A Survey on Detection and Rectification of Distorted Fingerprints

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Abstract- Identifying person accurately is important aspect in many application areas like criminal cases. Face recognition system should be fault tolerant to handle such cases. Fingerprint recognition system has suffering through Positive and Negative classifications. In positive classification, where physical access control systems and user should be cooperative and wishes to identify. In Negative classification broadly talks about low quality of images in case of user identification may authenticate malicious user. Distortion detection is viewed as a two-class classification problem, for which the registered ridge orientation map and period map of a fingerprint is used as the feature vector and a SVM classifier is trained to perform the classification task. Distorted fingerprint rectification (or equivalently distortion field estimation) is viewed as a regression problem, where the input is a distorted fingerprint and the output is the distortion field. For such problems Detection and Rectification of distorted fingerprint is must

Keywords- Fingerprint, Distortion, Registration, Nearest Neighbor Regression, Orientation Field Map, Ridge Orientation map, PCA.

I. INTRODUCTION

In the last forty-year fingerprint recognition technologies have rapidly advanced, there still exist several challenging research problems, recognizing low quality fingerprints is major challenge. Fingerprint matching device is very sensitive to image quality as watched in the FVC2006, where the matching accuracy of the same algorithm alters significantly among different data-sets due to fluctuation in image quality. The difference between the accuracies of plain, rolled and latent fingerprint matching is major problem observed in technology evaluations conducted by the NIST [4]. The problem of low quality fingerprints is dependent on the type of the fingerprint recognition system. Basically there are two types of recognition systems i.e. positive recognition system and negative recognition system. In a positive recognition system, i.e. physical access control systems, the user is supposed to be cooperative and wants to be identified.

In a negative recognition system, such as pinpointing persons in watch lists and detecting multiple registration with multiple names for the same person, the user (e.g., criminals) might be uncooperative and does not want to evade their identified. In a positive recognition system, degraded quality causes false reject of legitimate users and thus bring inconvenience.

Low quality fingerprint recognition result is termed as negative recognition system however, which is much more serious than positive recognition system, since malicious users may purposely degenerate fingerprint quality to preclude fingerprint system from finding the real identity. A number of factors like degradation of fingerprint image quality, including small finger area, cuts and abrasions on the finger, wet or dry finger, dirt on the finger or sensor, and skin distortion. The aftermath of low quality
fingerprints depends on the type of the fingerprint recognition system. Those fingerprints we call Altered Fingerprint [6].

The paper is organized into four sections: Section II gives brief review of the distortion detection and rectification of distorted fingerprint. Section III describes the performance parameters considered to compare these approaches and finally, Section IV summarizes and presents the conclusions.

II. RELATED WORK
Distortion fingerprint recognition is important and researchers have classified distortion fingerprint recognition into below categories.

1. Hardware based Distortion Detection
During Fingerprint acquisition detect altered fingerprint so that altered fingerprint can be rejected. Researchers proposed to detect inappropriate force using specially designed hardware Bolle et al. [5] proposed to detect excessive force and torque exerted by using a force sensor. They concluded that monitored fingerprint acquisition improves matching performance. Fujii [6] proposed to detect distortion by detecting distortion of a transparent film attached to the sensor surface. Dorai et al. [5] proposed to detect distortion by analyzing the motion in video of fingerprint. This method has following limitations -
   i) they need special force sensors or fingerprint sensors having video capturing capability;
   ii) this method fails for existing database images and
   iii) they could not check distorted fingerprints distorted before pressing on the sensor.

2. Distortion-Tolerant Matching
This method deals with fingerprint distortion in every aspect which means for every pair of fingerprint is compared. For minutiae-based fingerprint matching method adopted below strategies for Distortion -
   i. assume a global rigid transformation and use a tolerant box of fixed size or adaptive size to reduce distortion;
   ii. explicitly model the spatial transformation by thin plate spline (TPS) model;
   iii. enforce constraint on distortion locally
However, allowing larger distortion in fingerprint recognition will definitely result in higher false match rate. Consider if we increased the bounding zone around a minutia, many non-mated minutiae will be paired. And also, allowing larger distortion in matching will result slower matching speed.

3. Distortion Rectification Based on Finger-Specific Statistics
Ross et al. studied the deformation pattern from a set of training images of the same finger and transmuted the template with the average deformation. They showed that this result s to higher minutiae matching accuracy. But this method has the below limitations: (i) requires multiple images of the same finger which is inconvenient in some applications and existing databases generally contain only one image per finger; and (ii) even if multiple images per finger are available, it is not necessarily sufficient to cover various skin distortions.

4. Distortion Rectification Based on General
Statistics Senior and Bolle [5] developed an interesting method to remove the alteration before matching stage. This method assumes that the ridges in a fingerprint are constantly spaced. So it deals with distortion by normalizing ridge density in the entire fingerprint into a fixed value. Since they did not have a distortion detection algorithm, they tried the distortion rectification algorithm to every
fingerprints. This method compared with the other methods considered above, Senior and Bolle method has the following advantages: (i) no need of specialized hardware; (ii) handles a single input fingerprint; and (iii) it doesn’t require to maintain training set images of the same finger [1]. However, ridge density is neither fixed within a finger nor fixed across fingers.

Many researchers have described improved fingerprint matching accuracy by using incorporating ridge density information into minutiae matchers. This method has below limitations –

1. Simply normalizing ridge density of every fingerprints might lose insightful information for the fingerprint and may improve impostor matching scores
2. Without having any constraint on validity of orientation map, this method may result fingerprints having fixed ridge period but weird orientation map [8].

Second limitation is more harmful, as it reduces genuine match scores. And these limitations are not addressed while testing on small databases consisting of six fingerprint image and finger rotation was not considered.

These limitations were not found since the algorithm was tested only on a small database consisting of six fingers and finger rotation was not considered. Our method shares the advantages of Senior and Bolle method over other methods, meanwhile overcomes some of its limitations. Our method is based on statistics learnt from real distorted fingerprints, rather than on the impractical assumption of uniform ridge period made [9]. Distortion due to finger rotation can be handled by our method. In fact, the proposed method is able to deal with various types of distortion as long as such distortion type is contained in the training set. In addition, extensive experiments have been conducted to validate the proposed method. The current work is a significant update of our preliminary study in [1], which detects distortion based on simple hand-crafted features and has no rectification functionality.

III. PERFORMANCE PARAMETERS
Distorted fingerprint two class classification problem. Distorted fingerprint is categorized into positive samples and normal fingerprint which is used as negative samples. If distorted fingerprint comes into positive sample then true positive occurs otherwise false positive.

The purpose of rectification to improve matching performance. To measure performance researcher conducted experiment on four databases. To evaluate rectification algorithm verifinger is used as fingerprint matcher. Matching score of verifinger is linked to FAR [7].

IV. CONCLUSION
In this paper existing fingerprint quality improvement algorithms are developed to study if an image contains discrete information such as minutiae, for matching, they have limited capability in determining if an image is a natural fingerprint or a distorted fingerprint. Obliterated fingerprints can evade fingerprint quality control software, depending on the area of the damage. If the distorted finger area is small, the existing fingerprint quality evaluation software unable to detect it as an altered fingerprint. In Distortion Rectification Nearest Neighbor approach is used to predict the distortion field and then used inverse of distortion field to transform into appropriate one. Experienced security hole is resolved using NFIQ algorithm (existing fingerprint image quality assessment algorithms) as it does not take distortion in account.

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