An Advanced Method: Fingerprint Recognition and Analysis for All Investigation & Industrial Applications

[1]A. V. Subbarao, M.Tech,(Ph.D),
[1]Assoc.Professor,
HOD,Dept Of ECE,St Marry's Group of Institutions,
Chebrolu, Guntur, A.P,India-522212.

[2]S K. Imam, M.Tech,
[2]Asst.Professor,
Dept Of ECE,St Marry's Group of Institutions,
Chebrolu, Guntur, A.P, India-522212.

[3]Ashok Kumar Balijepalli, M.Tech.
[3]Asst.Professor,
Dept Of ECE,St Marry's Group of Institutions,
Chebrolu, Guntur, A.P, India-522212.

***Abstract*— Security systems are now computerized. Automated security systems are essential now. These days most of the banking transactions, use of cell phones and personal digital assistants (PDAs) are frequently performed. This rapid progress in personal communication system, wireless communication system and smart card technology in the society makes information more quick & realistic. Reliable extraction of features from poor quality prints is the most challenging problem faced in the area of fingerprint recognition. Fingerprints are the oldest and most widely used form of biometric identification. Local characteristic called minutiae points represent fingerprints. This can be used as identification marks for fingerprint recognition. The goal of this thesis is to develop a complete system for fingerprint recognition through minutiae extracting and matching minutiae. To achieve good minutiae extraction in fingerprints with varying quality, preprocessing in form of image enhancement, image segmentation and binarization is first applied on fingerprints before they are evaluated. The combination of multiple methods comes from a wide investigation into research papers. Minutias marking with special consideration of the triple branch counting and false minutiae removal methods are used in the work. Also some novel changes like segmentation using morphological operations, improved thinning, false minutiae removal methods, minutia marking with special considering the triple branch counting, minutia unification by decomposing a branch into three terminations, and matching in the unified x-y coordinate system after a two-step transformation are used in the work. The minutiae based fingerprints recognition technique is studied in detail and implemented in MATLAB**

Keywords*:*Finger Print Recognisation, Latent matching, MATLAB.

I. INTRODUCTION

In an increasingly digitized world the reliable personal authentication has become an important human computer interface activity. National security, e-commerce and access to computer networks are now very common where establishing a person's identity has become vital. Existing security measures rely on knowledge-based approaches like passwords or token-based approaches such as swipe cards and passports to control access to physical and virtual spaces, but there methods are not very secure. Tokens such as badges and access cards may be duplicated or stolen. Passwords and personal identification number (PIN) numbers may be stolen electronically. Furthermore, they cannot differentiate between authorized user and a person having access to the tokens or knowledge.

Biometrics such as fingerprint, face and voice print offers means of reliable personal authentication that can address these problems and is gaining citizen and government acceptance.Biometrics is the science of verifying the identity of an individual through physiological measurements or behavioural traits. Since biometric identifiers are associated permanently with the user they are more reliable than token or knowledge based authentication methods. Biometrics offers several advantages over traditional security measures. These includes

1. Non-repudiation
2. Accuracy and Security

With token and password based approaches, the perpetrator can always deny committing the crime pleading that his/her password or ID was stolen or compromised even when confronted with an electronic audit trail. There is no way in which his claim can be verified effectively. This is known as the problem of deniability or of 'repudiation'. However, biometrics is indefinitely associated with a user and hence it cannot be lent or stolen making such repudiation infeasible.

On the other hand, biometric authentication requires the physical presence of the user and therefore cannot be circumvented through a dictionary or brute force style attack. Biometrics has also been shown to possess a higher bit strength compared to password based systems and is therefore inherently secure. In screening applications, we are interested in preventing the users from assuming multiple identities e.g. a

terrorist using multiple passports to enter a foreign country. This requires that we ensure a person has not already enrolled under another assumed identity before adding his new record into the database. Such screening is not possible using traditional authentication mechanisms and biometrics provides the only available solution.

In enrollment the biometrics of the user is captured and the extracted features templates are stored in the database.
In authentication the biometrics of the user is captured again and the extracted features are compared with the ones already existing in the database to determine a match. The specific record to fetch from the database is determined using the claimed identity of the user. The database itself may be central or distributed with each user carrying his template on a smart card. The various stages of a typical fingerprint recognition system are shown in Fig. 1 The fingerprint image is acquired using off-line methods such as creating an inked impression on paper or through a live capture device consisting of an optical, capacitive, ultrasound or thermal sensor. The first stage consists of standard image processing algorithms such as noise removal and smoothening.

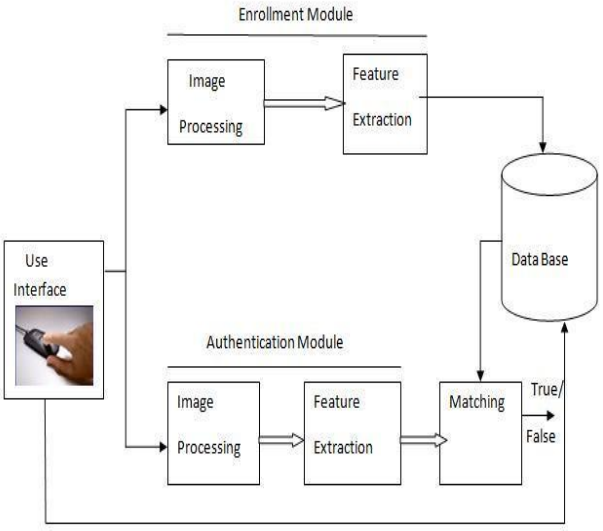


Fig.1.General Process to recognize a finger print

Fingerprint Matching

Matching fingerprint images is an extremely difficult problem, mainly due to the large variability in different impressions of the same finger i.e. large intra-class variations. The main factors responsible for the intra-class variations are displacement, rotation, partial overlap, non-linear distortion, variable pressure, changing skin condition, noise, and feature extraction errors. Therefore, fingerprints from the same finger may sometimes look quite different whereas fingerprints from different fingers may appear quite similar. A three class categorization of fingerprint matching approaches. Correlation-based matching , Minutiae matching, Ridge feature-based matching

Correlation-Based Matching

Two fingerprint images are superimposed and correlation at the intensity level between corresponding pixels is computed for different alignments e.g. various displacements and rotations.

Minutiae Matching

Minutiae are extracted from the two fingerprints and set of points in the two-dimensional plane. Minutiae matching essential consists of finding are alignment between the template and the input minutiae set the results in the maximum number of minutiae pairings.

Ridge Feature-Based Matching

Minutiae extraction is difficult in very low quality fingerprints images, whereas other features of the fingerprints ridge pattern e.g. Local orientation and frequency, ridge shape, texture information may be extracted more reliability then minutiae. Even through their distinctiveness is generally lower the approaches belonging to this family compare fingerprints in terms of features extracted from the ridge pattern.

Pattern-Based Matching

Pattern based algorithms compare the basic fingerprintpatterns arch, whorl and loop between a previously stored template and a candidate fingerprint. This requires that the images be aligned in the same orientation. To do this, the algorithm finds a central point in the fingerprint image and centres on that. In a pattern-based algorithm, the template contains the type, size, and orientation of patterns within the aligned fingerprint image. The candidate fingerprint image is graphically compared with the template to determine the degree to which they match. Given a complex operating environment, it is critical to identify a set of valid assumptions upon which the fingerprint matcher design could be based. Often there is a choice between whether it is more effective to exert more constraints by incorporating better engineering design or to build a more sophisticated similarity function for the given representation. For instance, in a fingerprint matcher, one could constrain the elastic distortion altogether and design the matcher based on a rigid transformation assumption or allow arbitrary distortions and accommodate the variations in the input images using a clever matcher. In light of the operational environments mentioned above, the design of the matching algorithm needs to establish and characterize a realistic model of the variations among the representations of matched pairs.

Design Description

A fingerprint recognition system constitutes of fingerprint acquiring device, minutia extractor and minutia matcher as shown in Fig.2.

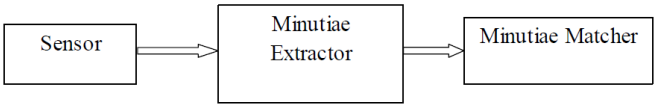


Fig.2 Simplified fingerprint recognition system

For fingerprint acquisition, optical or semi-conduct sensors are widely used. They have high efficiency and acceptable accuracy except for some cases that the user's finger is too dirty or dry.

Algorithm Level Design

To implement a minutia extractor, a three-stage approach is widely used by researchers. They are preprocessing, minutia extraction and post processing stage as shown in fig.3.

Image Enhancement
Image Binarization
Image Segmentation
Thinning
Minutiae Marking
Remove False Minutiae

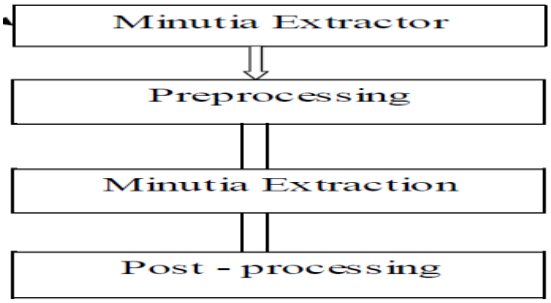


Fig.3.Minutia extractor

For the fingerprint image preprocessing stage, Histogram equalization and Fourier transform have been used to do image enhancement. And then the fingerprint image is binarizing using the locally adaptive threshold method. The image segmentation task is fulfilled by three-step approach block direction estimation, segmentation by direction intensity and region of interest extraction by morphological operations. For minutia extraction stage, iterative parallel thinning algorithm is used. The minutia marking is a relatively simple task. For the post processing stage, a more rigorous algorithm is developed to remove false minutia. Also a novel representation for bifurcations is proposed to unify terminations and bifurcations.

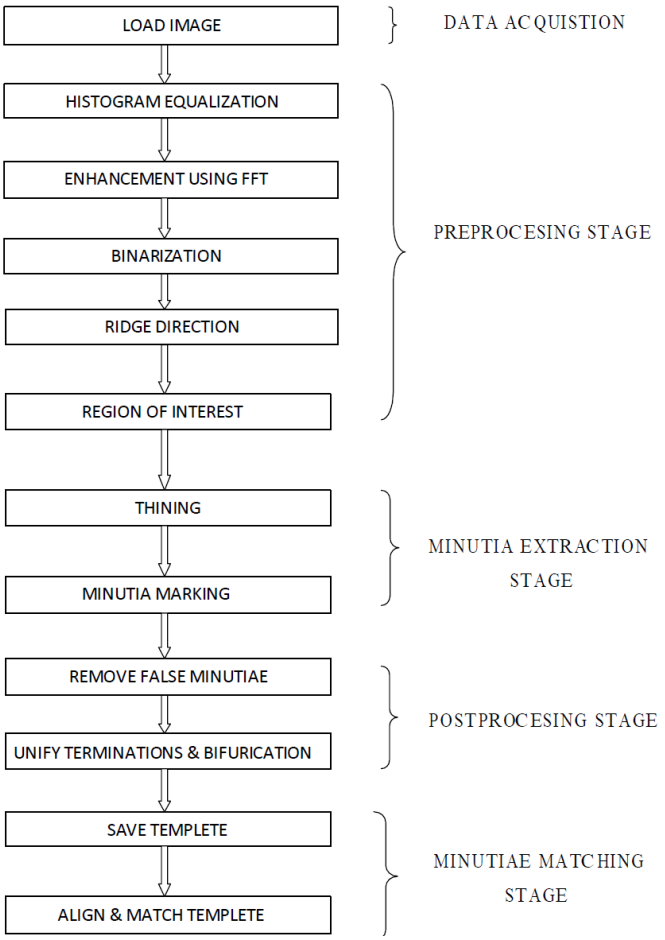


Fig. 4 Steps involved in Fingerprint Recognition Algorithm

Fingerprint image enhancement

Fingerprint Image enhancement is to make the image clearer for easy further operations. Since the fingerprint images acquired from sensors or other medias are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and furrows and for connecting the false broken points of ridges due to insufficient amount of ink are very useful for keep a higher accuracy to fingerprint recognition. One method is adopted for image enhancement stage the first one is histogram. In a fingerprint image, ridges and valleys flow smoothly in a locally constant direction ideally. There are certain factors that affect the quality of a fingerprint image As wetness or dryness of the skin, noise of the sensor, temporary or permanent cuts in the skin, variability in the pressure against the sensor, etc. Several enhancement algorithms have been proposed in the literature with the aim of improving the clarity of ridges and valleys. The most frequently used fingerprint enhancement techniques use a contextual filter, which means changing the filter parameters according to the local characteristics of image.

In the matching step, features extracted from the input fingerprint are compared against those in a template which represents a single user retrieved from the system database based on the claimed identity. The result of such a procedure is either a degree of similarity also calledmatchingscoreor anacceptance /rejection decision. There are fingerprint matching techniques that directly compare gray scale images or sub images using correlation-based methods so that the fingerprint template coincides with the gray scale image. One of the biggest challenges of fingerprint recognition is the high variability commonly found between different impressions of the same finger. This variability is known as interclass variability and is caused by several factors, including (a) displacement or rotation between different acquisitions (b) partial overlap, specially in sensors of small area (c) skin conditions, due to permanent or temporary factors (cuts, dirt, humidity, etc.) and (d) noise in the sensor for example, residues from previous acquisitions and (e) nonlinear distortion due to skin plasticity and differences in pressure against the sensor. Fingerprint matching remains as a challenging pattern recognition problem due to the difficultyin matching fingerprint affected byone or several of the mentioned factors. Fingerprint Image Binarization is to transform the 8-bit Gray fingerprint image to a 1- bit image with 0-value for ridges and 1-value for furrows. After the transformation, ridges in the fingerprint are highlighted with black colour while furrows are white. Locally adaptive binarization method is performed to binarize the fingerprint

image. Mechanism of transforming a pixel value to 1 if the value is larger than the mean intensity value of the current block (16x16) to which the pixel belongs comes under the application of this method. Fingerprint segmentation consists of the separation of the fingerprint area i.e. fore - ground from the background. This is good to avoid subsequent extraction of fingerprint features in the background, which is the noisy area. Global and local thresholding segmentation methods are not very effective. So that more robust segmentation techniques are frequently.

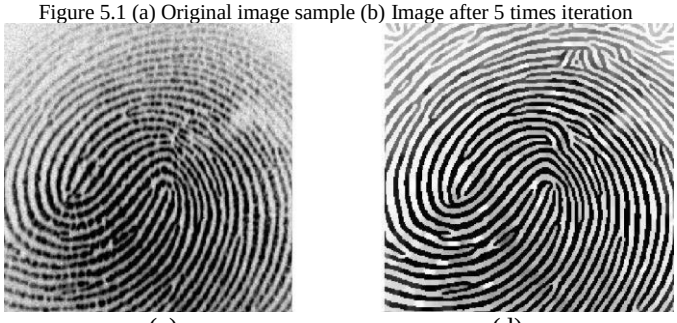
Ridge Thinning is done to eliminate the redundant pixels the ridges are brought to a level of just one pixel wide. An iterative, parallel thinning algorithm is used for this purpose in each scan of the full fingerprint image. This the algorithm marks down redundant pixels in each small image window of size 3x3. And finally removes all those marked pixels after several scans. The thinned ridge map is filtered with the help of three morphological operations H breaks, isolated points and spikes. The problem of minutiae detection is trivial & then this theory is used. The resulting pixel wide map is scanned sequentially and minutiae points are identified based on its neighbourhood. Ridge endings are characterized by single neighbour and bifurcations are identified by locating pixels with three or more neighbours.

RESULTS & DISCUSSION

In the fingerprint recognition and analysis by minutiae extraction technique we get these results of fingerprint images as shown in the Fig. 5 shows fingerprint images from the MATLAB after complete the iteration of 0 to 30 times and the output of our fingerprint images are shows Based on the findings the minutiae Based matching method proved reliable with a high level of accuracy.

(a) (b)

Figure 5.1 (a) Original image sample (b) Image after 5 times iteration



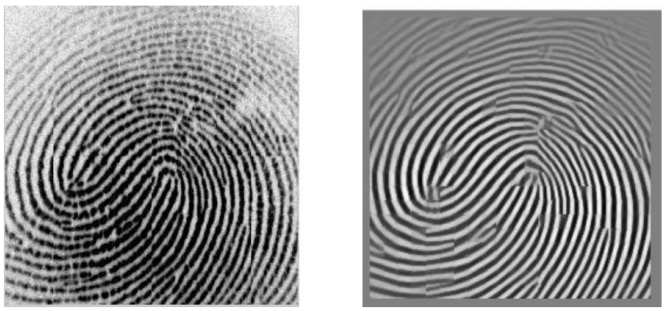
(c) (d)

Figure 5.2 (c) Original image sample (d) Image after 10 times iteration

(e) (f)

Figure 5.3 (e) Original image sample (f) Image after 15 times iteration

ENHANCEMENT RESULT



5.4 (g) Original fingerprint image sample (h) Enhancement image

Figure 5.5 Original image of fingerprint

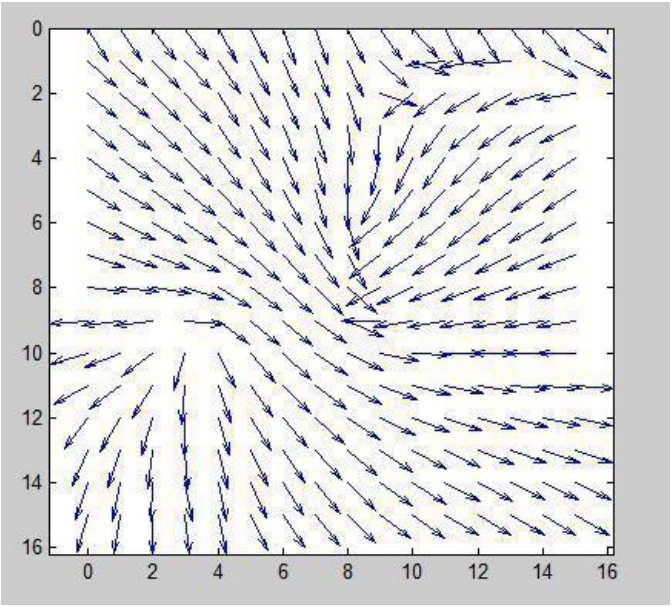


Figure 5.6 Orientation image of fingerprint

Among the many current biometric technologies, fingerprint verification is most popular method widely used in different commercial and security application. To accelerate the process, in my thesis pursue the solution using smaller fingerprint images region to extract the minutiae. The relationship between the number of matching minutiae and the verification accuracy in order to find relatively small sub regions of the captured images for use in the matching process is deeply investigated. I have revealed that our system identifies the most of minutiae present in the original acquired image. However note that the final numbers of minutiae obtained depend heavily of the acquired system used and the pre-processing stage applied.

CONCLUSION

The reliability of any automatic fingerprint system strongly relies on the precision obtained in the minutiae extraction process. A number of factors are detrimental to the correct location of minutia. Among them, poor image quality is the most serious one. In this thesis, Minutiae based fingerprint matching is studied in detailed and implemented in MATLAB and I have combined many methods to build a minutia extractor and a minutia matcher. The following concepts have been used- segmentation using Morphological operations, minutia marking by specially considering the triple branch counting, minutia unification by decomposing a branch into three terminations and matching in the unified x-y coordinate system after a 2-step transformation in order to increase the precision of the minutia localization process and elimination of spurious minutia with higher accuracy. The proposed alignment-based elastic matching algorithm is capable of finding the correspondences between minutiae without resorting to exhaustive research.

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