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Reconstruction of Fingerprint for Incomplete Regions-A Survey

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Abstract: Fingerprints offer an infallible means of personal identification. Fingerprint recognition offers many advantages over traditional PIN number or password and token based approaches. Fingerprint have been accepted throughout the world and is considered to be the most prominent biometric because of its characteristics such as universality, Uniqueness and permanence. So fingerprint is mainly used for authentication purpose. This paper discusses about the various classifications and matching algorithm of fingerprints. This paper also discusses about the various methodologies for reconstructing the incomplete regions of fingerprints which reduces the percentage of false detection and improves the fast identification of a person.

Keywords: Fingerprint, Universality, Uniqueness, permanence. Orientation field, Reconstruction, Minutiae

I. INTRODUCTION

In 14th century Persia, various official government papers had impressions (fingerprints), and one doctor, observed that no two fingerprints were exactly alike. Other visible human characteristics tend to change but fingerprint do not. So the fingerprint is chosen for authentication and it provides a security for communication. Only from 19th century onwards fingerprints have been used for identification. Henry fauld [1] has first scientifically suggested the individuality and uniqueness of fingerprints. An important advance in fingerprint identification has been made by Edward Henry, who has established a system known as "Henry System" for fingerprint classification. [2].

The science of "Poroscopy", the comparisons of sweat pores for the purpose of personal identification has introduced by Locard [2] and science of "edgeoscopy", the use of ridge edges to establish individualization has proposed by Chatterjee [2]. The Biometric system consists of the following steps such as data input, Preprocessing, feature extraction, classification and calculation of reference data. The data input is taken via sensors. The data is preprocessed and image has been enhanced. For categorizing fingerprint image types into fingerprint classes, classification and feature extraction is used.Atlast the input data is compared with the reference image.

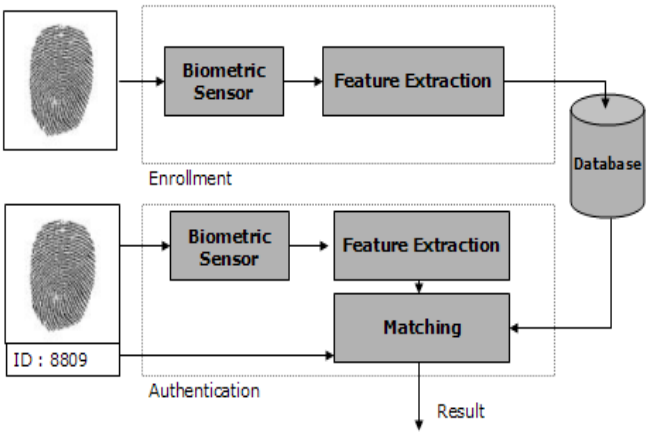

Figure 1. Architecture of Biometric system

The fingerprint types can be categorized as Level 1, Level 2 and Level 3 features. [3].The Level 1 features comprises of arch, loop and whorl. Again this can be further classified into tented arch, left-loop, right-loop and double-loop. The level 2 feature includes ridge endings and bifurcation. A ridge ending is defined as the ridge point where a ridge ends abruptly. A bifurcation is defined as the ridge point where ridge bifurcates into two ridges. Minutiae are the most prominent features because it is stable and robust to fingerprint impression conditions. Level 3 features are the fine intra ridge details present in fingerprints. [3].They is essentially the sweat pores and ridge contours. Pores are the openings of the sweat glands and they are distributed along the ridges. Ridge contours contains information including ridge width and edge shape.

Injuries or surgery causing deep scarring, or diseases such as leprosy damage the formative layers of friction ridge skin. So the finger and palm print features have been shown to move about or change their unit relationship throughout the life of a person. So the matching will be delay and errors may occur.

II. LITERATURE REVIEW

The input of the image is acquired by Data acquisition. This paper discusses the various data acquisition techniques, enhancement, classification and matching techniques.

A. Data Acquisition:

The fingerprint image is captured by sensors. There are various sensors like optical sensors, capacitive sensors and Ultrasound sensors. The optical sensors are most commonly used and these sensors are based on Frustrated Total Internal Reflection (FTIR) technique. [3]. The sensors exploit this differential property of light reflection to differentiate the ridge from the valleys. The capacitive sensors utilize the principle associated with capacitance to form the fingerprint images. These sensors consist of 2D array of metal electrodes. The ridges have increased capacitance compared to valleys. The ultrasound technology based sensors are the most accurate of the fingerprint sensing technologies. It uses ultrasound waves and measures the distance based on the

impedance of the finger, the plate and air. To capture the fingertip a new technique called a contactless fingertip recognition systems based on three dimensional model which uses structured light illumination. This design is of touch-less fingertip recognition systems based on CCD cameras. [3].

B. Fingerprint Enhancement:

To make the image clearer than the original image to perform further operations a preprocessing technique is performed. The image enhancement is a pre-processing technique. The images acquired from sensors or other media are not always assured with perfect quality. To increase the contrast between the ridges and furrows, for connecting the false broken points of ridges due to insufficient amount of ink, the image enhancement methods are needed.

Various enhancement techniques for fingerprint are done by several types of filters. The purpose of the filters is to fill small gaps in the direction of the ridge and to increase the discrimination between ridge and valleys. [4] [5]. Gabor filters [6] have both frequency-selective and orientation-selective properties which have optimal joint solutions in both spatial and frequency domains. Greenberg et al [7] proposed the use of an anisotropic filter that adapts its parameters to the structure of the underlying region. The most widely used technique for fingerprint image enhancement is based on contextual filters. The parameters of these filters change according to the local context.

a) Original image

b) Image Enhanced

C. Classification Of Fingerprints:

In Henry classification system [8] fingerprint images are classified into four major classes such as arch, left-loop, right-loop and whorl. The arch class can be further divided two subclasses consisting of the plain arch and tented arch. The Whorl is again divided into central pocket whorl and twin loop whorl.

a) Arch

b) Tented Arc

c) Right-Loop

d) Left-Loop

e) Central pocket Whorl

f) Twin loop Whorl

A number of approaches have been developed for automatic fingerprint classification. [9]. These approaches can be grouped into five main categories (i) approaches based on singular points (ii) Structure based (iii) frequency based (iv) syntactic or grammar-based (v) approaches based on mathematical models. Fingerprint classification proceeds by inspecting the geometric characteristics of major ridge curves in a fingerprint image. An automatic approach of identifying the geometric characteristics of ridges based on curves generated by the orientation field called orientation field flow curves (OFFCs). [10].

Input fingerprint
↓
Orientation field estimation
↓
Generation of OFFC
↓
Determine OFFC label
↓
Determine fingerprint class
↓
Fingerprint class: W, L, R, A

D. Feature Extraction:

In this section the feature extraction technique is discussed. There are different levels of fingerprint features. They are extraction techniques for Minutiae points, Pores and ridge contours. The Minutiae extraction techniques find the ridge bifurcation and ridge endings which are the minutiae types. These minutiae types will be used by the matching algorithms. The normal minutiae extraction algorithm [11] consists of the stages like (i) Estimation of Orientation field (ii) segmentation (iii) Detection of Ridges (iv) Detection of Minutiae and (v) Post process sing.

The second technique is pore Extraction. This technique is for extracting fine details. These fine details can be lost after the enhancement of image. So this technique is used in preprocessing stage so that enhancement of fingerprint is omitted. The pore extraction algorithm is of 2 classes. The first class is to extract pores by tracing fingerprint skeleton. [11]. This approach is reliable for extracting pores in good quality with high resolution images. The second class of algorithm extracts pores directly from gray-scale image.

The third technique is Ridge contour extraction method. Jain et al [11] have proposed an algorithm to extract the ridge contours which uses simple filters to detect ridge contours. This ridge contours can be detected by edge detection algorithm. This is done by enhancing an image by Gabor filters and a wavelet transform is applied to the original image. [11].

E. Fingerprint Matching:

The common matching algorithms are Minutiae based matching and Ridge feature based matching.

a. Minutiae Based Matching: Minutiae based matching algorithm can be broadly classified as follows:

a) Global matching: It aligns all points at once. This global matching algorithm [12] can be further categorized into (i) implicit alignment and (ii) Explicit alignment.

b) Local matching: This type of matching tries to match points occurring within a small local neighborhood. The matching of all the points is obtained by combining these local matches.

c) Graph Based Matching: A new representation called k-plet [12] is to represent local neighborhood of minutiae points. This approach uses 3 aspects such as (i) Representation (ii) Local Matching (iii) Consolidation.

b. Ridge Feature Based Matching: Sometimes the minutiae features will not give a good result of matching. So the alternative features are (i) global and local texture information, and (ii) Level 3 features [12].Global and Local Texture: Texture is defined by the basic elements such as Scale, frequency, Orientation, Symmetry, isotropy and so on. Global texture analysis fuses contribution from different characteristics regions into a global measurement and local texture analysis has proves to be more effective than global feature analysis. The Level 3 features based technique [12] is focused on extracting the pores and to establish the pores in high resolution fingerprint image.

III. OVERVIEW OF THE PROBLEM

When Low-cost acquisition devices are used a poor quality of fingerprint is obtained and matching the fingerprint image will be very difficult. In the existing fingerprint matching algorithm there are error rates called False Acceptance Rate [FAR] and False Rejection Error [FRR]. If there is a high displacement / rotation during the acquisition of fingerprint then there will be an overlap of fingerprints. And also several factors such as poor skin condition, unclean scanner surface, dirt on finger and incomplete regions of fingerprint results in false matching of fingerprint.

IV. RECONSTRUCTION METHODOLOGY

The quality of fingerprint image is affected by some gaps in ridges, due to noise the parallel ridges are connected and natural effect to the fingers like wrinkles, cuts and injuries. If incomplete regions are there in fingerprint we can reconstruct the fingerprint again. The main features of fingerprint are minutiae. So by estimating the orientation field of minutiae points we can reconstruct the incomplete regions. A novel fingerprint reconstruction algorithm [13] [14] [15] is proposed to reconstruct the phase image. The reconstructed fingerprint image gives the full fingerprint image and very few spurious minutiae points. This fingerprint image is represented as phase image which consists of the continuous phase and the spiral phase. This algorithm reconstructs the continuous phase from minutiae.

Grayscale Phase image Skeleton image Minutiae.

Estimating the orientation field from fingerprint minutiae is to improve the matching accuracy. [17] [18]. (1) Estimate the orientation field of incomplete regions. (2) Connection of disrupted ridges and recovery of missing minutiae.

V. CONCLUSION

The Reparation method for incomplete fingerprint regions brings more information than the enhancement algorithm. The Reconstruction of incomplete fingerprint by minutiae based approach increases the matching performance .Even though some minutiae points are not enough to reconstruct the incomplete fingerprint regions. So my research will engage the estimation of orientation field for singularities information. So with all these information we can reconstruct the fingerprints incomplete regions perfectly and this approach might overcome some failed cases and incorrect prediction.

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