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Optimization of Image Recognition: Fingerprint Matching

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ABSTRACT:- There has always been a need for effective solutions for the security. Biometrics has been proven to be an effective answer to this problem because of the uniqueness that biometric keys possess. Therefore, the challenge now is to develop effective biometric solutions of finger print technology optimized to certain constraints depending on the needs and resources of the end user. Some will prefer solutions with real-time results while others will prefer solutions that are nearly error-free. Our research focuses on using the fundamentals of digital image processing to bring about the optimized solutions.
In this Paper, It involves the optimization of fingerprint recognition through different procedures such as convolution and matched filtering. Also included are the classifications of different fingerprints according to their composition of lines, arches, and swirls. This classification is used in conjunction with the procedures and other techniques such as deblurring.

Keywords:- Fourier Transform, FFT, Correlation Function, Deblurring, Matched Filter

I. INTRODUCTION

Fingerprint image matching process involves the process in which we matches the given image with the image stored in our database. In this process we correlate both the images to test it for it's matching. Here two images can be executed in one of two ways using image processing. In the Time Domain (Spatial Domain) or in the Frequency Domain. For these images analysis, we use Matlab software. These technical papers focus on various issues on this concept such as matched filtering and debluring.
Spatial Domain involves 'Two dimensional Convolution' to find Correlation between image matrices and the maximum value for the matrix[1,4].

Time domain and frequency domain method:
Frequency domains in this we use a Matched Filter to determine the correlation between tow images, the original image and the database image. In this Domain we calculate Two Dimensional Convolution, which is multiplied by Fourier Transform obtained by these images. In order to get Good Results we simply take Fast Fourier Transform (FFT) of the two image matrices instead of spending large time in finding convolution of two large images (256x256 pixels)[1,5].
For frequency domain matching following steps are incorporated:

1. Take normalized matrices of both the images.
2. Perform FFT of both images.
3. Multiply resultant matrices together.
4. Find the maximum value, in the same as spatial domain.

Fourier Transform Method:

In this method the process is same as time domain. This method is much faster then the time domain method. But having disadvantage that it cannot work with three-dimensional images which makes Fourier methods applicable to limited images.

FFT Method Using Rotation Property:

In this method we use Rotation matrix which is added in order to give certain orientation to the scanned image matrix which makes results much accurate .in this method scanned image is first passed through the rotational matrix to get an array of matrices. Each matrix in this array corresponds to a different angular orientation. From this point, each matrix in the array is compared to the database image matrix. Again, like in the FFT Method, the maximum point is obtained to find the point of highest correlation[Fig. 1].

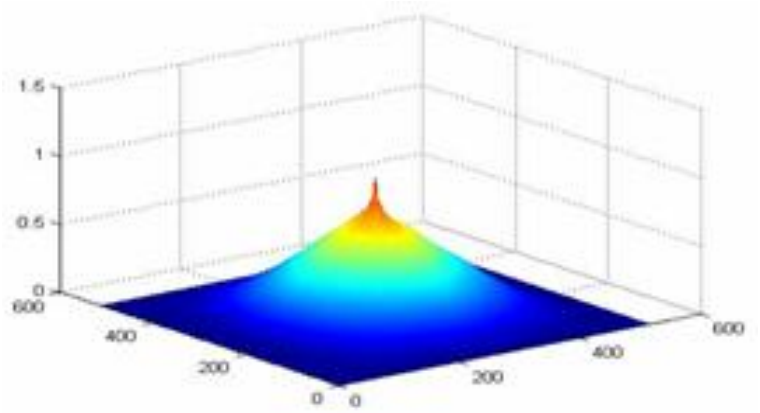

Fig. 1: Full correlation between two images

The matrix that contains the largest correlation is the angle that matches most closely to the database image[2,4]. The process follows these steps:

1. Pass scanned image through a rotation matrix of user set range
2. Place each resultant orientation matrix into an array
3. Perform the FFT Method on each matrix in the array, against the database image
4. Identify the highest correlation and the image matrix that a matching would take place.

This method is much robust and likely to get much accurate results as compared to simple FFT method & also does not take much more time as compared to time domain method. But if the Rotation matrix is much more tidies it may happen that this method may also take much more time as compared to conventional time domain method.

II. PHYSICAL PROPERTIES MATCHING METHOD

The previous all methods may be classified using signal processing but some good methods can be also used to classify the fingerprint images based on physical properties of fingerprint images. From the any fingerprint image we can obtain or in other words the image can be broken down in to various components or properties. These properties patterns are compared with similar properties of database image[Fig.2]

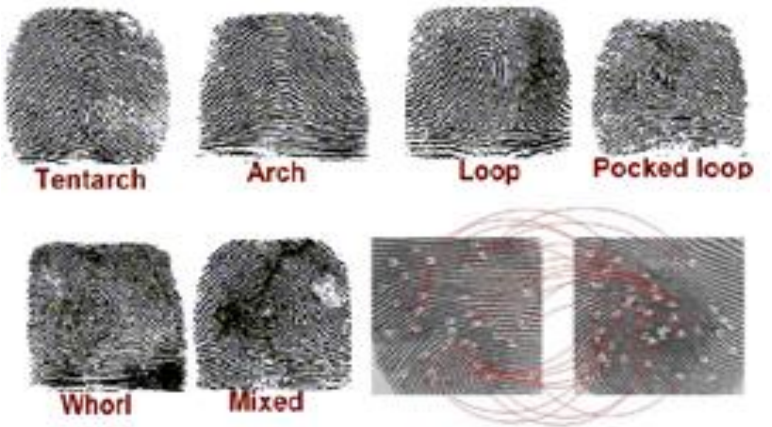

Fig.2: Different types of fingerprint patters & Physical Properties Based Matching

In this method the subset of images must be compared with entire database. Though this method gives us better identification/verification process in compared to above methods. But it require huge database, hence large storage capacity, so give Rise to higher cost. This method is highly dependent on image quality and size of scanned image [2,3].

III. ADDITIONAL OPTIMIZATION

It has been shown in this paper how additional optimization schemes have helped distinct performance features of our biometric authentication process:

(a) The frequency domain is the processing domain of choice due to the lower computational complexity thus greater computation speed.
(b) The dynamic rotational matrix utilizes orientation shifts rather than vertical and horizontal shifts. It was necessary to add this feature since the Two-dimensional convolution is not a very robust scheme considering orientation shifts in fingerprint placements. Although this method is more complex since it has the complexity of frequency domain and computational complexity, it is a more robust method ensuring that carelessness of the end user does not result in unwanted errors.

IV. DEBLURRING METHOD

While the strengths of these primary optimization schemes are clear, another optimization method takes place considering their weaknesses *deblurring method.* If an image is scanned and the digital image is blurred such that the distinguishable ridges of the fingerprint can no longer be extracted. Regardless of the computational advantages of the other methods, it can be shown that this roadblock is dependent on the technology used to implement the biometric solution [Fig.3].

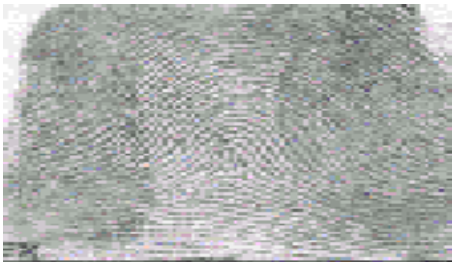

Fig. 3: Original Image

Often images are slightly blurred and image restoration aims at deblurring the image. The blurring can usually be modeled as an LSI system with a given PSF h [m, n].
The observed image is
$g[m, n] = h[m, n] * f[m, n]$
$G(u, v) = H(u, v)\, F(u, v)$
$$F(u, v) = \frac{G(u, v)}{H(u, v)}$$
Above we showed the equations for representing the common model for blurring an image. Below we have an original image and a PSF function that we wish to apply to the image in order to model a basic blurred image[5,4]. Therefore, a deblurring algorithm is helpful in reconstructing the scanned image, which is comparable with original image it is implemented by the following steps:

- Noise is simulated with a point spread function
- Deconvolution of the image and the simulated noise is then performed to obtain a "deblurred" image[F4].

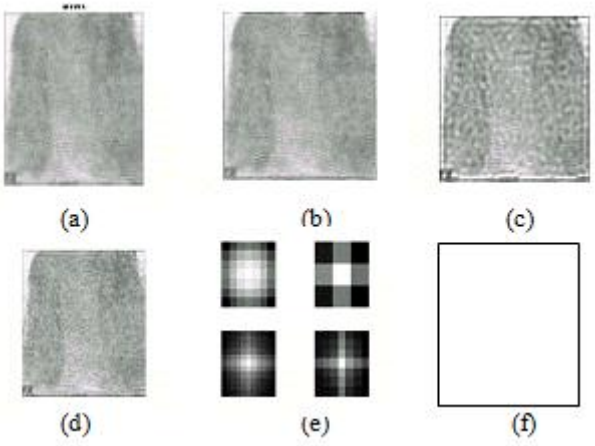

Fig. 4: Figure obtained from Matlab program

a) Blurred image, b) Deblurring with Undersized PSF, c) Deblurring with Oversized PSF, d) Deblurring with INITPSF, e) PSF images, (f) Weight array,

It is clear that the advantage of this optimization is that blurred images will be restored to a better state so that they can be matched [Fig. 5]. It should be pointed out that this method is not a method to compare the scanned image with the data base image .It is simply the method to improve the clearness of the image so that scanned image may visualize more better way as without filtering. Therefore deblurring optimization should not be a crutch of the biometric solution but rather another level of error precaution.

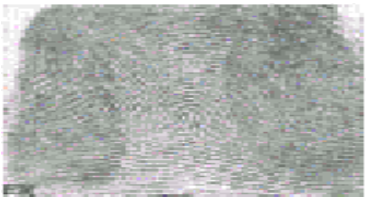

Fig. 5: Deblurred image

Applications:

(1) In industrial security.
(2) In financial offices like banks.
(3) In Technical area of armed forces.
(4) Biometrics.

V. CONCLUSIONS

Here in this paper we have find that time domain method was little bit time taking then frequency domain method. But after adding rotation matrix we can analyze even three-dimensional images using signal processing method. On the other hand we divide the image in different patterns and these patterns are matched in which the result was dependent on clarity of the images. So the great need of deblurring method is applied. At the last we can say that this all process are almost used in security purposes so these system always requires modifications.

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