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Feature Extraction from Blurred Fingerprints Using Image Negative Method

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Abstract: ***A blurred fingerprint image has very less number of minutiae features in it and it is very difficult to extract minutiae features from a blurred fingerprint. So we tried to extract valleys (dark lines) instead of ridges (bright lines) from a blurred fingerprint. We found that more valleys can be extracted from blurred fingerprints. And now in this paper, we tried to extract features from negative fingerprint image instead of normal fingerprint image. Actually this image negative concept is applied to iris recognition method and proved that more features can be extracted from an iris image. So we tried the same image negative concept for fingerprint recognition method and found that more ridges can be extracted from blurred fingerprints.***

Keywords: **Blurred Fingerprints, Image Negative, Ridges, Filter.**

I. INTRODUCTION

Biometrics are widely used in various areas like security applications, forensic science, ATM, criminal identification and passport control. Fingerprint verification is very convenient and reliable way to verify the individual's identity. It is proved that no two people (even identical twins) have identical fingerprint in this world [1]. Forensics department mainly depends on fingerprints in their various investigations. Only sometimes the forensics department captures normal fingerprint images from the scene of crime and blurred fingerprints at maximum places. So the extraction of features and identification of criminals become a tedious process. In our last work, we extracted valleys from blurred fingerprints and after comparison we found that more valleys can be extracted than ridges. We tried the valley extraction with the help of 4 different filters from blurred fingerprints and found that valleys can be extracted in more number than ridges. And also we notified that when compared with remaining filters what we used, Gabor filter produces some best results [2]. This paper is organized into the following sections. Section 2 discusses about Image negative method and Section 3 discusses about Preprocessing and Feature Extraction. Histogram Equalization is discussed in Section 4. Section 5 discusses about Modified 2D Gabor filter. Section 6 discusses about Matching and Section 7 discusses about the Conclusions and Future work.

Fig 1.a.

Fig 1.b.

Fig 1.a. shows the important features of fingerprint and Fig 1.b., shows the difference between ridges and valleys and minutiae features like terminations and bifurcations.

Fig 2.a.

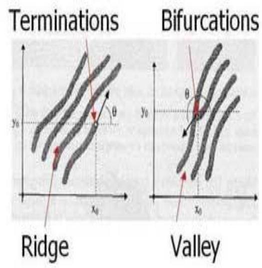

Fig 2.b.

Fig 2.a. shows a normal fingerprint with good minutiae and 2.b. shows a blurred fingerprint with less minutiae.

II. IMAGE NEGATIVE METHOD

The image negative or inverse transformation method reverses light and dark. A negative image is obtained by subtracting each pixel from the maximum pixel value. Negative images are useful in the display of medical images and producing negative prints of images. For an 8-bit image, the negative image can be obtained by reverse scaling of the gray levels, according to the transformation

$$g(m,n) = 255 - f(m,n) \qquad (1)$$

Where, g(m,n) is the output negative image and f(m,n) is the given normal input image [3].

Fig 3.a.

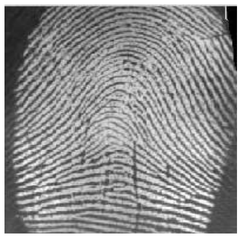

Fig 3.b.

Fig 3.a., and 3.b., shows the negative images of fig 2.a., and 2.b., respectively

III. PREPROCESSING & FEATURE EXTRACTION

We have used fingerprints for this research from the fingerprint database FVC 2000, FVC 2002 and FVC 2004. A critical step in an automatic fingerprint identification system (AFIS) is reliably extracting features from the input fingerprint images [4,5]. The skeleton based method generally consists of the following main steps:

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1) First the fingerprint image is converted into gray scale image by using color to gray conversion method [6].
2) Then the gray scale fingerprint image is converted into negative image by inverse transformation method [3].
3) Enhancement is done on the negative fingerprint image by histogram equalization method [3,7].
4) Modified 2D Gabor filter is applied to the enhanced image for feature extraction [8].
5) Binarization is done after filtering by 2D mean method [9].
6) To find the direction and area for the binary image, first the edge is detected by sobel operator and then a gradient filter is applied to detect the direction of the binary image and then ROI (Region of Interest), where more features are present in the given fingerprints is identified [10].
7) Thinning and pruning are done by applying a morphological algorithm [11].
8) To detect minutiae, neighborhood operation method (max 3 connector) is applied. All minutiae points are extracted by finding the angle of minutiae in the constant region.
9) All the minutiae points (angle) are saved in a notepad [12].
10) Similarity Matching algorithm is performed for matching process, by calculating the similarities between ridgeMap1 (k1) and ridgeMap2 (K2) that is choosing the current two minutiae as origins and adjusting other minutiae, based on the origin minutiae [13].

IV. HISTOGRAM EQUALIZATION

Histogram equalization modifies the histogram of an input image so as to improve the visual quality of the image. The histogram of an image is a plot of the number of occurrences of gray levels in the image against the gray-level values. Equalization is a process that attempts to spread out the gray levels in an image so that they are evenly distributed across their range. Histogram equalization reassigns the brightness values of pixels based on the image histogram. Histogram equalization is done by performing the following steps,

a. Find the running sum of histogram values.
b. Normalize the values from step a by dividing by the total number of pixels.
c. Multiply the values from step b by the maximum gray-level value and round.
d. Map the gray level values to the results from step c using a one-to-one correspondence.

Mathematically histogram equalization can be represented as

$$s_k=T(r_k) = \sum_{j=0}^{k} n_j / n \ (L-1) \quad (2)$$

Where

k=0,1,2,….,L-1

L=number of gray levels in image, for example 255

n_j=number of times j-th gray level appears in image.

n=total number of pixels in the image [3,7].

After enhancing the fingerprint image using histogram equalization, filtering operation is performed to extract the minutiae features from the fingerprint image.

V. MODIFIED 2D GABOR FILTER

We combined the equations of 2D Gabor filter and 2D log Gabor filters to form a modified Gabor filter as illustrated by Peng Yao and Jun Li for their iris recognition [8]. We utilized both the advantages of Gabor filter and 2D log Gabor filter for our fingerprint feature extraction. The frequency expression of 2D log Gabor filter is changed and we constructed modified Gabor filter in the Cartesian coordinate system of the frequency domain as follows,

$$G(u, v) = \exp\{-(\log(u_1/u_0)^2/2\log(k/u_0)^2)\} \ \mathrm{Exp}(-v_1^2/2\sigma_v^2) \quad (3)$$

Where $u_1=u\cos\theta+v\sin\theta$ (4)

And $v_1=-u\sin\theta+v\cos\theta$ (5)

In the above eqn 3, θ represents orientation of modified Gabor filter, u_0 represents center frequency, k represents the bandwidth of the filter in the u_1 direction and σ_v represents the bandwidth of the filter in v_1 direction.

VI. MATCHING

After applying modified 2D Gabor filter to the negative fingerprint image, the image is converted into binary image by using binarization process [9]. Then region of interest is identified where more number of features are present in the given input image [10]. After identifying ROI, Morphological algorithm is applied for thinning and pruning process. Thinning process is done to convert the binary image into a thinned or skeleton image [11]. By using neighborhood operation method all the minutiae features are extracted and stored in a notepad [12]. After the features (minutiae) are all extracted and stored in a database, post processing has to be done for removing false minutiae like dot, spur etc. Due to different types of noise which may be present in the fingerprint image due to scars, over-inking etc, and also due to segmentation, binarization and thinning processes, a large number of false minutiae are present in the thinned fingerprint image. So we applied a post processing technique proposed by Marius Tico and Pauli Kuosmanen [14] before matching process. Then by removing all false minutiae, the fingerprint features are stored in a database as a template for each individual fingerprint. The template consists of the fingerprint individual's name or any identity for identification process. We have used similarity matching algorithm for this research work. Similarity Matching Algorithm calculates the similarities between ridgeMap1 (k1) and ridgeMap2 (K2) to choose the current two minutiae as origins and adjusting other minutiae, based on the origin minutiae. If the similarity for two fingerprint features are greater than a threshold, then the decision that "the two images come from the same finger" is made, otherwise a decision that "the two images come from different fingers" is made [13].

VII. CONCLUSION & FUTURE WORK

From the above work, we can conclude that, for a blurred image, after converting the fingerprint image into its negative and then extracting features will give best result. Already we have proved that for blurred fingerprints instead of ridges, valley extraction will give best result [2]. In this paper we have used modified 2D Gabor filter instead of Gabor filter. In future we are planning to compare either valley extraction or image negative method will extract more features. Then we are going to modify the similarity matching method to reduce the error rate and time consumption.

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