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REGISTRATION OF LATENT FINGERPRINTS BASED ON ORIENTATION FIELD

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ABSTRACT: In biometric recognition applications fingerprints are widely used for security purposes. In forensics, latent fingerprints are used to identify suspects. Fingerprint that has to be recognized are matched with the prints in the database. To reduce the search space of minutiae set in the database, registration of partial fingerprint is used. Correlation-based techniques require the precise location of a registration point and are affected by image translation and rotation. Correlation based techniques are also expensive. To overcome these drawbacks of correlation based registration method, another method called hierarchical based registration is used. The orientation field of the fingerprint is generated for registering partial fingerprint by using hierarchical based registration. This will help to reduce the search space of minutiae set and improves the result of latent fingerprint identification especially for poor quality latent fingerprints. NIST-SD 27(National Institute of Standards and Technology - Special Database) database is used.

I. INTRODUCTION

Biometrics is the science of authenticating the identity of an individual through physiological measurements or behavioural traits. Since biometric identifiers are associated constantly with the user they are more reliable than token or knowledge based authentication methods. The various biometric modalities are Physical biometrics, Behavioural biometrics, Chemical biometrics**.** In general, biometric verification consists of two stages (i) Enrolment and (ii) Authentication. During verification, the biometrics of the user is captured and the extracted features (template) are stored in the database. During authentication, the biometrics of the individual is captured again and the extracted features are compared with the ones already existing in the database to determine a match.

Fingerprints are mostly used as biometric identifier**.** Fingerprints were formally accepted as valid personal identifier in the early twentieth century and have since then become a de-facto verification technique in law-enforcement agencies worldwide. The FBI currently maintains more than 400 million fingerprint records on file. Fingerprints offer a reliable means of personal identification. Other visible human characteristics such as facial features will change with age, but fingerprints are relatively persistent. Barring injuries or surgery causing deep scarring, or diseases such as leprosy damaging the formative layers of friction ridge skin, finger and palm print features have never been shown to move change their unit relationship throughout the life of a person (injuries, scarring and diseases tend to exhibit tell-tale indicators of unnatural change). The science of fingerprint identification leads first among all other forensic sciences. Fingerprints have several advantages over other biometrics, such as High universality, High distinctiveness, High permanence, Easy collectability, High performance, Wide acceptability.

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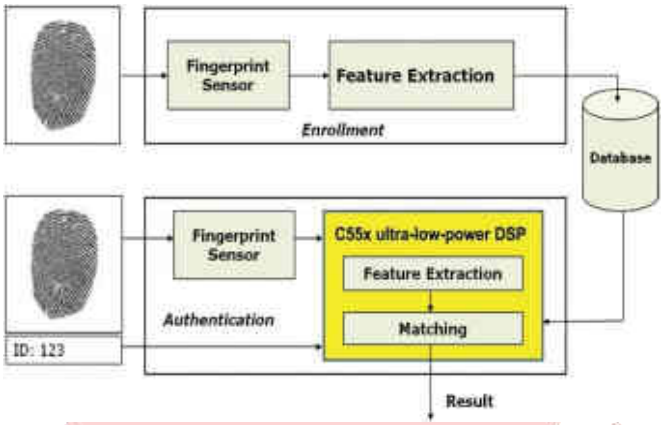

Fig. 1: General Architecture of a Fingerprint Verification System

Applications of fingerprint recognition systems are forensic, government, commercial systems. NIST-SD 27(National Institute of Standards and Technology -Special Database) database is used in this work.

II. DATABASE

The NIST-SD 27 coordinated with the Federal Bureau of Investigation and developed a new database of gray scale fingerprint images and corresponding minutiae data. NIST-SD 27 contains latent fingerprints from crime scenes and their matching fingerprint mates. This NIST database can be used to develop and test new fingerprint algorithms, test commercial & research AFIS systems, to train latent examiners, and to promote the ANSI/NIST file format standard.

NIST-SD27 is a publicly available forensic fingerprint database which comprises of 258 latent fingerprint images, its matching tenprint images and their minutiae sets. The NIST-SD27 minutia set database is classified into two (i) 'ideal' and (ii) 'matched' minutiae sets. The 'ideal' minutiae set for latent was manually extracted by a forensic examiner without any prior knowledge of its corresponding ten print images. The 'ideal 'minutiae set for tenprint was initially extracted using an AFIS, and then these minutiae were manually validated by at least two forensic examiners. The 'matched' minutiae set contain those minutiae which are in common between the latent and it's mated tenprint images. There is one-to-one correspondence in the minutiae between the latent and its mate in the matched minutia set.

The NIST-SD27 database consists of latent fingerprint images of varying quality. Each image is of 800 × 768 pixels in size and has been scanned at 500 pixels per inch as a grey-scale image. It already contains a classification of the latent fingerprints based on the subjective quality of the image into good, bad and ugly, containing 88, 85 and 85 fingerprints, respectively, determined by the forensic examiner. The average number of minutiae for good, bad and ugly category latents is 32, 18 and 12, respectively.

III. PROPOSED SYSTEM

This work uses Orientation Field (OF) to perform finger print alignment which is used to estimate the transformation parameters to find an optimal transformation. In this work fingerprint images are gets reduced to orientation images while registering. This system uses area based registration for registering fingerprints. Relative pre-alignment is used here for aligning fingerprints. In this work orientation images are correlated for getting correlation

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peaks for various alignments. Hierarchical registration method is used for registering. This system consists of

1. Pre processing
2. Orientation field generation
3. Choosing target location for registration
4. Pre-registration

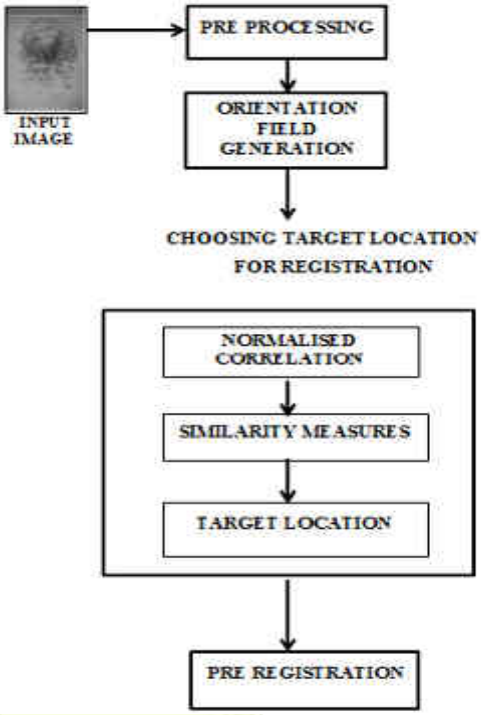

Fig. 2: System Architecture

1. PRE PROCESSING

Pre-processing step is to improve the later processing results. It commonly involves removing low-frequency background noise, to normalize the intensity of the individual particles images, removing reflections, and masking portions of images. Pre-processing is the process of enhancing data images prior to computational processing.

1.1 Filtering

Filters are used to enhance the images. It is of many types like linear filter, median filter, adoptive filter, etc. Noise filters reduce noise by diminishing statistical deviations.

Here Gaussian filter is used. It is a filter whose impulse response is a Gaussian function (or an approximation to it). It have the property that while minimizing the rise and fall time there will be no overshoot to a step function input. Gaussian filters are used in image processing because they have a property that its support in the time domain is equal to its support in the frequency domain. It is considered the ideal time domain filter.

A gray scale image is used in order to reduce the processing time in entire process. The gray scale image only has one colour channel that consists of 8 bits while RGB image has three

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colour channels. To reduce image noise image smoothing is performed from input image in order to achieve high accuracy for detecting the moving object. Gaussian filter is used to perform smoothing process. Gaussian filter modifies the input signal by convolution with a Gaussian function.

2. ORIENTATION FIELD GENRATION

Orientation field is a reliable feature of fingerprint images used for finger print enhancement, minutiae extraction and matching. In this module OF is generated from images taken in NIST-SD27.

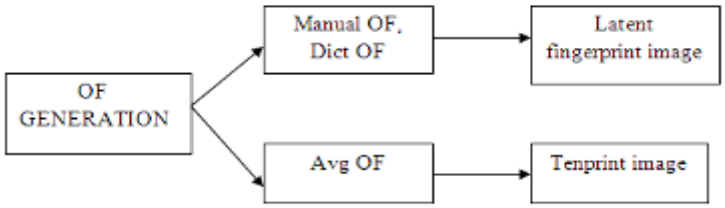

Fig 3: OF Genration

Techniques to compute OF are:

- Manually estimated OF from the fingerprint image (‘MANUAL_OF’).
- OF estimated directly from fingerprint image using local Fourier analysis and then performing context-based correction of the OF using dictionary lookup of orientation patches (‘DICT_OF’).
- OF estimated directly from the fingerprint image using gradient-based approach (‘IMG_OF’).
- OF reconstructed from the minutiae (‘MINU_OF’).
- OF estimated by taking the average of both of ‘IMG_OF’ and ‘MINU_OF’, denoted as ‘AVG_OF’.

For latent fingerprints MANUAL OF and DICT OF is used and for ten print images AVG OF is used.

3. CHOOSING TARGET LOCATION FOR REGISTRATION:

To find a target location normalized correlation is performed between the generated orientation field of the latent and ten print for various rotations alignments. Next correlation peaks for each rotation is shortlisted. These peaks are the possible target locations for registration.

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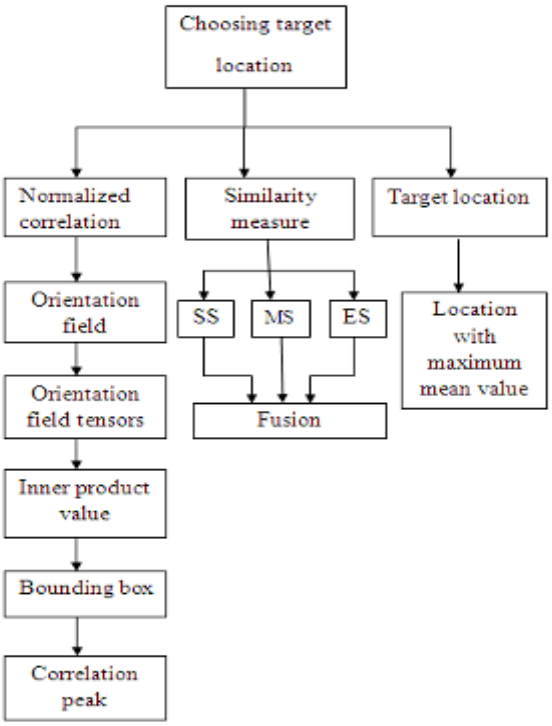

Fig. 4: Choosing target location for registration

For better accuracy similarity measures are performed on these candidate locations. So similarities like MS (Manhattan similarity), ES (Euclidean similarity), CS (Consistency similarity) are performed on these candidate locations.

The final registration location is chosen from the candidate locations as the one that maximizes the mean similarity between SS, MS, ES and CS. This gives better registration accuracies than deciding only based on the normalized correlation

4. PRE REGISTRATION:

Pre- registration is performed using hierarchical registration algorithm to reduce the minutiae search space of the ten print minutiae set, and then use the reduced minutiae set template as the reference template for the matcher. NIST-Bozorth3 and MCC-SDK are used as minutiae-based matchers. The performance of the matcher is analyzed separately using correlation only based registration and using hierarchical registration. NIST –Bozorth3 is used to match latent fingerprints. MCC-SDK is used for good quality fingerprints. NIST –Bozorth3 minutiae matcher is publicly available. Rank identification accuracy is reported to NIST-SD27 database. Performance accuracy of matcher is showed by CMC (Cumulative Match Characteristic) curve.

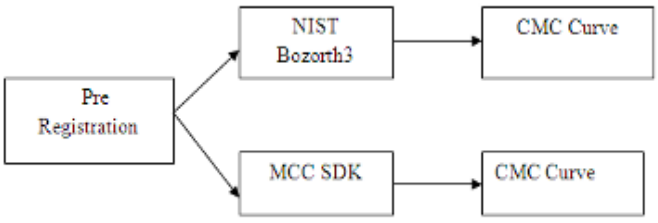

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Fig. 5: Pre Registration

CONCLUSION

This work presents a hierarchical registration of latent fingerprints using OF. In this work the fingerprint image taken from the NIST-SD27 database is filtered and then OF is generated from filtered image. For generating OF, various estimation techniques has been studied and the best representative OF was obtained. The work for finding target location to register the partial fingerprint is done in the proposed system. This will helps to reduce the search space of minutiae set in the database and mainly the identification accuracy will be improved. Performance of minutiae matchers gets boosted. Overall efficiency gets improved when comparing to the correlation based registration.

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