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Fingerprint Matching System for Spurious Minutiae

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Abstract: *Fingerprint Recognition refers to the automated method of verifying a match between two human fingerprints. Fingerprints are one of many forms of biometrics used to identify individuals and verify their identity. Everyone is known to have unique, immutable fingerprints. Fingerprint recognition algorithm extract's primarily uniqueness of the images obtained from the fingerprint. Fingerprint Recognition is a widely popular but a complex pattern recognition problem. Among all the biometric techniques, fingerprint-based identification is the oldest method which has been successfully used in numerous applications. A fingerprint is made of a series of ridges and furrows on the surface of the finger. The uniqueness of a fingerprint can be determined by the pattern of ridges and furrows as well as the minutiae points. Minutiae points are local ridge characteristics that occur at either a ridge bifurcation or a ridge ending. The information contained in a fingerprint can be categorized into three different levels, namely, Level 1 (pattern), Level2 (minutia points), and Level 3 (pores and ridge contours). Despite their discriminative power, the Level 3 features are barely used by the vast. Majority of contemporary automated fingerprint authentication systems which rely mostly on minutiae features. In this thesis the above mentioned techniques have been addressed and a new approach of identification of minutia term's with bifurcation, termination and orientation has been proposed. In our thesis extraction of minutia terms from the image is developed using termination and bifurcation process and elimination of false minutia from the image is carried out using distance formulae's. All those minutiae points are thus undergone with orientation characteristics' which gives the determination more powerful in case of image sizing and plasticity. All these terms are stored in a user profile for matching .Results and testing is performed by taking different user profiles.*

1. INTRODUCTION

Biometric based recognition, or biometrics, is the science of identifying, or verifying the identity of, a person based on physiological and/or behavioral characteristics .Physiological traits are related to the physiology of the body and mainly include Fingerprint, face, DNA, ear, iris, retina, and hand and palm geometry. Behavioral traits are related to behavior of a person and examples include signature, typing rhythm, gait, voice etc. Biometric recognition offers many advantages over traditional PIN number or password and token-based (e.g., ID cards) approaches. A biometric trait cannot be easily transferred, forgotten or lost, the rightful owner of the biometric template can be easily identified, and it is difficult to duplicate a biometric trait.

There are a number of desirable properties for any chosen biometric characteristic.

These include:

1. *Universality*: Every person should have the characteristic.
2. *Uniqueness*: No two persons should be the same in terms of the biometric characteristic.
3. *Permanence*: The biometric characteristics should not change, or change minimally, over time.
4. *Collectability*: The biometric characteristic should be measurable with some (practical) sensing device.
5. *Acceptability*: The user population and the public in general should have no (Strong)objection to the measuring/collection of the biometric trait.

A *biometric system* is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired

Data, and comparing this feature set against the template set in the database.

Depending on the application context, a biometric system may operate either in

Verification mode or identification mode:

- In the verification mode, an individual provides his/her biometric data and claims an identity, usually via a PIN (Personal Identification Number), a username, a smart card, etc. The system then varies the individual's identity by comparing the acquired biometric data with the individual's own biometric template(s) stored in system database. Such a system basically performs a one-to-one comparison to determine whether the claimed identity is true or not.
- In the identification mode, the system compares the given biometric data with the templates of all the users in the database. Therefore, the system conducts a one-to-many comparison to establish an individual's identity (or fails if the subject is not enrolled in the system database) without the subject having to claim an identity.

The effectiveness of a biometric system can be judged by following characteristics:

1. *Performance :* This refers to the achievable recognition accuracy, speed, ro-bustness, the resource requirements to achieve the desired recognition accuracy and speed, as well as operational (work environment of individual, e.g., manual workers may have a large number of cuts and bruises on their fingerprints) or environmental factors (humidity, illumination etc.) that affect the recognition accuracy and speed .
2. *Scalability* : This refers to the ability to encompass large number of individuals without a significant decrease in the performance.
3. *Non-invasiveness* : This refers to the ease with which the information can be captured from individuals, without damaging an individual's physical integrity and ideally without special preparations by/of an individual.
4. *Circumvention* : This refers to the degree to which the system is resistant to spoofs or attacks.

A practical biometric system should meet the specified recognition accuracy, speed, and resource requirements, be harmless to the users, be accepted by the intended population, and be sufficiently robust to various fraudulent methods and attacks to the system.

1.1 FINGERPRINT REPRESENTATION

The types of information that can be collected from a fingerprint's friction ridge impression can be categorized as Level 1, Level 2, or Level 3 features as shown in Fig. 1.1.

At the global level, the fingerprint pattern exhibits one or more regions where the ridge lines assume distinctive shapes characterized by high curvature, frequent termination, etc. These regions are broadly classified into arch, loop, and whorl. The arch, loop and whorl can further be classified into various subcategories.

Level 1 features comprises these global patterns and morphological information. They alone do not contain sufficient information to uniquely identify fingerprints but are used for broad classification of fingerprints**.**

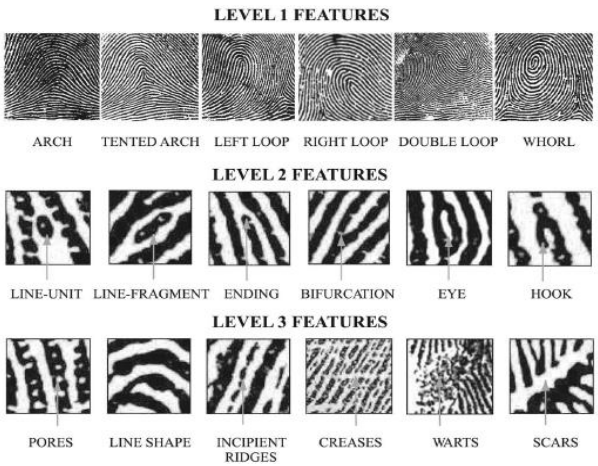

Fig. 1.1: Level 1, Level 2 and Level 3

Level 2 features or minutiae refers to the various ways that the ridges can be discontinuous. These are essentially Galton characteristics, namely ridge endings and ridge bifurcations. A ridge ending is defined as the ridge point where a ridge ends abruptly. A bifurcation is defined as the ridge point where a ridge bifurcates into two ridges. Minutiae are the most prominent features, generally stable and robust to fingerprint impression conditions. The distribution of minutiae in a fingerprint is considered unique and most of the automated matchers use this property to uniquely identify fingerprints. Uniqueness of fingerprint based on minutia points has been quantified by Galton .Statistical analysis has shown that Level 2 features, have sufficient discriminating power to establish the individuality of fingerprints.

Level 3 features are the extremely fine intra ridge details present in fingerprints. These are essentially the sweat pores and ridge contours. Pores are the openings of the sweat glands and they are distributed along the ridges. Studies have shown that density of pores on a ridge varies from 23 to 45 pores per inch and 20 to 40 pores should be sufficient to determine the identity of an individual. A pore can be either open or closed, based on its perspiration activity. A closed pore is entirely enclosed by a ridge, while an open pore intersects with the valley lying between two ridges as shown in Fig. 1.2. The pore information (position, number and shape) are considered to be permanent, immutable and highly distinctive but very few automatic matching techniques use pores since their reliable extraction requires high resolution and good quality fingerprint images. Ridge contours contain valuable Level 3 information including ridge width and edge shape. Various shapes on the friction ridge edges can be classified into eight categories, namely, straight, convex, peak, table, pocket, concave, angle, and others as shown in Fig. 1.3. The shapes and relative position of ridge edges are considered as permanent and unique.

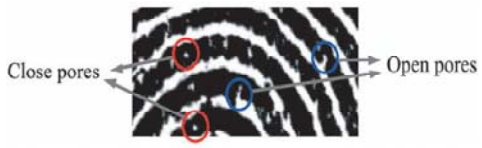

Fig. 1.2: Open and closed pores

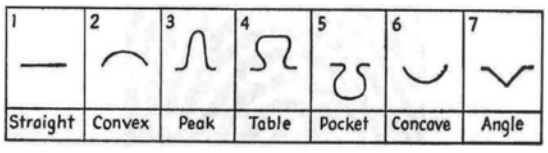

Fig. 1.3: Characteristics of ridge contours and edges

2. IMPLEMENTATION PROCEDURE

In this thesis an approach has been presented which addresses the various issues and challenges in Fingerprint matching. The

aim is to reduce the error rates, namely False Acceptance Rate (FAR) and False Rejection Error (FRR) in the existing Fingerprint matching algorithms.

In first stage image extraction where binarization and thinning of image is carried out by setting and thresholding image constituents. After thinning minutia detection is done by 3X3 window pixel determination for bifurcation and termination of ridges. Again spurious minutia is suppressed by using Euclidean distance formulae and ROI by which false minutia is suppressed. Orientation of minutia is also carried out for both bifurcation and termination which gives algorithm a solid foundation for matching process. Results are processed and a text file with the details is saved for a template.

we introduce various fingerprint representations and provide a general review of image enhancement, feature extraction, and matching techniques that are used in Minutiae-based fingerprint recognition systems.

2.1 Global Ridge Pattern

This representation relies on the ridge structure, global landmarks and ridge pattern characteristics,

Such as the singular points, ridge orientation map, and the ridge frequency map.

This representation is sensitive to the quality of the fingerprint images. However, the discriminative abilities of this representation are limited due to absence of singular points.

2.2 Local Ridge Detail

This is the most widely used and studied fingerprint representation. Local ridge details are the discontinuities of local ridge structure referred to as *minutiae*? Sir Francis Galton (1822-1922) was the first person who observed the structures and permanence of minutiae.

Therefore, minutiae are also called “Galton details”. They are used by forensic exports to match two fingerprints. There are about 150 different types of minutiae categorized based on their configuration.

Among these minutia types, “ridge ending” and “ridge bifurcation” are the most used, since all other types of minutiae can be seen as the combinations of “ridge endings” and “ridge bifurcations”. Some minutiae are illustrated in Fig. 2.1. The American National Standards Institute-National Institute of Standard and Technology (ANSI-NIST) proposed a minutiae-based fingerprint representation. It includes minutiae location and orientation. The minutia orientation is defined as the direction of the underlying ridge at the minutia location (Fig. 2.2). Minutiae-based fingerprint

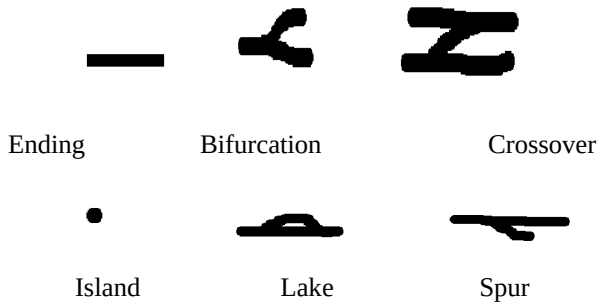

Fig. 2.1: Some of the common minutiae types.

representation also has an advantage in helping privacy issues since one cannot reconstruct the original image from using only minutiae information. Minutia is relatively stable and

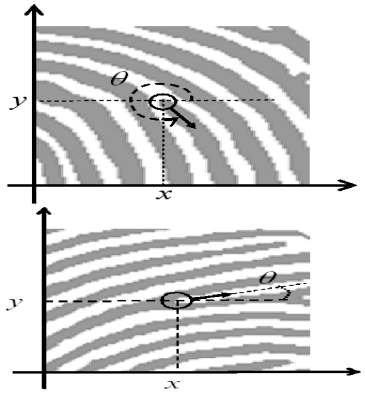

Fig. 2.2: (a) A ridge ending minutia: (x,y) are the minutia coordinates; theta is the minutia’s orientation; (b) A ridge bifurcation minutia: (x,y) are the minutia coordinates; theta is the minutia’s orientation.

Robust to contrast, image resolutions, and global distortion when compared to other representations.

However, to extract the minutiae from a poor quality image is not an easy task.

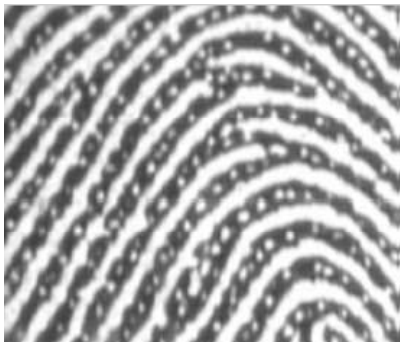

Fig. 2.3: A portion of a fingerprint where sweat pores (white dots on ridges) are visible.

Today, most of the automatic fingerprint recognition systems are designed to use minutiae as their fingerprint representations.

2.3 Intra-ridge Detail

On every ridge of the finger epidermis, there are many tiny sweat pores (Fig. 2.3). Pores are considered to be highly distinctive in terms of their number, positions, and shapes.

However, extracting pores is feasible only in high-resolution fingerprint images (for example 1000 DPI) and with good image quality. Therefore, this kind of representation is not practical for most applications.

3. RESULT AND CONCLUSION

In reference to the idea propose in IEEE journal [73] *Fingerprint Reconstruction: From minutiae to Phase*, Fingerprint reconstruction is carried out from the minutiae template to phase image, which is then converted into grayscale image. Reconstructed image thus eliminate false minutiae terms that corresponds to minutiae. Our thesis is centered upon collection of minutiae terms on the bases of

1. Ridge bifurcation and endings
2. False minutiae rejection based on distance from ridges.
3. Orientation field of minutiae terms based on
   a) Termination
   (b) Bifurcation

All these data sets are then reutilized in a manner for direct verification of fingerprint and reconstruction of phase image as describe by the paper. Among all these things Region of Interest of the image is carried out in a autonomous way, which makes the work fitted to reconstruction and recognition phases further.

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