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Analysis of Distance Measures for Human Eyebrow Recognition Using Fast Template Matching

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***Abstract*- Eyebrow is one of the most salient features. It has a lot of potential application in face recognition, non verbal communication and revelation of emotions. This paper presents an human eyebrow recognition system based on fast template matching and fourier spectrum distance (FSD). Normalized Cross Correlation (NCC) is used for matching similarity in fast template matching. The features are extracted by using the Local Binary Pattern(LBP). Various distance measures like manhattan distance, Euclidean distance, mahalanobis distance were used and Euclidean distance performed the best by recognizing human eyebrows with an accuracy of 92%.**

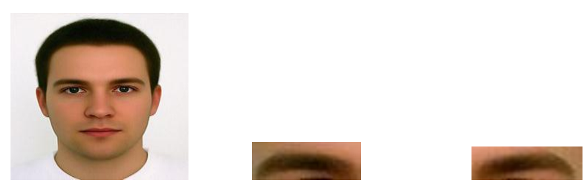
***Keywords* - NCC, FSD, Eyebrow recognition, LBP, NSSD.**

I. INTRODUCTION

Biometrics allow a person to be authenticated or identified using behavioural or physiological characteristics. These characteristics must be automatically recognizable and verifiable. At present the common biometric technologies are face recognition, fingerprint recognition, iris identification, palmprint recognition, and so on [1]. Although face and gait may be almost identical between twins and even gradually vary with time, both of them have been widely accepted as an independent biometric [2-5]. The human eyebrow is not much reliable as the human face for recognition, but it is considered as it could be more reliable than the human gait. Even gait as a biometric can only achieve a middle level of recognition accuracies with great difficulty to identify a single person in a relatively large database.

The human eyebrow can be used to determine the identity of an individual with a high probability of success. It should be noted that the eyebrows used for personal identification generally contain richer texture information than those cropped as a small detail from biometric faces, and they are obviously more distinctive and more reliable for recognizing individuals correctly.

Usually, a biometric face contains too small eyebrows to be cropped for after enlargement as shown in (Fig. 1b and 1c). For lack of clear texture information, such eyebrows are not sufficient to reach a satisfactory distinctiveness and reliability for recognition. Some positive evidence supports the concept of eyebrow recognition. For example, it has been made clear that the eyebrows, with relatively stable shapes (in some facial variations such as eye switching between open and closed states), play an important role in the identification of faces, for which they are among the most important of the different facial features [6]. Even a significantly greater decrement in human performance is observed in the absence of eyebrows than in the absence of eyes [6].



(a) (b) (c)

Fig.1. Eyebrows cropped from a face; (a) Face (b) Left eyebrow (c) Right eyebrow

The effectiveness of partial face features such as eyes, nose, mouth and chin, have been extensively studied for determining the identity of a human face in both human and computer vision literature [5,7–9], the most investigations of facial features have manipulated only the eyes or a combination of eyes and eyebrows. The main contribution in this paper is only the eyebrow to be cropped from a face and it can match the input image with the corresponding templates via fast template matching with various distance measures. The Local Binary Pattern is used for feature extraction and finally the minimum distance is taken to recognize an eyebrow image.

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It is obviously not so robust to recognize an eye in eye switching between open and closed states, eyebrow would be somewhat special as a biometric feature.

II. RELATED WORKS

A Existing system

In previous recognition techniques a detector is used to find out the candidate object (eg: eyebrow) and recognize it. Detector which is a practical object increases the computational process and determine the final identity by the minimum distance between all gallery templates t1, t2, . . ., tN and the candidate e is given in Eq.(1) [10],

$$r = argmin\{d(t_{i}, e)\} \qquad \ldots(1)$$

Where e is a candidate object located by a detector, not a target subregion by fast template matching. Note that it is in general a difficult task to design a practical object detector [10], which usually needs much training from large number of object examples.

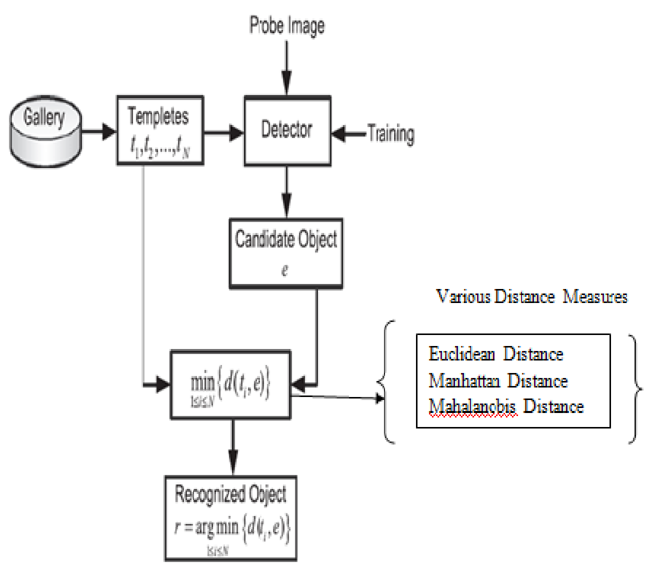

Fig.2. The detecting framework and the Distance measures used in proposed work

B Proposed system

The human eyebrow recognition system consists of two main steps:1)Eyebrow matching is a process of matching the template and target subregions by the method of fast template matching, 2)Eyebrow recognition determines the final identity of an eyebrow image using the minimum distance. The overall architecture of eyebrow recognition system is described in fig.3. As shown in Fig.1, the two eyebrows are : Fig. 1(a) are too small, and will be very blurred.

The gallery is composed of eyebrow templates which are created from training eyebrow images. Fast template matching algorithm uses normalized cross correlation as a matching similarity, the best matched target regions for each template of the gallery are automatically located in a probe image.

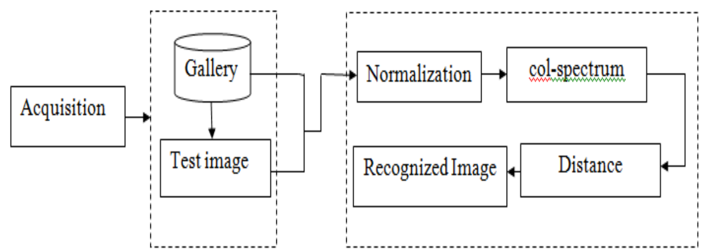

Fig.3. The overall Architecture diagram of eyebrow recognition system

After normalizing these couples of templates and their corresponding target regions, a discriminative similarity for each couple is computed via fourier spectrum distance. Then the minimum value among all these discriminative similarities with various distance measures are used to determine the final recognized identity of the probe image.

III. TECHNICAL APPROACH

A. *Preprocessing*

First a rectangle is selected to manually cropp the eyebrow portion from sample image and these rectangle image is called as pure eyebrow image. This is shown in Fig.4.

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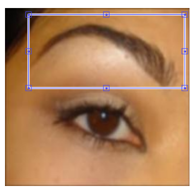
All images are preprocessed using Gaussian filter. Gaussian smoothing is very effective for removing noise [11]. The weights give higher significance to pixels near the edge. The degree of smoothing is controlled by σ and is given in Eq(2) [11].

$$g(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-x^2/2\sigma^2} \qquad \text{... (2)}$$

Where σ denotes the standard deviation and larger the number of standard deviation more intensive smoothing occurs.

a) Original Eyebrow Image b) Selected Eyebrow Image

c) Pure Eyebrow Image

Fig.4. Outline of proposed eyebrow recognition system

B. Fast template matching

Fast Template matching is a technique in digital image processing for finding small parts of an image which match a template image. This method is used to locate a target sub region of template image into a probe image. The standard way of tracking features between two images is by template matching[12-18].

Normalized cross-correlation is a measure of covariance between random vectors in statistics. Correlation based matching typically produces dense depth maps by calculating the disparity at each pixel within a neighborhood. [19]. The NCC method is a simple template-matching method that determines the location of a desired pattern represented by a template function, t , inside a two dimensional image function, f . This is achieved by taking a square window of certain size around the pixel of interest in the reference image and finding the homologous pixel within the window in the target image, while moving along the corresponding scan line. Normalized sum of square differences is given by Eq.(3) [10]

$$\mathrm{NSSD} = \frac{\sqrt{\sum(f(x+u,y+v)-t(u,v))^2}}{\sqrt{\sum f^2(x+u,y+v)} + \sqrt{\sum t^2(u,v)}} \qquad \text{... (3)}$$

Where f(x,y) is a source image and t(u,v) is a template image.

C. Normalization

The sizes of an eyebrow may vary according to the change due to variations of the camera to the eyebrow distance. such deformation in eyebrow texture will affect the recognition result. To achieve the better performance, normalization take place. Suppose t_1(x,y) and t_2(x,y) are two templates in the gallery, s_1(x,y) and s_2(x,y)are their target sub regions in a probe image. Clearly, s_1(x,y) and t_1(x,y) have a same size denoted as $W_1 \times H_1$, whereas s_2(x,y) and t_2(x,y) may have another same size denoted as $W_2 \times H_2$. All of them have to be normalized into a fixed size of $W \times H$ (e.g.256×256).The Normalization of templates and their target subregions are shown in fig.5.

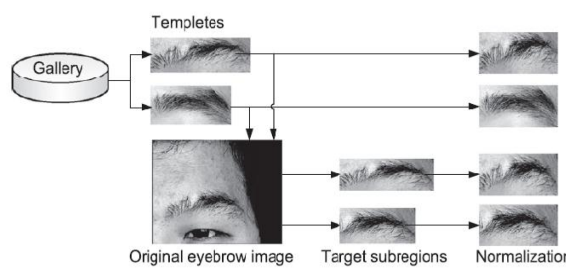


Fig.5. Normalization of template and their target subregions.

D. Fourier Spectrum Distance

Different similarity metrics to measure the difference between template and its target sub region in a probe image exists. Fourier Spectrum Distance is defined as a discriminative similarity on the basis of Fourier coefficients [20].

Using fourier spectrum distance as a discriminative similarity, it can automatically recognize the identity of a probe original eyebrow image in the matching recognizing framework for image based object classification where matcher is used to compute the target sub regions of all the gallery templates in the probe image. A matcher actually means a general fast template matching algorithm without need of any special training.

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The main merit of the matching recognizing framework is that in its recognition step, it is not required to detect a pure eyebrow image beforehand from a probe image. Thus it can determine the identity of the probe image by the minimum distance between all gallery templates and their target sub regions. In this method 1D Discrete Fourier Transforms(DFT) of $s(x,y)$ and $t(x,y)$ is used as shown in Eq.(4) and Eq.(5),

$$F_s(x,h) = DFT\big(s(x,.)\big)(h) = \frac{1}{\sqrt{H}}\sum_{y=0}^{H-1} s(x,y)e^{-j2\pi(h\frac{y}{H})}$$

$$0 \le h < H, \quad 0 \le x < w \qquad \dots (4)$$

$$F_t(x,h) = DFT\big(t(x,.)\big)(h) = \frac{1}{\sqrt{H}}\sum_{y=0}^{H-1} t(x,y)e^{-j2\pi(h\frac{y}{H})}$$

$$0 \le h < H, \quad 0 \le x < w \qquad \dots (5)$$

Where H and W denotes the width and height and the exponential term is the basis function corresponding to each point $f(x,h)$ in the Fourier space.

The features are extracted by using Local Binary Pattern(LBP). The original LBP operator labels the pixels of an image with decimal numbers, which are called *LBPs* or *LBP codes* that encode the local structure around each pixel. Each pixel is compared with its eight neighbors in a 3×3 neighborhood by subtracting the center pixel value; the resulting strictly negative values are encoded with 0, and the others with 1. For each given pixel, a binary number is obtained by concatenating all these binary values in a clockwise direction, which starts from the one of its top-left neighbor. The corresponding decimal value of the generated binary number is then used for labeling the given pixel. The derived binary numbers are referred to be the LBPs or LBP codes.

E. Eyebrow Recognition

Using Fourier spectrum distance method as a discriminative similarity, it is possible to automatically recognize the identity of a probe original eyebrow image in the matching recognizing framework for image-based object classification, where ‘‘Matcher’’ is used to compute the target subregions of all gallery templates in the probe image. To compare two feature vectors, to measure how different (or how similar) they are.

The distance between two items depends on both the representation used by the feature vectors and on the distance measure used. In this paper for eyebrow recognition, Euclidean distance is used as a minimum distance to recognize an image. Various distance measures are used [21].

The Euclidean distance for the two feature vector is given as in Eq.(6),

$$E(x,y) = \sqrt{(x-y)^2} \qquad \dots (6)$$

Where x and y are the feature vectors of training and testing images.

The manhattan distance is between two points along axes at right angles. It is also known as rectilinear distance or cityblock distance. It is given in Eq.(7),

$$E(x,y) = \sum_{i=1}^{n} |\, x_i - y_i \,| \qquad \dots (7)$$

The mahalanobis is between two points *x* and *y* is the distance from *x* to *y* divided by the square root of *C(x-y.x-y)* are given in Eq.(8),

$$E(x,y) = \sqrt{(x-y)^T C^{-1}(x-y)} \qquad \dots (8)$$

IV. Experimental Results

To evaluate the performance of eyebrow recognition the following experiments are carried out with database containing some eyebrow images. In this work, sample database is constructed with 13 images in training set and 10 images in the test set. It was made to run with pc of 3 GB RAM and Processor of 2 GHZ. The images have resolution of 256×256.The most straightforward way to verify the accuracy of recognized image is to measure the minimum distance between the training and the testing features.In this method Euclidean distance is used for performance recognition. The various distance measures are tabulated in Table.1.

In Table.1 the accuracy rate which is defined as the percentage of the occurances where it is correctly accepted by the system, while the false rate which is defined as the percentage of the occurances where it is Falsely accepted by the system.

$$\text{False rate} = \frac{\text{Number of images falsely recognized}}{\text{Total Number of images}}$$

Accuracy

Accuracy is the proximity of measurement results to the true value. The **accuracy** of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual (true) value. Accuracy is often the starting point for analyzing the quality of a predictive model, as well as an obvious criterion for prediction. Accuracy measures the ratio of correct predictions to the total number of cases evaluated [22].

$$\text{Accuracy} = \frac{\text{Number of images correctly recognized}}{\text{Total Number of images}}$$

With an accuracy of 92% it can able to recognize the eyebrow image correctly.

Table.1.
Prediction of recognition performance

Distance used	Accuracy rate(%)	False rate(%)
Euclidean Distance	92	8
Manhattan Distance	70	30
Mahalanobis Distance	20	80

By testing the test images with the corresponding training set using Euclidean distance gives the highest accuracy rate of 92 % than the other distance measures such as manhattan distance which gives an accuracy of nearly 70% and mahalanobis distance gives an accuracy of only 20%. From the above distance measures, it is observed that Euclidean distance gives a good accuracy rate.

V. CONCLUSION

Normalized cross correlation technique may use for Template matching and Normalized cross correlation pattern search algorithm is efficient for pattern matching under noisy environments. A fast globally optimal algorithm for template matching using low resolution pruning uses a coarse to fine template matching which do not find the absolute match. To find the exact match normalized cross correlation is used.

Fast template matching using normalized cross correlation is used to automatically match the template with the target sub regions and it is more robust under illumination changes. Various distance measures were analyzed in this method and it is observed that the Euclidean distance gives a good result for eyebrow recognition. Human eyebrow recognition can be used for verifying work attendance, designing door access control systems, inspecting criminals and terrorist etc.

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