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Personnel Identification Using Global Features Of Fingerprint Biometric

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***Abstract*— In this paper we use personnel identification with global feature of fingerprint biometrics. In detecting the finger biometrics we use a Gabor filter for extract the features such as the shape, size and color. After detecting the features, a technique was proposed in which determining the core and treating it as a center was done by a method known as Poincare. In our database we have collected 200 inked fingerprint images from 100 persons. The fixed length square finger code of size $16\times16\times4$, generated using a set of Gabor filters contains all the local information about the fingerprint image useful for fingerprint verification. The matching of fingerprint is done using Euclidean distance between two corresponding finger codes it is extremely fast. By using this technique, we were able to achieve a verification accuracy of 93% with a very small computation time.**

Keywords— *Finger print, Gabor filter, Euclidian distance*.

I. INTRODUCTION

Now a days the Biometrics personnel identification is very important and it is used in computer security, banking, having the personnel identification like aadhar card etc. In past some years the researchers started working on the biometrics, such as several traits were investigated exhaustively such as face [1], fingerprint, iris [2, 3], palm print [4], ear, signature etc. Very much difficulty was found such as illumination for face, occlusion and cooperative acquisition for iris etc [5]. Among different types of biometrics the hand based biometrics has attracted the attention over recent years. Fingerprint [6-8], palm print [9-15], hand geometry [16-18], hand vein [19-20], and inner-knuckle-print [21-22] have been proposed and well investigated in the literature. The image pattern in the finger knuckle surface is highly unique and thus it can serve as a distinctive biometrics identifier [23]. Using this biometrics the user can easily be authenticated as currently, passwords and smartcards are used for the purpose of authentication. But the problem is that the password can easily be cracked by the attackers, as well as the smart cards are stoles by anybody, and then it is impossible to check the authorized user is. So the only one solution is a biometrics which can remove these problems [24]. This paper discusses the Personnel identification using global features of fingerprint biometric in which determining the core and treating it as a center was done by a proposed method known as Poincare. After detecting the core which was located at the center is been assign to the core point with the value as lower as y. The Co-variance matrix of vector field $(q \times q)$ in a local neighborhood of each point of orientation field can be computed if the core point is not detected. Once computation is done, using co-variance matrix a largest eigen value is found out and assigns its co-ordinates as the center. Now if the center is been found the fingerprint image can be cropped into 128×128pixels. When the cropped image is achieved, the cropped image should be divided into a set of 8×8 non-overlapping blocks and it must be sample by the set of four Gabor filters [26]. The calculation of the AAD i.e. average absolute distance which is stated as $16\times16\times4$ finger code which are features of gabor filter having the four sets used. The fingerprint matching is extremely fast. By using these techniques a accurate result with less computational time can be achieved. [26].

II. METHODOLOGY

Methods

A. Feature extraction using Gabor filter:-

The true edge and furrow structures can be significantly emphasized by applying the tuned Gabor filters to a fingerprint image. These accentuated ridges and furrow structures form an effective demonstration of a fingerprint image. The 2D Gabor filter is defined as,

$$g(x, y, f, \theta_k, \delta_x, \delta_y) = \exp\left[\frac{-1}{2}\left(\frac{x_{\theta_k}^2}{\delta_x^2} + \frac{y_{\theta_k}^2}{\delta_y^2}\right)\right] \times \exp\left(2\pi j f x_{\theta_k}\right) \quad (1)$$

where,

$$x_{\theta_k} = x\cos\theta_k + y\sin\theta_k$$

$$y_{\theta_k} = x\cos\theta_k - y\sin\theta_k$$

f Is the sinusoidal plane wave frequency along with the direction θ_k,

θ_k Is the orientation of the Gabor filter,

δ_x And δ_y specify the Gaussian envelope along x and y axes, which decides the bandwidth of the Gabor filter [26].

For analysis of the Gabor filter for even symmetric and odd symmetric, the equation (5.1) can be expressed in complex form as,

$$g(.) = g_{even}(.) + j\, g_{odd}(.) \qquad \dots (2)$$

Where,

$$g_{even}(x, y, f, \theta_k, \delta_x, \delta_y) = \exp\left[\frac{-1}{2}\left(\frac{x_{\theta_k}^2}{\delta_x^2} + \frac{y_{\theta_k}^2}{\delta_y^2}\right)\right] \times \cos(2\pi f x_{\theta_k})$$

$$g_{odd}(x, y, f, \theta_k, \delta_x, \delta_y) = \exp\left[\frac{-1}{2}\left(\frac{x_{\theta_k}^2}{\delta_x^2} + \frac{y_{\theta_k}^2}{\delta_y^2}\right)\right] \times \sin(2\pi f x_{\theta_k})$$

Corresponding to four different values of θ_k $(0^0, 45^0, 90^0\ and 135^0)$ with respect to the x-axis, fingerprint image is disintegrated into four component images A typical 2-dimensional and 3-dimensional Gabor filter response with various values of orientations is as shown in Figure 2.1 and Figure 2.2 respectively.

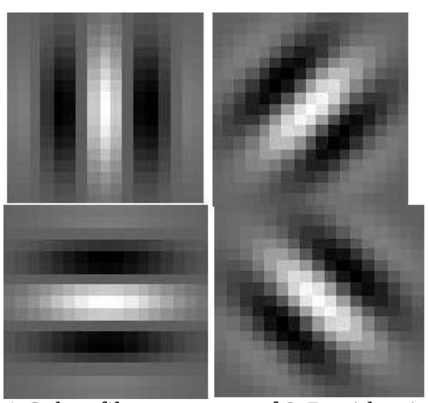


Figure 2.1 Gabor filter response of 2-D with orientations of $0^0, 45^0, 90^0\ and 135^0$.

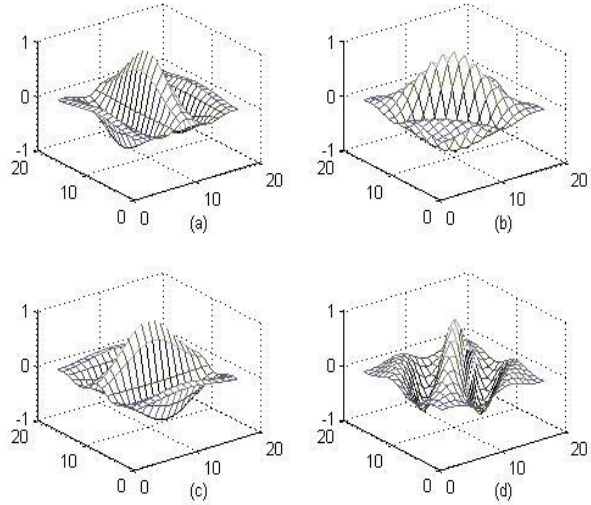


Figure 2.2 Gabor filter response 3-D with orientations of $0^0, 45^0, 90^0\ and 135^0$.

B. Center Point Location

Following steps have been performed in order to find the center point location:

Divide the input image, into non-overlapping blocks of size 8×8.

1) Compute the gradients $\partial_x(i, j)$ and $\partial_y(i, j)$ at each pixel (i, j). According to the computational constraint, we can vary simple *Sobel* operator to the more complex *Marr-Hildreth* operator using the gradient operator.

2) Evaluate the local alignment of each block centered at pixel (i, j) using

$$o(i, j) = \frac{1}{2}\tan^{-1}\left(\frac{V_y(i, j)}{V_x(i, j)}\right) \qquad \dots (3)$$

where,

$$V_x(i, j) = \sum_{u=i-4}^{i+4} \sum_{v=j-4}^{j+4} 2\partial_x(u, v)\partial_y(u, v)$$

$$V_y(i, j) = \sum_{u=i-4}^{i+4} \sum_{v=j-4}^{j+4} \left(\partial_x^2(u, v) - \partial_y^2(u, v)\right)$$

The value of $o(i, j)$ is equal to least square estimate of the local ridge orientation in the block centered at pixel (i, j). Mathematically, the value of $o(i, j)$ represents the direction that is orthogonal to the dominant direction of the Fourier spectrum of the 8×8 window.

3) Smoothing the location field in a local neighborhood. In order to perform low pass filtering (smoothing), the orientation image needs to be transformed into a *constant vector field*, which is defined as,

$$\phi_{1x}(i, j) = \cos(2\, o(i, j)) \quad \dots (4)$$

and

$$\phi_{1y}(i,j)=\sin(2\,o\,(i,j)) \quad \ldots(5)$$

Where,

ϕ_{1x} and ϕ_{1y}, are the x and y components of the vector field, respectively. With the resulting vector field, the low pass filtering can be performed as,

$$\phi_x(i,j)=\sum_{u=-w/2}^{w/2}\sum_{v=-w/2}^{w/2}W(u,v)\phi_{1x}(i-wu,j-wv) \ldots(6)$$

and

$$\phi_y(i,j)=\sum_{u=-w/2}^{w/2}\sum_{v=-w/2}^{w/2}W(u,v)\phi_{1y}(i-wu,j-wv) \ldots(7)$$

Where,

$w\times w$ Specifies the filter size and $W(.)$ is a 2-D low pass filter with unit integral.

Note that smoothing operation is performed at the block level. For our experimentation we have used a 5×5 mean filter. The smoothed orientation field O at (i,j) is computed as,

$$O(i,j)=\frac{1}{2}\tan^{-1}\left(\frac{\phi_y(i,j)}{\phi_x(i,j)}\right) \quad \ldots(8)$$

4) Initialize R as a labeled image which can be used to indicate the core point.

5) Calculate the Poincare index and then allot the equivalent pixels in R for each pixel (i,j) in O. Computation of the Poincare index at pixel (i,j) surrounded by a digital curve which contains a series of pixels that are above or below a distance of single pixel apart from the equivalent curve which can be done using,

$$Poincare(i,j)=\frac{1}{2\pi}\sum_{k=0}^{7}\Delta(k) \ldots(9)$$

where,

$$\Delta(k)=\begin{cases}\delta(k), & if\ |\delta(k)|<\frac{\pi}{2}\\ \pi+\delta(k), & if\ \delta(k)\le-\frac{\pi}{2}\\ \pi-\delta(k), & otherwise,\end{cases}$$

$$\delta(k)=O(i',j')-O(i,j)$$

$$i'=(i+1)\bmod(8)$$

$$j'=(j+1)\bmod(8)$$

here i and j are the x and y coordinates of the closed digital curve with 8 surrounding pixels of 3×3mask.

6) Find the components connected in R which has the area of a coupled component greater than seven, a core is noticed at the centroid of the related section. For the area of a linked component greater than 20, two cores are noticed at the centroid of the linked component.

7) Assign the co-ordinates of the core point with the lower y value (the upper core) to center if two cores are detected. Assign the co-ordinates of the core point to center f only one core is identified.

8) Find the matrix co-variance of the local neighborhood vector field $(q\times q)$ of each point in the orientation field if no core point is detected. Define a largest Eigen value of the covariance matrix feature image F for each element in the orientation image. At the centroid the largest linked component in the threshold image of F is a core which is identified and the center is given to the co-ordinates of the core

III. ALGORITHM

In the proposed algorithm, since most local edge structures of fingerprints can be used by the local frequency and directions the filter frequency f is used to set the inter-ridge distance in reciprocal. The average inter edge distance is approximately equal to 10 pixels in a 500 dpi fingerprint image. Fake edges may be created in the filtered image if f is too large whereas nearby ridges may be merged into one if f is too small and can also determine the bandwidth of Gabor filters by δ_x and δ_y. The filter is more robust to noise if the values of δ_x and δ_y are too large and probably we can smooth the image to the level that the edge and groove will lose the details of fingerprint. On the other hand, to remove the noise the filter used is not effective if they are too small. In the proposed algorithm, δ_x and δ_y values where practically firm to set both to 4.0 and the filter frequency f is set to 0.1. Decomposing the fingerprint image $I(x,y)$ is $N_i(x,y)$ done after normalization of the region of interest in each sector block individually to a constant mean and variance. Stabilization is done to eliminate the effects of finger pressure difference and sensor noise. Let $I(x,y)$ denote the gray value at pixel (x,y), M_i and V_i, the probable mean and variance of the sector block S_i respectively and $N_i(x,y)$, the normalized gray-level value at pixel (x,y).

For all the pixels in sector S_i, the normalized image is,

$$N_i(x,y)=\begin{cases}M_0+\sqrt{\frac{V_0\times(I(x,y)-M_i)^2}{V_i}}, & if\ I(x,y)>M_i\\ M_0-\sqrt{\frac{V_0\times(I(x,y)-M_i)^2}{V_i}}, & otherwise,\end{cases} \quad \ldots(10)$$

Where, M_0 and V_0 are the preferred mean and variance values. Normalization of pixel wise operation that doesn't changes the clarity of the furrow and ridge structures. Normalization cannot compensate for the intensity differences in the different parts of the finger if it is done on the entire image due to the finger pressure differences Normalization of each sector distinctly improves this problem. Both M_0 and V_0 are the value which were set to 100 in the proposed algorithm. Once locating all the parameters of the Gabor , the even and odd feature of gabor filter at sampling point is (X,Y) can be calculated using (1), (2) and (10) as,

$$G_{mag}\left(X,Y,\theta_k,f,\delta_x,\delta_y\right)=\left|\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} N_i\left(X+x,Y+y\right)\times g\left(x,y,f,\theta_k,\delta_x,\delta_y\right)\right| \quad \ldots (11)$$

$$G_{even}\left(X,Y,\theta_k,f,\delta_x,\delta_y\right)=\left|\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} N_i\left(X+x,Y+y\right)\times g_{even}\left(x,y,f,\theta_k,\delta_x,\delta_y\right)\right| \quad \ldots (12)$$

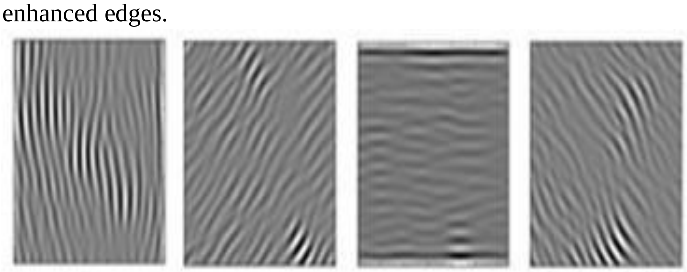
$$G_{odd}\left(X,Y,\theta_k,f,\delta_x,\delta_y\right)=\left|\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} N_i\left(X+x,Y+y\right)\times g_{odd}\left(x,y,f,\theta_k,\delta_x,\delta_y\right)\right| \quad \ldots (13)$$

Where,

$N_i(.,.)$ Shows a sector block of normalized fingerprint image $I(x,y)$ of size $M \times N$, having 256 gray-levels.

Because the magnitude of Gabor feature has the shift-invariant property the magnitude feature of Gabor filter the section point and those of its adjoining points within three pixels are similar.

Thus, a fingerprint image $I(x,y)$ is normalized and is convolved with each of the Gabor feature of four component to produce four component images. Ridges parallel to the x -axis accentuated by convolution with an $0°$ oriented filter and ridges that are not parallel to the x -axis smoothen by it. As shown in Figure 3.1, we can similarly tuned filters to other directions. According to the experimental results, most of the edge directionally informs present in a fingerprint image is captured by the four component images and thus form a valid representation. The figure shows the all four filtered image together added and the fingerprint image is reconstructed. The image achieved is same as the original image but the difference is that the image obtained has the enhanced edges.



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

Figure 3.1 Gabor filters convolved with crop finger print image for $\theta_k = (0^0, 45^0, 90^0, and 135^0)$.

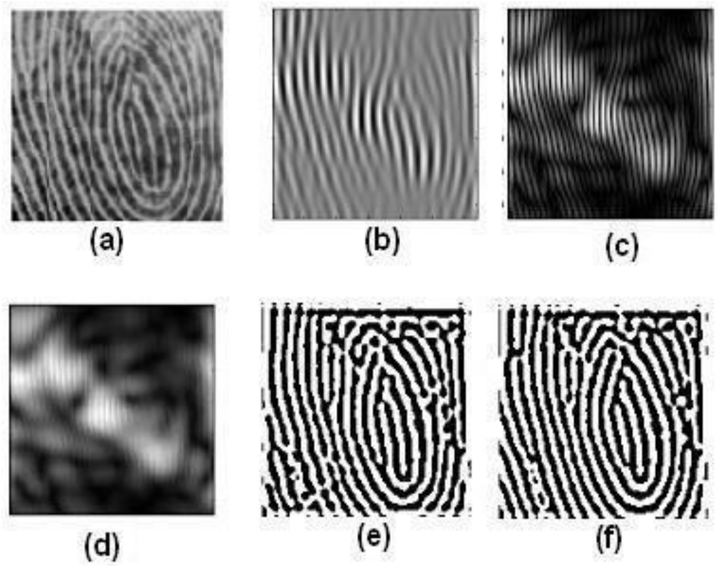


Figure 3.2 (a) Crop image, (b) Gabor feature with $\theta_k = 0^o$, (c) Normalized image with $\theta_k = 0^0$, (d) Filter image, (e) Remodeled image using four features of Gabor filter,
(f) Remodeled image using eight features of Gabor filter.

- Steps for fingerprint code generation:-

Following steps are performed sequentially for generation of the feature of Gabor filter which are constructed by using the finger code from the fingerprint image:

1) Find the core point of each fingerprint image.
2) Using the core point as the center crop the fingerprint image into 128×128 pixels.
3) After achieving the fingerprint image, we have to Split the crop image into a set of 8×8 blocks which are non-overlapped and then sample the image of fingerprint by set of Gabor filters to give $F_{i\theta_k}(x,y)$, the filtered image in θ_k directions.
4) Now, $\forall\, i \in \{1, 2, 3,.......,256\}$ and $\theta_k \in \{0°,45°,90°,135°\}$, the feature values are the AAD of the mean which is defined as

$$F_{i\theta} = \frac{1}{n_i}\left(\sum_{n_i}\left|F_{i\theta}(x,y) - P_{i\theta}\right|\right) \quad \ldots (14)$$

where,

$n_i = 64$, is the pixels of number in the block of 8×8,

P_i^{θ} = mean pixel values in that block.

Thus the components of the finger code $(16\times16\times4)$ defined by the average absolute deviation of each 8×8 block of the four filtered images

IV. RESULT

In our database we have collected 200 inked fingerprint images from 100 persons (two images per person) and captured their digital format with a scanner at 200dpi and 256 gray-level resolutions. Although the fingerprint databases of NIST, MSU, and FBI are sampled at 500 dpi, the fingerprint images can be recognized at 200 dpi by the human eye. The recognition of low quality images is efficient and practicable for a small-scale fingerprint recognition system.

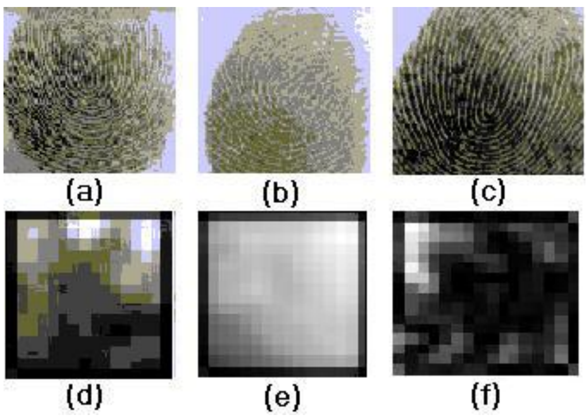


Figure 4.1 (a)-(c) Crop fingerprints, (d)-(f) respective finger codes for 0^0 Gabor orientation.

Figure 4.1 shows finger code of the fingerprints belonging to different persons ($\theta_k = 0^o$). From the figure we find that the different fingerprint images carry different finger codes. Also, codes with same fingerprint image carry similar finger codes. Finger codes with different θ_k are different from each other. The fixed length square finger code of size $16\times16\times4$, generated using a set of Gabor filters contains all the local information about the fingerprint image useful for fingerprint verification.

V. CONCLUSION

All the local information about the fingerprint image useful for fingerprint verification is contained in the fixed length square finger code of size $16\times16\times4$, generated using a set of Gabor filters. The parameters which determine the bandwidth of the Gabor filter filter viz. frequency f and the values of δ_x and δ_y should be selected properly. Since fingerprint matching is done by using the Euclidean distance between two corresponding finger codes with a very small computation time for verification that is almost same for all the matches and is extremely fast. we are able to achieve a verification accuracy of 93%. This method tells that by setting the parameters to suitable values for a small-scale fingerprint verification system this method is more effective and appropriate than conventional methods.

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