Review on Fingerprint Analysis and its Effect on Fractals

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Abstract— Biometrics is one of the most widely used approaches for identification and authentication of individuals. It uses a person's physiological or behavioral characteristics such as fingerprint, face, iris, gait, and signature for authentication. Most of the biometric systems use fingerprint for authentication as it is unique for every individual, easy to capture, and is universal. Law enforcement applications also involve identification using rolled and partial fingerprints obtained from different surfaces.

Key words: Fingerprints, Identification, Biometrics

I. INTRODUCTION

Cryptography Fingerprints are also being extensively used for person identification in a number of commercial, civil, and forensic applications. Most of the current fingerprint verification systems utilize features that are based on minutiae points and ridge patterns. While minutiae based fingerprint recognition systems have shown fairly high accuracies, further improvements in their performance are needed for acceptable performance, especially in applications involving very large scale databases.

The most popular method for fingerprint representation is based on local landmarks called minutiae. This scheme evolved from an intuitive system design tailored for forensic experts who visually match the fingerprints. The minutiae-based systems first locate the points, often referred to as minutiae points, in fingerprint image where the fingerprint ridges either terminate or bifurcate and then match minutiae relative placement in a given finger and the stored template. A good quality fingerprint contains between 25 and 80 minutiae depending on sensor resolution and finger placement on the sensor.

In forensic science, it is used for investigation of crimes, missing children etc. It is also used for social safety, passport control, border control and also in driving license. Fingerprint also find application in commercial life where it is used in e-commerce, in internet access, ATM card and credit card etc.[1]. Because of uniqueness and reliability, fingerprint has been used for person identification and recognition for years.In forensic application, fingerprint can be divided in to their different categories:

1) Rolled fingerprint: This type of fingerprint is obtained by rolling the fingers from one corner of nail to other corner of the nail on appear or scanner. In order to take the fingerprint impression, ink is first applied on the finger surface.
2) Plain fingerprint: This type of fingerprint is obtained by placing the fingers on the paper rather than rolling the fingers.
3) Latent fingerprints: These types of fingerprint are obtaines from the crime scene by lifting the fingerprint impression unconsciously touched by the person on the crime scene.

Fig. 1: Fingerprint image from a sensor

It is very interesting to note that in fingerprint recognition task, It is not a ridge and furrows which are used to distinguished the fingerprint but the known as minutia is used for distinguish the fingerprints. Minutia can be considered as some abnormal points of the ridges.

II. FINGERPRINT RECOGNITION SYSTEM

Fingerprint recognition is also known as the dactyloscopy. Fingerprint recognition is the process of comparing and testing the query fingerprint with the fingerprint impression already available in the form of database. Fingerprint recognition task is performed to determine whether the query fingerprint has the match in the available database. This process is used in person identification or recognition. It is also used in forensic science to identify the criminal with the help of fingerprint impression found from the crime scene.The whole process of fingerprint verification and the second phase is the fingerprint identification . It is different from the manual fingerprint identification where fingerprint recognition is performed manually by the individual and hence known as the automatic fingerprint recognition system (ARFS).

Fingerprint recognition (sometimes referred to as dactyloscopy) is the process of comparing questioned and known fingerprint against another fingerprint to determine whether the fingerprint impressions are from the same finger or palm . It includes two sub- domains: one is verification of fingerprint and another is identification of fingerprint (figure1). In addition, different from the manual approach of fingerprint recognition by experts, the fingerprint recognition here is referrd as ARFS also has digital storage media and computer system. Digital media is used for storing the fingerprint impression in the form database. Computer in this system is used to extract out feature or minutia from the fingerprint image and store these feature in the form of database. Computer is also used to process the fingerprints and also to accomplish the fingerprint matching task with the help of some alogrithim. Software or alogrithim is also the part od ARFS. Optical sensor for sensing the fingerprint is also some – times a part of the ARFS. A typical Automatic fingerprint recognition system is shown in the figure given below. It consists of following blocks:

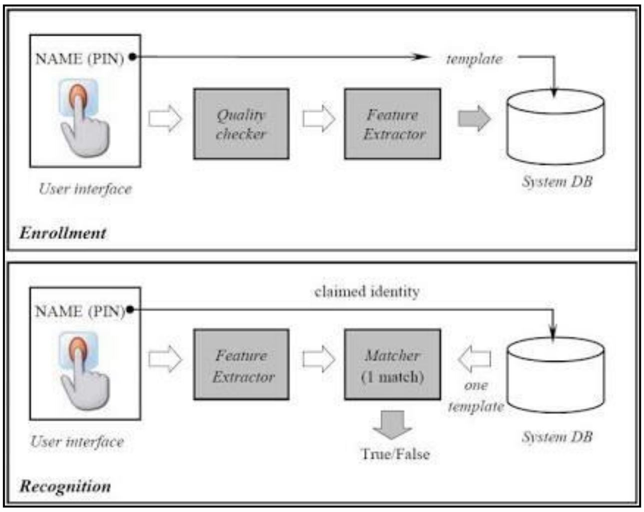

Fig. 2: Verification vs Identification

A. User Interface-

This block is used to get the fingerprint impression from the fingers. Optical sensor is the main part of this block. The resolution of the fingerprint impression depends on the quality and the resolution of the optical sensor.

B. Feature Extraction

This is a software part of the fingerprint recognition system, which is responsible for extracting the important features from the fingerprint. There are different types of feature extraction algorithms.

C. Feature matcher

It is also software part of the fingerprint recognition system. It is used to match the query fingerprints available in the database. There are different kinds of algorithm used for matching the one fingerprint with other. Some employ a Euclidean distance while other, method apply some other matching algorithm.

D. Database

It is basically a collection of the features of the different fingerprint.

The main difference between fingerprint recognition and identification is while in the former matching is accomplish to verify whether the fingerprint is available in database or not while in later fingerprint matching is accomplish to identify the person. The basic building blocks of both the systems are same but the objest of both the system is different.

The performance or accuracy of the fingerprint matching depends on the quality of the input fingerprints which hence depends on the quality or resolution of the optical sensor. Bad skin condition, nose in sensor, inadequate pressure of the finger during fingerprint taking process and bad conditioned fingers of the manual workers or elderly people, significant amount of fingerprint impressions are of poor quality. This makes it difficult to match the fingerprint. In such types of fingerprint, it is very difficult to extract the important feature from the fingerprint image.

It was early 20 centuary when law enforcing bodies started using the fingerprint recognition for identifying the suspect. In early days, manual marking of minutia and matching was carried out. This was very tedious and cumbersome task. But with adavancement in digital technology now a day the same task is performed by the AFIS (Automated Fingerprint identification system). The AFIS has made the fingerprint recognition and identification not only accurate but also very fast.

III. LITERATURE REVIEW

Like in any other field in biometrics, a lot of research work has been done in the fingerprint recognition. The study of past work in any project is one of the vital steps which throw some lights on the previous work, pros and cons of the work and it application. This chapter presents a brief literature work done for fingerprint recognition.

Ru Zhou, et.al (2011) [1] proposed a system For the purpose of Specific kinds of verification, a Scale Invariant Feature Transformation (SIFT) feature-based algorithm for fingerprint verification is presented. This approach is not based on traditional minutiae or ridge features. The SIFT keypoints in Gaussian scale-space and the local descriptor for each SIFT keypoint can be extracted by using this method. The verification is done by matching the descriptor, which is invariant to image scale and rotation. In this paper a proper pre-processing is carried out on the fingerprint image instead of using the original fingerprint image. This can make the algorithm adaptive to the variation of the impression condition. Furthermore, a Hough transform adapted to fingerprint verification is performed rather than only using SIFT keypoint descriptor matching. The fusion with minutiae information is also applied for efficiency and accuracy.

Jakub Sobek, Damian Cetnarowicz et.al (2012) [2] presents paper in which the SIFT algorithm finds keypoints and uses them to compare fingerprints. All keypoints have equal importance, thus precise comparison should be based on many keypoints. The SIFT is being able to find a big number of keypoints in a fingerprint image. A big number of the matched keypoints in the impressions (exposures) of the same finger of the same person. A small number of the matched keypoints in the case of different fingerprints. It is very likely that different fingerprints can have very similar small parts. The SIFT algorithm will be useful if the maximum number of the matched keypoints in different fingerprints is unambiguous lower than the minimum number of the matched keypoints in the same fingerprint.

Unsang Park, Sharath Pankanti, A. K. Jain (2008) [3] In this paper, author have shown that the SIFT operator can be used for fingerprint feature extraction and matching. This paper performed fingerprint matching in two steps: i) point-wise match and ii) trimming false matches with geometric constraints. The fusion with a minutiae based matcher shows significant performance improvement on two public domain databases. SIFT shows a good possibility of extending minutiae based or minutiae related fingerprint representations. The typical preprocessing in minutiae based technique involves connecting broken ridges and extracting skeletons of the ridge pattern, which removes all the texture information that is used in the SIFT operator. A proper preprocessing for the SIFT operator would require reducing noise in such a way as to preserve the inherent texture information. The average matching speed of the SIFT matcher, including feature extraction, is ~4 seconds on a

3.2GHz Pentium 4 PC. By trimming out false matches using geometric constraints, the EER of SIFT matcher is almost reduced by about 50% for both the databases.

David G.Lowe (1999 and 2004) [4, 5] In this paper, the author focus on Scale Invariant Feature Transform (SIFT) [4], [5] as a method of feature extraction. SIFT is one of the popular methods for image matching and object recognition. It efficiently extracts reliable features; therefore, it is used to overcome different fingerprint image degradations such as noise, partiality, and rotations. Since SIFT does not need any specified knowledge about biometric treat, the results of an evaluation with SIFT features are expected to show general properties.

Ali Ismail Awad and Kensuke Baba (2012) [9] In this paper, author applies SIFT feature extraction that translates the fingerprint image into a set of key points according to the detected local maxima. Each extracted key point is represented by a number of descriptors related to the pixel orientation around it. The default SIFT feature extraction produces key points with 128 descriptors as a features vector as 16 cell × 8 orientations. Then, a comparison of two images was done by matching the two sets of descriptors. In this paper, SIFT features have been extracted and matched using the VLFeat library. The output of matching process is the similarity Score between the two input images. This paper evaluated one of the available algorithms, MSM, for identification time reduction with fingerprint SIFT features. The conducted evaluation proved the applicability of MSM for fingerprint identification using SIFTS features. The superiority of MSM over the linear search with respect to the identification time and accuracy has been confirmed.

Jialiang Peng, Ning Wang et.al (2012) [10] In this paper author presents, a novel method to verify the infrared finger-vein patterns which is proposed for biometric purposes. Firstly, they select parameters for Gabor filter with eight orientations to exploit finger-vein network, then author extract vein patterns by the fusion of two distinct orientation results. Secondly, then utilizes SIFT features to offset the effect of images rotation and shift impact during finger-vein verification. Finally, the number of matching SIFT features between the registered and test fingervein patterns is calculated as the similarity measurement to verify the personal identification. The experiment results show that EER is low to 0.46% which demonstrates our proposed approach is valid and effective for finger-vein verification. This paper has addressed the problems of finger-vein segmentation and verification. The Gabor filters are exploited to extract finger-vein pattern. The SIFT features are extracted to describe the finger-vein pattern. Then the matching SIFT feature associations between the registered and test images are computed to verify the personal identification.

Mrs.S.Malathi, Dr.C.Meena (2011) [11,12] In this paper author propose a method for partial fingerprint matching based on score level fusion by using pore and SIFT features. In this work involves extract the pore feature and SIFT feature points, then Matching algorithm is performed and matching score is calculated. Then score level fusion is applied. The accuracy of proposed method is observed to be 97.32% for image size of 60%of original image partial with 1000 ppi resolution fingerprint image and 97.15% for image size of 60%of original image partial with 500 ppi resolution fingerprint image.

Xinghua Yu, Tiejun Huang (2009) [13] author proposes a SIFT-based image fingerprinting algorithm which is robust to geometric transformations. Firstly, they introduce SIFT-based algorithm to extract features as a unique fingerprint. Secondly, a method based on area ratio invariance of affine transformation is utilized to verify valid matched keypoint pairs between the queried image and the pre-registered image. Finally, by counting the valid matched pairs, the author estimate whether the two images are homologous or not. If the number of matched keypoint pairs is larger than a threshold T, which is suggested to be 6 by experiments, it is possible that image A and B are homologous otherwise heterogeneous.

Xin Shuai, Chao Zhang et.al (2008) [14] author proposed the implementation details of the system. There are mainly two phases. First, the index construction phase builds the composite set of reduced SIFT descriptors of each fingerprint image in the database, and indexes all of the local features via LSH. Then, in the query phase, the user can perform queries to find the corresponding fingerprint.In order to be done Indexing; first, they take randomly select 3 fingerprint images acquired from the same finger. A fingerprint enhancement algorithm is performed on each image to avoid the affection of noise. Then, the reduced SIFT features (N = 200 in our experiment) are extracted. Finally, author create the LSH indexing structure using the Composite set of reduced SIFT features of the three impressions. Now for Query, when the user queries a fingerprint image, they perform the enhancement, the extraction of reduced SIFT features as described above. Then, for each descriptor, author calculate the bucket ids using the l locality hash functions and find out all the key points within those buckets to form the candidate list. All these candidate key points are checked by L2 norm to find the nearest key point of each query key point. Finally, the retrieved nearest key points vote for the finger they belong to. The vote result shows the similarity between the query finger and the ones in the database.

Ru Zhou, et.al (2013) [15] In this paper author proposed the technique uses key points of SIFT for fingerprint verification. The proposed algorithm has several advantages over previous SIFT-based methods. Firstly, the proposed approach utilizes proper image processing to make the SIFT feature extraction robust against variations attributable to different finger pressures and noises. Secondly, the SIFT matcher is optimized for fingerprint verification based on a Hough Transform to expand the fingerprint images into large rotation cases. Thirdly, in order to enable the recognition system to perform in real time, a two-step Fast matcher is proposed. Two optimizations are performed based on ADM. Firstly the point-wise matching rejects a large number of genuine descriptor pairs because of the similar parallel ridge shapes. Secondly the trimming of false matches assumes that the fingerprint images are limited to very small rotations, so it would not work properly if the fingerprint images have large rotations. Therefore, the ADM can be optimized by employing the Hough Transform for all closest pairs calculated by Euclidean Distance. The Hough Transform is performed on the 2D location and orientation.

FISiA (fingerprint identification algorithm) can not only deal with normal fingerprints, but also specific fingerprints with lots of cuts and less overlapping areas. FISiA employed image processing to make the descriptor more robust to variations in finger pressure or differences in skin characteristics. SMD (SIFT-based Minutia Descriptor) is proposed to improve the SIFT-based algorithm through image processing, descriptor extraction and matcher. Furthermore, a two-step fast matcher, i.e., iADM (Improved All Descriptor-Pair Matching), is proposed to decrease the computational complexity. Experimental results on well-known databases indicate a significant improvement compared with the conventional minutiae matcher and other recent methods. FISiA could be applied as a universal or specific fingerprint authentication system dealing with different fingerprints obtained by a variety of sensors.

Megha Sahu, Neeraj Shukla (2013) [16] In this paper, a new detector and descriptor, named Speed-Up Robust Features (SURF) is used. Author proposed that just like SIFT, the SURF, detectors are also first employed to find the interest points in an image, and then the descriptors are used to extract the feature vectors at each interest point. However, instead of difference of Gaussians (DoG) filter used in SIFT; SURF uses Hessian-matrix approximation operating on the integral image to locate the interest points, which reduces the computation time drastically. As for the descriptor, the first-order Haar wavelet responses in x and y directions are used in SURF to describe the intensity distribution within the neighborhood of an interest point, whereas the gradient is used by SIFT.

Firstly, Image Acquisition is done which is used to read fingerprint images. The images of thumbprint are scanned and collected at 500 dpi. Secondly, Image Enhancement is sort out for image enhancement that is carried out to remove the noise from fingerprint image. They use Gaussian smoothing filter for noise removal with average and median filter used for noise removal followed by it, however they found the best result in case of Gaussian filter. In the feature extraction module, features from the enhanced fingerprint image are extracted. They have used SURF for feature extraction. The reason behind using SURF is that it is robust against rotation. Also, since SURF represents image using local features, it also works well in presence of occlusion i.e. for partial fingerprint image. In matching module, two fingerprint images are matched with the help of extracted local features. Depending upon the obtained matching score, two fingerprints are declared as matched or not-matched.

A. Paulino et at (2013) [17], in his paper titled "Latent fingerprint matching using descriptor based. Hough transform" proposed that a new fingerprint matching algorithm which is especially designed for matching latents. The proposed algorithm used a robust alignment algorithm (descriptor-based Hough transform) to align fingerprints and measures similarity between fingerprints by considering both minutiae and orientation field information. Latents are partial fingerprints that are usually smudgy, with small area and containing large distortion. Due to these characteristics, latents have a significantly smaller number of minutiae points compared to full (rolled or plain) fingerprints. The small number of minutiae and the noise characteristic of latents make it extremely difficult to automatically match latents to their mated full prints that are stored in law enforcement databases. They often rely on features that are not easy to extract from poor quality latents. It was easily used in la enforcement application.

The proposed algorithm relies only on manually marked minutiae, proposed algorithm suffered from matching accuracy. The proposed algorithm performs better than the three fingerprint matchers used in pervious work. The proposed algorithm was implemented for only on manually marked minutiae. If finger is noisy then proposed algorithm does not provide much accurate result. Proposed algorithm does not work properly especially when the overlap between the latent and rolled print is small. Speedup performance is also a major drawback of proposed algorithm.

Yang et al (2012) [18], in his paper titled "a Template Selection Method Based on Quality for Fingerprint Matching" Proposed a method to select template based on fingerprint image Quality. In the proposed method, four Features firstly were extracted from a fingerprint image. Add then, a support vector machine (SVM) model was trained to analyze image qualities, and lastly the fingerprint image with the best quality was choosing as the template to match for each finger. The matching accuracy of fingerprint was effectively improved by selection fingerprint images of high quality as template. The matching accuracy of this system was affected by lower quality of fingerprint.

Feng et al, (2011) [19], in his paper titled "Latent fingerprint matching using descriptor-based Hough transform" developed a latent matching algorithm that uses only minutiae information. The proposed approach consists of following three modules: (i) align two sets of minutiae by using a descriptor based Hough Transform: (ii) establish the correspondences between minutiae and (iii) compute a similarity score. Latents are usually partial fingerprints with small area, contained only smaller number of minutiae points therefore it was extremely difficult in automatically match latents to plain or rolled fingerprints that are stored in law enforcement database.

Mohammed S Khalil, 2010 [20], in his paper titled "Fingerprint Verification Based on Statistical Analysis' suggested statistical descriptor based fingerprint recognition system. In this approach he used four statistical descriptor for characterizing the co-occurrence matrix. This method, first of all, extracts the 129x129 Area of the fingerprint image and transforms it into a co-occurrence matrix.

Jain. A.K. et al. (2008) [21], in his paper "On Matching latent Fingerprints" has developed filter-based representation technique for fingerprint identification. Each fingerprint image is filtered in a number of directions and a 640-dimensinal feature vector is extracted in the central region of the fingerprint. Identification score was much improved by exploited both local and global characteristic in a fingerprint images. The feature vector was compact. It required only 640 bytes.

Wei Cui et al., 2008 [22], in his paper titled "The Research of Edge Detection Algorithm for Fingerprint Images" presented a various edge detection method for fingerprint images. In this paper, some of the common edge operator has been discussed and compared. In his experiments, authors showed that each and every edge detector has its advantages and disadvantages. One must select the suitable edge detector for fingerprint images. Canny edge detector is able to detect even a weak edge from the images. It is very useful to extract out the ridges and pores from the image.

S. Mil'shtein et al ., 2008 [23], in his paper titled "fingerprint Recognition Algorithms for Partial and Full fingerprint "presented a finger print recognition system which can be used for full and partial fingerprint image. In this paper authors, introduced two new approaches. One in called SFTA (Spaced Frequency transformation algorithm).

Anil jain et at., 2004 [24], in his paper titled " Pores and Ridges: Fingerprint Matching using Level 3 Features" proposed a level 3 feature based fingerprint matching algorithm. Fingerprint characteristics can be defined in three different levels. Level 1(Pattern), in which pattern are used for fingerprint matching. Level 2 is known as the minutia points in which first of all the minutia is extracted and then matched. Pores and ridge shape come under level 3.

IV. Conclusion

All these above problems have been identified by the literature survey. Since from its inception, finger- print matching area has been in the search of some robust technique for matching the fingerprint accurately. We have achieved till now precised processed Image in order to get accurate matched fingerprint recognition system. And the featured points of the fingerprint image are extracted in efficient way.

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