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A Bar Code Design and Encoding for Fingerprints

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Abstract

Fingerprint recognition is a popular, very widely used and accurate Biometric technology. Nowadays, fingerprints are being used in many real life applications such as access control, forensics, etc. However, recognizing fingerprints in poor quality images is still a very complex problem. In recent years, many algorithms and models are given to improve the accuracy of fingerprint recognition system. Here, we are presenting a Barcode approach for Fingerprint recognition systems.

Keywords: - Fingerprint; Ridge; Barcode.

1. Introduction

Fingerprint is one of the wonders in the biometric and forensic science. Day by day it is groomed and turned into digital application.

Fingerprint images are considered as a class. Fingerprints are an effective choice for recognition. Fingerprints and analysis of fingerprint images' properties have been an area of great historical interest, dating back to the age of early cave drawings of finger ridge patterns.

Until the recent advancements of experimental automated systems, all fingerprint analysis had been done by human beings.

The need for automated systems becomes quite obvious when one realizes that the Federal Bureau of Investigation (FBI) alone is called upon to classify and file thousands of sets of fingerprint cards everyday.

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We are presenting here a method for fingerprint recognition, by designing and encoding a barcode. Not much work is done in literature by this method which can give better time and space complexity values. This is an approach to make fingerprint recognition technology more ease of use in our daily life for security, forensic, and other biometrics purposes.

An individual's fingerprints are unique thus giving all humans an identification barcode itself.

2. Fingerprints

Fingerprints are graphical flow-like ridges present on human fingers or fingertips. Human fingertips enclose ridges and valleys which altogether forms distinctive patterns [3], [5].

These patterns are fully developed under pregnancy (during seventh month of fetus development) and are permanent throughout the whole lifetime of a person. Prints of these patterns are called fingerprints or fingerprint images.

Injuries like cuts, burns and bruises can temporarily spoil quality of fingerprints but when/if fully healed patterns will be restored in most cases. This property makes fingerprints a very strikingly attractive biometric identifier.

Fingerprints have long been used for personal identification. It is assumed that every single person possesses unique fingerprints [1] and hence the fingerprint matching is considered one of the most reliable and effective techniques of person identification, therefore it is very widely used. (Not to mention fingerprint recognition system is quite cheaper than many other biometric identifiers).

A fingerprint image exhibits a pattern of ridges (darker regions) and valleys (lighter regions). The local topological structures of this pattern added with the spatial relationships determine the uniqueness of a fingerprint.

There are many different types of local ridge structures that have been identified [1]. Most of the automatic fingerprint identification/verification systems adopt the model used by the FBI [2].

Figure 1 shows a sample fingerprint and figure 2 shows different fingerprint types.

Fig 1: A fingerprint sample

3. Fingerprint Ridge

In Figure 3, a fingerprint is shown alongwith the different ridge features. The information carrying features in a fingerprint are the line structures, called ridges and valleys. In this figure, the ridges are black and the valleys are white.

4. Barcode

A barcode is an optical machine-readable representation of data relating to the object to which it is attached. Originally barcodes systematically represented data by varying the widths and spacings of parallel lines (linear i.e. one-dimensional). Figure 4 shows a barcode sample.

5. Fingerprint Barcode

We are going to propose a method of expressing a fingerprint by the means of barcode. The barcode obtained from a fingerprint would look like something in figure 6.

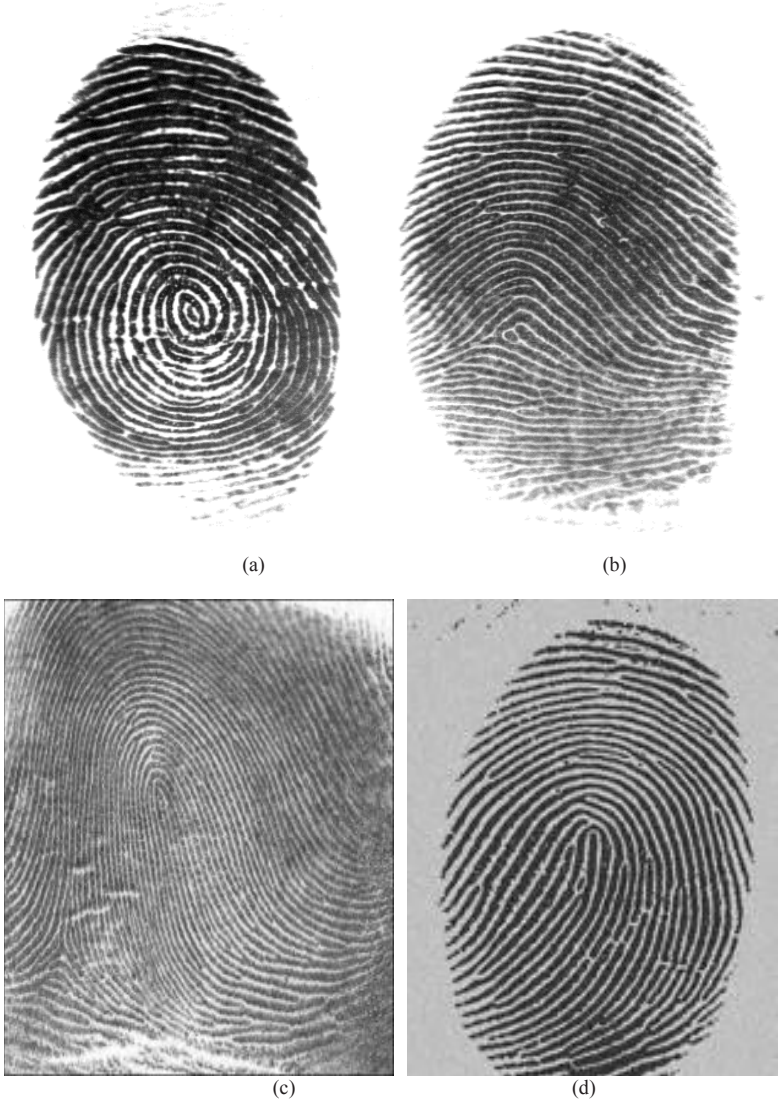

Fig 2: Fingerprint types:
(a) Whorl, (b) Arch, (c) Right Loop, (d) Left Loop

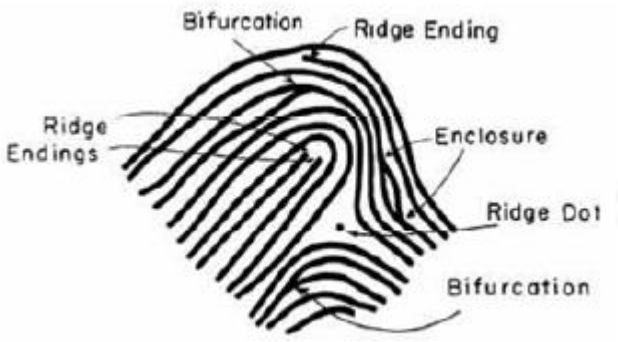

Figure 3: Fingerprint image showcasing different ridge features

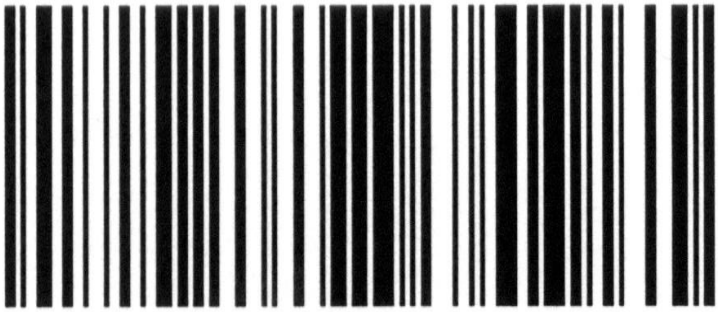

Fig 4: Sample barcode

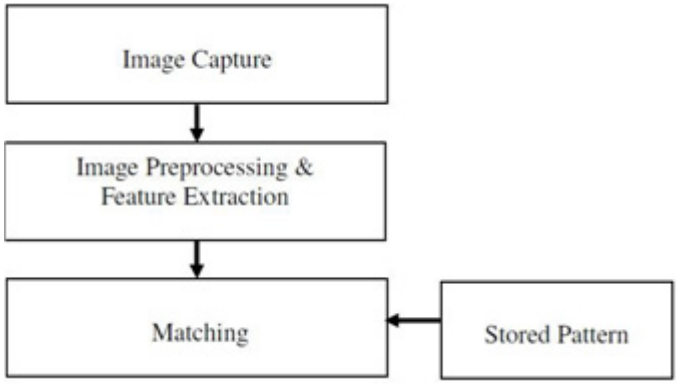

Figure 5*: S*teps of general fingerprint recognition system.

Fig 6: Fingerprint BARCODE

6. Algorithm

Step 1:- Take an image of fingerprint through a scanner.
Step 2:- Remove noise.
Step 3:- Binarize the image.
Step 4:- Calculate the four extreme points of the picture for border. i.e. Left, Right, Top, Bottom.
Step 5:- Make a rectangle using the four extreme points and calculate the middle point.
Step 6:- Draw an imaginary line horizontally using the middle point.
Step 7:- Check if the imaginary line crosses the original fingerprint ridges, and store the values as 1 if and where it cuts the line or as 0 if it does not. This way we can get a array of 1s and 0s.
Step 8:- Keep that array with a reference name or number in database.

7. Discussion

For a better result we need to remove pores from the fingerprint before applying the algorithm (As it can be seen in a good quality fingerprint image, the friction ridges are dotted with small circular openings – the sweat pores, the perspiration is exuded from these).

Noise is an unwanted perturbation to a wanted signal. It is the random variation of brightness or colour information in images, produced by the sensor and circuitry of a scanner or digital camera. Image noise is often regarded as an undesirable by-product of image capture. Noise reduction is the process of removing noise from a picture, and more than often it is a must to do process for image processing (in the pre-processing phase) [4], [6].

Here we used a different type of approach to remove noise: firstly apply Median filter and then the Sobel operator on the obtained image to remove noise for the original fingerprint image (figure 7).

We can take any other reference point (such as singular point) and not the middle point, but has to be the same for each image.

For an even better space complexity we can save the total number of 1s in the array followed by total number of 0s and not the 1s and 0s.

We can also save the total number of black strips as a feature (in the sample, figure 6, it is 25). Note in the barcode the strips always start and end white the black one.

We can also save the pixel values of black strips only for an even better space complexity, but in our project we saved both black and white strips.

To have a fixed number of array elements for each fingerprint image, we can crop a fixed length area around the reference point and perform the operation on that area.

Our observations showed that, for our database, for upto 15% of angular displacement the obtained barcode remains the same, thus helping in incorporating position invariant features.

If a person gets a scar in the finger after first storing his fingerprint in the database, later on his fingerprint may not match with the data value stored earlier giving a false rejection.

8. Model Analysis

(a) (b)

Figure 7: (a) Input image with noise, (b) the image after the noise removal

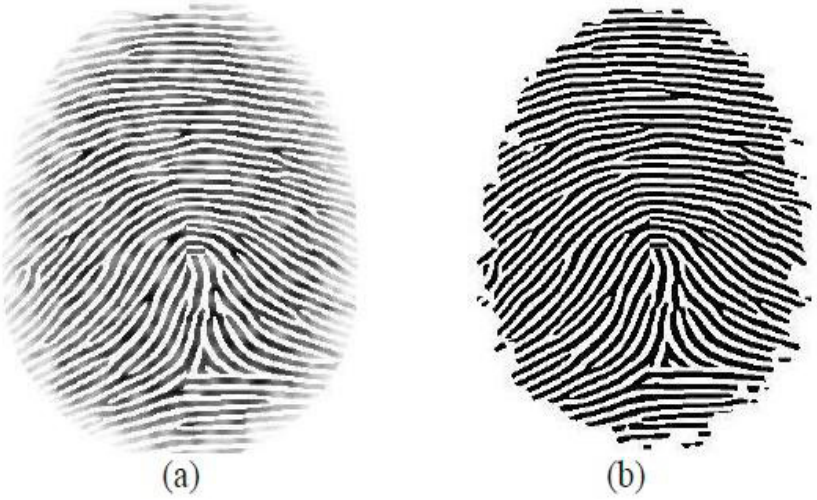

Figure 8: (a) Original Fingerprint, (b) Binarized Fingerprint.

Fig 9: Fingerprint BARCODE-ing intermediate state

The barcode obtained for the sample fingerprint (Figure 6) is as follows:

10 11 20 5 18 6 15 5 12 3 11 4 6 9 11 7 12 9 15 3 7 10 16 5 14 9 12 4 10 8 13 8 13 8 17 7 17 12 17 7 22 12 16 13 10 13 13 12 7

Where the numbers in red (underlined ones) represents the total number of black pixels (1s) followed by green number represents the number of white pixels (0s).

Here a random point is taken as the reference point.

9. Conclusion

There have been many algorithms developed for extraction of both local and global structures.

Most algorithms found in the literature are not only difficult to implement, but they also use heuristic approach.

The reliability and usuabily of any automatic fingerprint recognition system very much relies on the precision obtained in the feature extraction process. Extraction of appropriate features is one of the most important tasks for a recognition system.

Therefore, a very important phase is noise removal for this proposed barcoding system, as even a small amount of noise can make the ridge structure different, affecting the whole barcoding system..

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