



Enhancement Technique for Digital fingerprint image and quality control

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ABSTRACT

Fingerprint based personal identification is becoming more and more popular in everyday life. Designing an accurate real time automatic fingerprint identification system is of great importance in many circumstances, and this question has attracted lot of scholar's attention. Touch-less fingerprint recognition deserves increasing attention as it lets off the problems of information, maintenance, latent fingerprint problems and so on that still exist in the touch-based fingerprint technology. However, problems such as the low ridges-valleys contrast in the fingerprint images defocus and motion blurriness raise when developing a digital camera based fingerprint recognition system. The system comprises of preprocessing, feature extraction and matching stages. The proposed enhance fingerprint image using 2D Discrete Fourier Transform (DFT) stage presents the promising results in terms of segmentation, enhancement and core point detection. Feature extraction is done by Gabor filter followed by Principle Component Analysis and the favorable verification results are attained with Cosine Angle.

Keywords - Enhancement, touch-less fingerprint, recognition, 2D-DFT preprocessing, Principle Component Analysis

I. INTRODUCTION

Fingerprint based personal identification is becoming more and more popular in everyday life. Designing an accurate real time involuntary fingerprint identification system is of great importance in many conditions and this question has attracted lot of scholar's attention. Fingerprint image acquisition was performed by using the so-called "ink-technique". Today, most civil and criminal Automatic Fingerprint Identification Systems (AFIS) accept live-scan digital images acquired with an electronic fingerprint scanner where the finger surface is directly sensed [1]. Even so, touch-less fingerprint recognition has been gaining attention recently because it frees from the problems in terms of hygienic, maintenance, latent fingerprint problems and so forth that occur in the touch-based sensing technology. Most importantly, images captured with touch-less devices are distortion free and present no deformation since these images are exempted from the pressure of contact [2]. To date, several approaches for touch-less fingerprint recognition system have been published or proposed. In [2], the

authors proposed a preprocessing technique which included low pass filtering, segmentation and Gabor enhancement for their own-designed touch-less sensor. Later, [5] resolved the 3D to 2D image mapping problem that was introduced in [2] by a strong view difference image rejection method. We apply 2D discrete Fourier Transform on 2D image (normalized image). Preprocessing of fingerprint images captured with mobile camera was suggested by [5]. In this paper, we opted for a the digital camera to acquire the fingerprint images owing to its affordable cost and the unique features such as zooming, auto-focusing, and high resolution that are suitable to capture high quality images. However, some challenging problems appear when developing a fingerprint recognition system that uses a digital camera. First, the contrast between the ridges and the valleys in the fingerprint images acquired with a digital camera is low. Second, the depth of the field of the camera is small, hence some part of the fingerprint regions are in focus but some parts are out of focus. Third, motion vagueness in the images is obtained. Specifically, we propose an end to end resolution for the digital camera based fingerprint recognition system in which the raw images will be normalized, segmented, enhanced and followed by the core point detection. The normalized images will next be proposed by the Gabor filters. The outline of the paper is as follows: Section 2 provides an overview of the preprocessing system and also describes proposed 2-D Discrete Fourier Transform.

II. PREPROCESSING SYSTEM

The user interface module provides mechanisms for a user to input his/her fingerprints into the system (Fingerprints Acquisition) and also displays the matching result. Following figure shows the block diagram of proposed system.

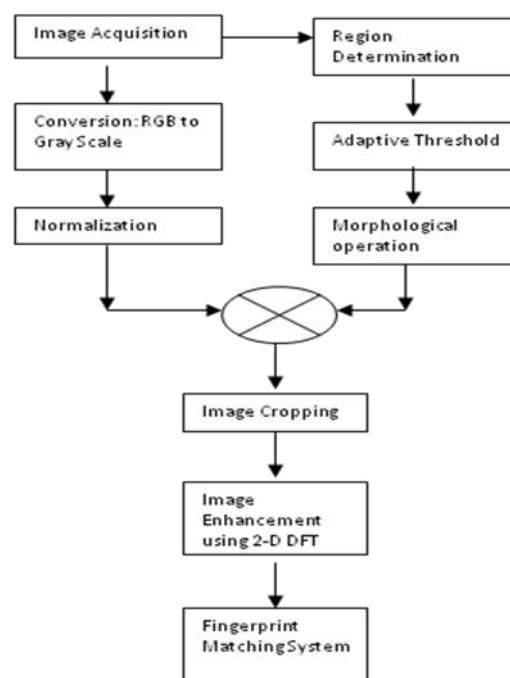


Fig1: Block diagram of digital webcam system.



As in block diagram shows, fingerprint image is acquired through digital camera. After that two parallel process i.e. conversion RGB to Gray scale and conversion of color full image to binary image. A preprocessing algorithm to segment, enhance and detect fingerprint's core point of the fingerprint images captured with digital camera is developed by [7]. The grayscale image which is converted from the RGB image is normalized to reduce the problem of non-uniform lighting. Parallel, we determine the probable fingerprint region. The adaptive threshold followed by the morphological processing are performed on the determined probable fingerprint region in order to create the fingerprint binary mask. The normalized image is then multiplied with the fingerprint binary mask. The resulting image is cropped and enhanced by using 2-D DFT. Finally, the ridge course is calculated and the core point detection is done on the enhanced image and final matching is done in fingerprint matching system.

III. FINGERPRINT ENHANCEMENT AND QUALITY CONTROL

A critical step in fingerprint recognition process is to automatically and reliably extract ridges from the input fingerprint images [4]. However, in practice, due to variations in impression conditions, ridge configuration, skin conditions, acquisition devices, and non-obliging attitude of subjects, etc., a significant percentage of acquired fingerprint images are of poor quality.

Therefore it is necessary to first use image processing techniques on raw fingerprint image to get enhanced fingerprint images for next process step. The key of a fingerprint enhancement algorithm is its filtering design [3]. Many filtering method have been proposed in last ten years.

However a better enhanced result often requires a more complex filter computation and it seems be a tradeoff question between enhanced image quality and process time. Here we adopt Gabor filtering method which is also the most popular fingerprint enhancement algorithm.

Our anticipated fingerprint enhancement method includes normalization, fingerprint mask estimation, ridge compass reading & frequency estimation. The fingerprint image is enhanced by using STFT analysis [6]. The fingerprint images can be segmented and enhanced finer in the STFT analysis if the images are normalized.

IV. FOURIER TRANSFORM AND INVERSE

The Fourier transform, $F(u)$, of a single variable, continuous function, $f(x)$, is defined by the equation

$$F(u) = \int_{-\infty}^{\infty} f(x)e^{-j2\pi ux} dx \quad (1)$$

Where $j = \sqrt{-1}$. Conversely, given $F(u)$, we can obtain $f(x)$

$$f(x) = \int_{-\infty}^{\infty} F(u)e^{j2\pi ux} du \quad (2)$$



These two equations comprise the Fourier transform pair. The most important property of discrete transform is that, unlike the continuous case, we need not to concern about the existence of the DFT or its inverse. The discrete Fourier transform and its inverse always exist.

Discrete Fourier transform of function (image) $f(x, y)$ of size $M \times N$ is given by equation

$$F(u, v) = \frac{1}{M} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) e^{-j2\pi(ux/M + vy/N)} \quad (3)$$

This expression must be computed for values of $u = 0, 1, 2, \dots, M-1$ and also for $v = 0, 1, 2, \dots, N-1$, we get $f(x, y)$ via inverse Fourier transform, given by following expression

$$f(x, y) = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u, v) e^{j2\pi(ux/M + vy/N)} \quad (4)$$

For $x = 0, 1, 2, \dots, M-1$ and $y = 0, 1, 2, \dots, N-1$.

Equations (3) and (4) comprise the two-dimensional, Discrete Fourier Transform (DFT) pair. The variables u and v are the transform or frequency and x and y are the image variable.

For rotating the image, we will introduce the polar coordinates:

$$x = r \cos \phi, y = r \sin \phi, u = \omega \cos \phi, v = \omega \sin \phi$$

Then $f(x, y)$ and $F(u, v)$ become $f(r, \phi)$ and $F(\omega, \phi)$, respectively. Direct substitution into definition of the Fourier transforms yields

$$f(r, \theta + \theta_0) \Leftrightarrow F(\omega, \phi + \theta_0) \quad (5)$$

This expression indicates that rotating $f(x, y)$ by an angle θ_0 rotates $F(u, v)$ by the same angle. Similarly, rotating $F(u, v)$ and $f(x, y)$ by the same angle.

V. FILTERING IMAGE

The value of Fourier transform defines a space known as frequency domain and its frequency variables (u, v) . In this section we deal with frequency domain, relates to fingerprint image processing.

As we early discussed that each term of $F(u, v)$ contains all values of $f(x, y)$, modified by exponential terms. Thus, with the exception of trivial cases, it usually is impossible to make direct associations between components of Fourier transform and spatial characteristics of fingerprint image. After cropping, since, frequency directly related to rate of change, it is not difficult instinctively to associates the frequencies in the Fourier transform with the pattern of ridges variation in the fingerprint image. As we move away from origin of transform, slowest varying frequency component ($u=v=0$) corresponds to the average gray level of an image, low frequencies correspond to slowly varying components of an image. As we move further away from the origin of transform, the higher frequencies begin to correspond to faster and faster gray level changes in the image. These are the ridges of finger as characterized by abrupt changes in gray level, such as noise.

For removing the noise from normalized fingerprint image, we propose a filtering technique on DFT. It consists of the following steps:

1. Multiply the input image by to center of transform, we get

$$\mathfrak{I}[f(x, y)(-1)^{x+y}] = F(u-M/2, v-N/2) \dots \quad .. (6)$$

2. Compute $F(u, v)$, the DFT of the image from (1).
3. Multiply $F(u, v)$ by a filter function $H(u, v)$.
4. Compute the inverse DFT of result (3).
5. Obtain the real part of the result in (4).
6. Multiply the result in (5) by.

$H(u, v)$ filter function suppresses certain frequencies in the transform while leaving others unchanged

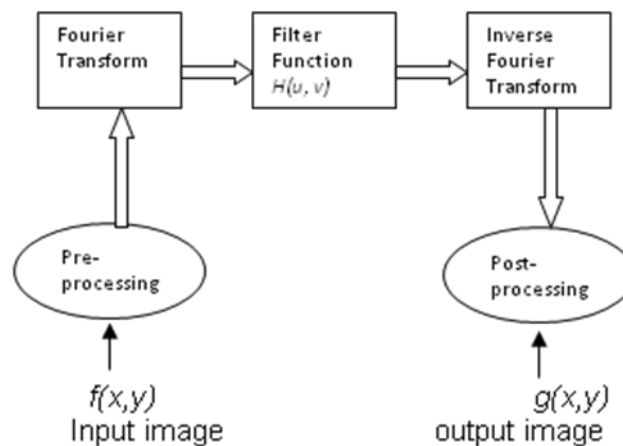


Fig2: Basic steps for filtering in frequency domain.

VI. RESULT



Fig3: show image before & after Enhancement

VII. CONCLUSION & FUTURE WORK

The image enhancement is versatile field of research using Fourier transformation and wavelet transformation. The application of image in different field such as medical diagnosis, satellite image and user application are needed de noising and enhancement technique of image. The conventional technique such as histogram equalization and multipoint histogram equalization not perform up to mark. In this paper we proposed cascading



model of Fourier transformation with some basic technique. The increased performance of cascade model set the value of transform as threshold and process of approximate value for filtration and increases the value of PSNR and enhanced the quality of image.

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