fusion. In Spatial fusion the pixel values from the source images are directly summed up and taken average to form the pixel of the composite image at that location [11].

E. Classifier

Minimum distance classifier is one of the simplest method. in minimum distance classification a sample or group of vectors is classified into the class whose known or estimated distribution most closely resembles the estimated distribution of the sample to be classified. The measure of resemblanceis a distance measure in the space of distribution functions. The minimum distance classifier is used to classify unknown image data to the classes which minimize the distance between the image data and the class in multi-feature space. The distance is defined as an index of similarity so that the minimum distance is identical to the maximum similarity. The following distances are often used in this procedure. i) Euclidian distance ii) Normalized Euclidian distance iii) Mahalanobis distance

III EXPERIMENTAL RESULTS

In this section, the results of the gender classification using hand shape are shown for images in the database. The accuracy of result is 91.99 % by using three feature extraction techniques.

Fig.7: Result

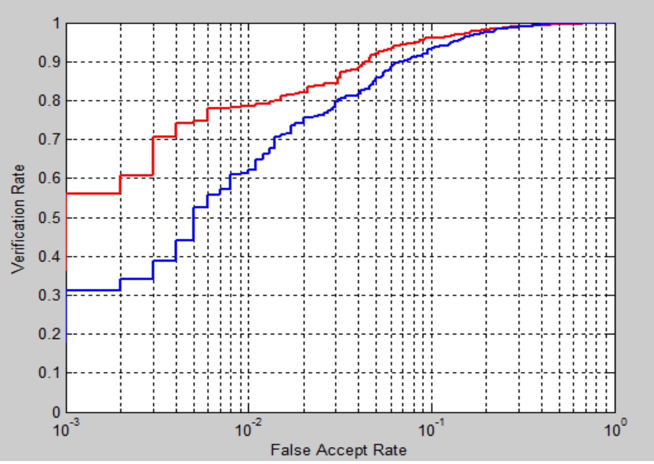

Fig.8: Male female recognition rate

IV CONCLUSIONS

A new system is developed for gender classification by using hand shape. A database of 25 male and 25 female is used for the male and female classification. The proposed system is able to detect both male and female. Thus from this and system comparison, it can be concluded that the proposed system has improved accuracy, Also the proposed method is used to improve the performance of gender classification. It is also used for the security purpose of women. the system gives results within few seconds. The minimum distance classifier achieved an average accuracy of 91.99%.

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