Recognition and Refinement of Distorted Fingerprints Using Markov Mapping

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Abstract – *Distortion 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. To solve this problem, a database (called reference database) of various distorted reference fingerprints and corresponding distortion fields is built in the offline stage, and then in the online stage, the nearest neighbor of the input fingerprint is found in the reference database and the corresponding distortion field is used to transform the input fingerprint into a normal one. One of the open come back outs in fingerprint confirmation is that the lack of strength against image quality degradation. Poor quality pictures end in specious and missing options, so degrading the performance of the general system. Consequently, it's very important to get a fingerprint reputation process to help approximate the quality as well as validity in the harnessed fingerprint photographs. In addition the particular variable distortion regarding fingerprints is one of the major causes for false non-match. Whilst this matter effects most fingerprint accepted purposes, it's especially unsafe in adverse recognition purposes, such as check out record as well as reduplication purposes.*

Keywords: *Fingerprint, distortion, registration, nearest neighbor regression, PCA*

I. Introduction

In Biometrics, fingerprint is still one of the most reliable and used technique to identify individuals. Recently, the need for automatic person identification has increased more and more in our daily activities, in general, and in the world of business and industry specifically.

To this end, the use of biometrics has become ubiquitous. Biometrics refers to metrics related to human characteristics and traits. Since biometric identifiers are unique to individuals, automatic person identification systems based on biometrics offer more reliable means of identification than the classical knowledge based schemes such as password and personal identification number (PIN) and token based schemes such as magnetic card, passport and driving license.

Among all the various forms of biometrics including face, hand and finger geometry, eye, voice, speech and fingerprint, the fingerprint-based identification is the most reliable and popular personal identification method. Fingerprints offer an infallible means of personal identification and have been used for person authentication since long. Possibly, the earliest cataloguing of fingerprints dates back to 1891 when the fingerprints of criminals were collected in Argentina. Now, it is used not only by police for law enforcement, but also in commercial applications, such as access control and financial transactions; and in recent times in mobile phones and computers.

In terms of applications, there are two kinds of fingerprint recognition systems, namely, verification and identification. In the former, the input is a query fingerprint with an identity (ID) and the system verifies whether the ID is consistent with the fingerprint and then outputs either a positive or a negative answer depending on the result. On the contrary, in identification, the input is only a query fingerprint and the system computes a list of fingerprints from the database that resemble the query fingerprint. Therefore, the output is a short (and possibly empty) list of fingerprints. Fingerprinting has been used historically to identify individuals using the so called ink-technique, where the fingers are dabbed with ink to get an imprint on paper cards which are then scanned to produce the digital image. In this off-line fingerprint acquisition technique, the fingerprints are matched by using the scanned images produced above. This method is still very important and popular especially in the forensics field, where fingerprints are captured from crime scenes. However, this type of off-line methods is not feasible for biometric systems. The other approach is to scan and match fingerprints in real time via scanners.

II. Biometric System

The term 'biometrics' is derived from the Greek words bio (life) and metric (to measure). In recent years, "Biometrics" has become the characteristic which is defined as a measurable biological and behavioral trait that can be used to recognize a person uniquely. Biometric systems have been researched and tested for several years, but widespread public use has only begun recently due to the need for individual recognition and content protection [5]. Biometric systems measure physical or behavioral characteristics information of an individual to determine or verify his identity. These characteristics are referred to by different terms such as traits, indicators, identifiers, or modalities. The several traits include fingerprints, face, iris, retina, voice, signature, gait, or the Deoxyribonucleic acid (DNA). There are two phases to the working of a biometric system, namely, enrollment and recognition [1].

Enrollment phase is where the biometric data is acquired from the individual and stored in a database along with the person's identity. During the recognition phase, the validation is done by acquiring the biometric data from the individual and compared with the stored data from the enrollment process. The biometric system consists of 4 basis components, which are sensor, feature extractor, database and matcher. The biometric system block representation is shown in figure 1.

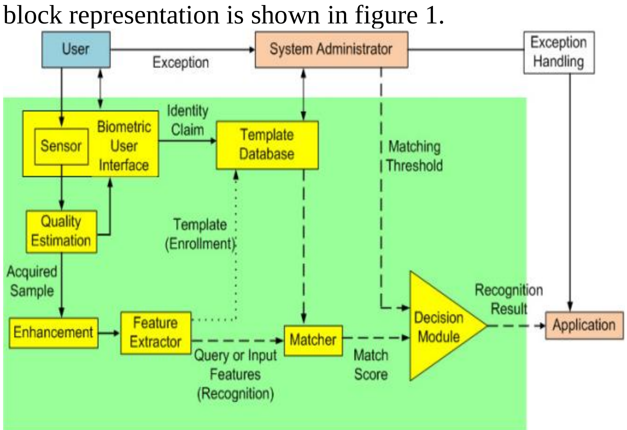

Fig.1 Block diagram of a biometric system

II.1. Sensor module

A suitable user interface incorporating the biometric sensor or reader is needed to measure or record the raw biometric data of the user. For example, an optical fingerprint sensor may be used to image the friction ridge pattern at the tip of the finger. The design of a good user (or human-machine) interface is critical for the successful implementation of a biometric system. An intuitive, ergonomic, and easy to use interface may facilitate rapid user habituation and enable the acquisition of good quality biometric samples from the user [8].

II.2. Feature extraction module

Usually, the raw biometric data from the sensor is subjected to pre-processing operations before features are extracted from it. The three commonly used pre-processing steps are (a) quality assessment, (b) segmentation, and (c) enhancement. First, the quality of the acquired biometric samples needs to be assessed to determine its suitability for further processing. If the raw data is not of sufficient quality, there are two options. One can either attempt to re-acquire the data from the user or trigger an exception (failure alarm) alerting the system administrator to activate suitable alternate procedures (typically involving some form of manual intervention by the system operator). The next pre-processing step is known as segmentation, where the goal is to separate the required biometric data from the background noise. Detecting a face in a cluttered image is a good example of segmentation. Finally, the segmented biometric data is subjected to a signal quality enhancement algorithm in order to improve its quality and further reduce the noise. In the case of image data, enhancement algorithms [10] [11] like smoothing or histogram equalization may be applied to minimize the noise introduced by the camera or illumination variations. In some cases, these pre-processing steps may be inseparable from the actual feature extraction step [8].

II.3. Database

The biometric system database acts as the repository of biometric information. During the enrollment process, the feature set extracted from the raw biometric sample (i.e., the template) is stored in the database along with some personal identity information (such as name, Personal Identification Number (PIN), address, etc.) characterizing the user. One of the key decisions in the design of a biometric system is whether to use a centralized database or a decentralized one. Storing all the templates in a central database may be beneficial from a system security perspective, because the data can be secured through physical isolation and by having strict access control mechanisms. On the other hand, compromise of a central database would have far greater implications than the compromise of one of the sites in the decentralized database. This is because malicious individuals (corrupt administrators or hackers) can abuse the biometric information stored in the database to compromise the privacy of innocent users [8]..

III. Fingerprint Recognition

Automatic fingerprint recognition technologies have quickly advanced throughout the last forty years, there still exists many difficult analysis issues, and for example, recognizing caliber fingerprints [2]. Fingerprint marriage broker is extremely sensitive to image quality as determined. In the FVC2006 [3], wherever the matching accuracy of identical algorithmic program varies considerably among totally different datasets owing to variation in image quality. The distinction between the correctness's of plain, rolled and latent fingerprint coordinating is much bigger as decided in innovation assessments led by the workplace [4]. The result of bore fingerprints relies on upon the sort of the unique finger impression acknowledgment framework.

III.1. Fingerprint Distortion

Versatile bending is presented in view of the innate adaptability of fingertips and a designedly sidelong drive or constrained. Skin distortion will increase the intra-class variations and so ends up in false non-matches because of restricted capability of existing fingerprint matchers in recognizing severely distorted fingerprints. This large distinction is because of distortion instead of overlapping space. Whereas it's attainable to form the matching algorithms tolerate giant skin distortion, this can result in additional false matches and impede matching speed.

III.2. Distortion Detection

It is seen as a two class arrangement. This report tends to use the registered ridge orientation map and amount map because the feature vector, which is assessed by a SVM classifier higher core points aren't properly detected, This report tend to manually estimate the middle purpose. Finger direction is outlined to be vertical to finger joint and was manually marked for all reference fingerprints [5]. Since the reference fingerprints were registered within the offline stage, manual intervention is acceptable. The planned distorted fingerprint rectification algorithmic rule consists of Associate in Nursing offline stage and a web stage. In the offline stage, an info of distorted reference fingerprints is generated by reworking many traditional reference fingerprints with numerous distortion fields at that point utilize the reverse of the relating contortion field to correct the distorted info of input fingerprint. Within the on-line stage, given a distorted input fingerprint it tends to retrieval its nearest neighbor within the distorted reference fingerprint info [6] and at that point utilizes the reverse of the relating contortion field to correct the distorted info of input fingerprint.

III.3. Distortion Rectification

A distorted fingerprint may be thought of being generated by applying Associate in nursing unknown distortion field d to the conventional fingerprint, which is additionally unknown. If this report will estimate the distortion field d from the given fingerprint, this report can easily rectify it into the normal fingerprint by applying the inverse of d. during this report a nearest neighbor regression approach is used for this task.

IV. Proposed Methodology

In Proposed System was evaluated at two levels: finger level and subject level. At the finger level, we evaluate the performance of distinguishing between natural and altered fingerprints. At the subject level, we evaluate the performance of distinguishing between subjects with natural fingerprints and those with altered fingerprints. This research work described a novel distorted fingerprint detection and rectification algorithm. For distortion detection, the registered ridge orientation map and period map of a fingerprint are used as the feature vector and a SVM classifier is trained to classify the input fingerprint as distorted or normal. A nearest neighbor regression approach is used to predict the distortion field from the input distorted fingerprint and then the inverse of the distortion field is used to transform the distorted fingerprint into a normal one. Fingerprint rectification algorithm consists of an offline stage and an online stage. In the offline stage, a database of distorted reference fingerprints is generated by transforming several normal reference fingerprints with various distortion fields sampled from the statistical model of distortion fields. The proposed distortion rectification algorithm by performs well by performing matching experiments on various databases. The proposed algorithm can improve recognition rate of distorted fingerprints evidently.

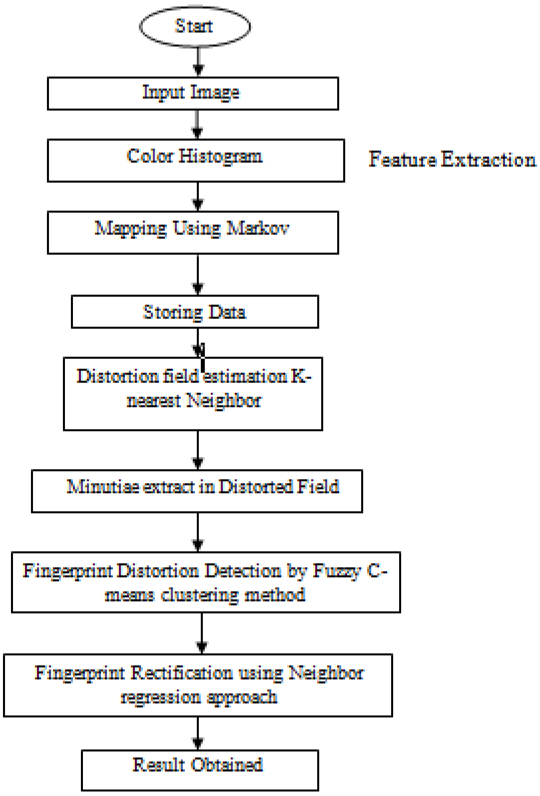

Fig. 2 Flow chart of proposed System

In statistical fingerprint distortion model, the distortion fields (or deformation fields) between paired fingerprints (the first frame and the last frame of each video) in the training set. The distortion field between a pair of fingerprints can be estimated based on the corresponding minutiae of the two fingerprints. Unfortunately, due to the severe distortion between paired fingerprints, existing minutiae matchers cannot find corresponding minutiae reliably. Thus, we extract minutiae in the first frame using VeriFinger and perform minutiae tracking in each video. Since the relative motion between adjacent frames is small, reliable minutiae correspondences between the first frame and the last frame can be found by this method. Given the matching minutiae of a pair of fingerprints, we estimate the transformation using thin plate spline model. We define a regular sampling grid on the normal finger-print and compute the corresponding grid (called distortion grid) on the distorted fingerprint using the TPS model.

IV.1. Fingerprint Distortion Detection:

Fingerprint distortion detection can be viewed as a two-class classification problem. We used the registered ridge orientation map and period map as the feature vector, which is classified by a classifier. Distorted Fingerprints are viewed as positive samples and normal fingerprints as negative samples. If a distorted fingerprint is classified as a positive sample, a true positive occurs. If a normal fingerprint is classified as a positive sample, a false positive occurs.

IV.2. Distorted Fingerprint Rectification:

A distorted fingerprint can be thought of being generated by applying an unknown distortion field d to the normal fingerprint, which is also unknown. If we can estimate the distortion field d from the given distorted fingerprint, we can easily rectify it into the normal fingerprint by applying the inverse of d. So we need to address a regression problem, which is quite difficult because of the high dimensionality of the distortion field (even if we use a block-wise distortion field). In our work, a nearest neighbor regression approach is used for this task. The proposed distorted fingerprint rectification algorithm consists of an offline stage and an online stage. In the offline stage, a database of distorted reference fingerprints is generated by transforming several normal reference fingerprints with various distortion fields sampled from the statistical model of distortion fields. In the online stage, given a distorted input fingerprint(which is detected by our algorithm), we retrieval its nearest neighbor in the distorted reference fingerprint database and then use the inverse of the corresponding distortion field to rectify the distorted input fingerprint.

IV.3. Nearest Neighbor Regression Method

In distortion rectification, a nearest neighbor regression method is utilized to look for the distortion field from the input distorted fingerprint, later the inverse of the distortion field is employed to alter the distorted fingerprint into a normal one. Finding the nearest neighbor among all distorted reference fingerprints is equal to the distortion field estimation. The choice of being likewise is measured based on level 1 feature of fingerprint, videlicet ridge orientation map and period map. We conjecture that distortion detection and correction of human experts also depends on these features instead of minutiae. NN regression method is a strong local dependency of target variable to explanation variables is seen. Some expertise in these fields also suggests this tendency. Thus, we use the k-NN regression methods first. Here, the k-NN regression means that we use mean value of the target values of the nearest feature variable points to the target prediction point in a Euclid sense.

IV.4. Fuzzy c-means clustering method

Cluster analysis has been a fundamental research area in pattern recognition. Clustering helps to find natural boundaries in the data. Since the fingerprint is distorted there is lot of vagueness involved during matching. To overcome this problem fuzzy clustering [2] technique is used to find vague boundaries of genuine and imposter cluster. In fuzzy clustering, the requirement of crisp partition of the data is replaced by a weaker requirement of fuzzy partition. For the process of fuzzy clustering, two features are selected.

• Number of matched minutiae points of the template and input fingerprint image

• The mean distance difference of the matched minutiae pairs

V. Result

A distorted fingerprint may be thought of being generated by applying an unknown distortion field d to the traditional fingerprint that is additionally unknown. If we will estimate the distortion field d from the given distorted fingerprint, we will simply rectify it into the traditional fingerprint by applying the inverse of d. thus we need to address a regression drawback, that is kind of tough due to the high dimensionality of the distortion field (even if we tend to use a block-wise distortion field). In our work, a nearest neighbor regression approach is employed for this task.

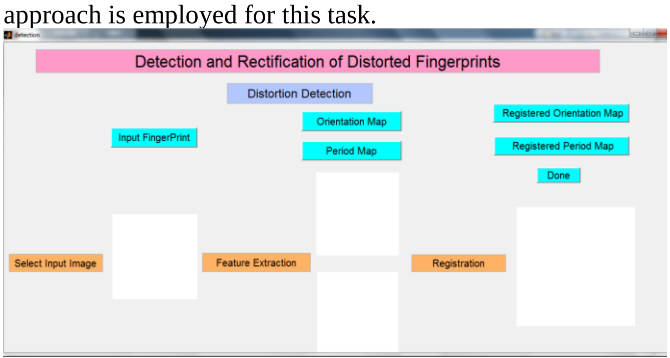

Fig. 3 Graphical Representation of Detection & Rectification of distorted fingerprints

The proposed distorted fingerprint rectification algorithm consists of an offline stage and an online stage. In figure 3 Graphical Representation of Detection & Rectification of distorted fingerprints of proposed method initial stage window shown.

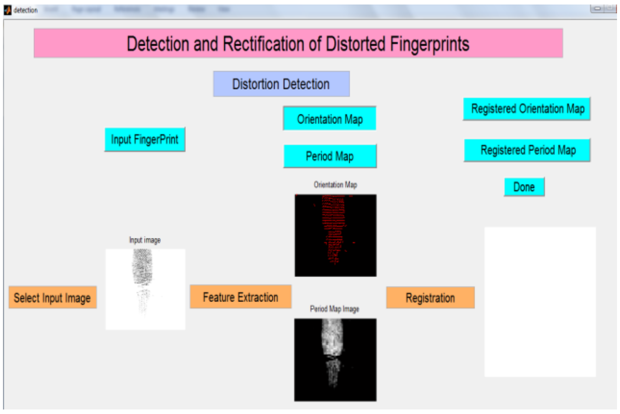

Fig. 4 Generation of period map

In figure 4 shows period map generation stage of proposed work. In this stage period map is successfully completed.

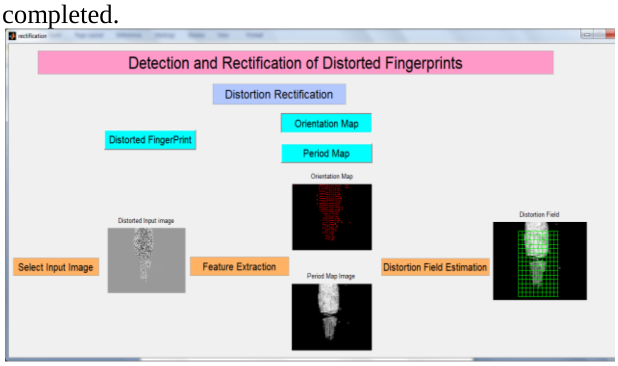

Fig.5 Distortion field estimation

In figure 5 show distortion field estimation in which distortion field is computed successfully.

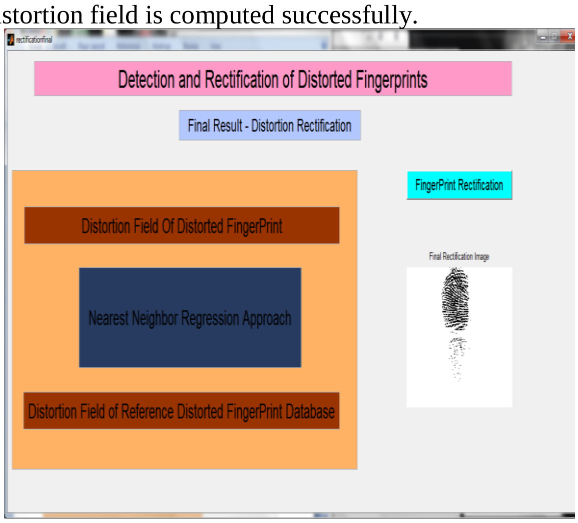

Fig.6 Fingerprint after rectification

Figure 6 shows the distortion rectification window in which rectification of distorted finger print all stages are shown. At last stage of the proposed work rectification of fingerprint is taken place and this is final result of proposed work.

Table 1: Comparison of Speed

S.No.	Algorithm	Speed
1.	Proposed Algorithm	45.2
2.	Previous Algorithm	67.1

VI. Conclusion

False non-match rates of fingerprint matchers are very high in the case of severely distorted fingerprints. This generates a security hole in automatic fingerprint recognition systems which can be utilized by criminals and terrorists. For this reason, it is necessary to develop a fingerprint distortion detection and rectification algorithms to fill the hole. This paper described a novel distorted fingerprint detection and rectification algorithm. For distortion detection, the registered ridge orientation map and period map of a fingerprint are used as the feature vector classifier is trained to classify the input fingerprint as distorted or normal. For distortion rectification (or equivalently distortion field estimation), a nearest neighbor regression approach is used to predict the distortion field from the input distorted fingerprint and then the inverse of the distortion field is used to transform the distorted fingerprint into a normal one. The experimental results on FVC2004. It is difficult to collect many rolled fingerprints with various distortion types and meanwhile obtain accurate distortion fields for learning statistical distortion model. It is our ongoing work to address the above limitations.

References

[1] Xuanbin Si, Jianjiang Feng, Jie Zhou. "Detection and Rectification of Distorted Fingerprints" IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 37, No. 3, March 2015

[2] Akinyokun Oluwole C., Alese Boniface K., and Iwasokun Gabriel B. " Fingerprint Matching Using Spatial Characteristics" In Proceedings of the World Congress on Engineering, vol. 1. 2014.

[3] S.Bindu Madhuri, Dr. V.V.Ramana, Dr.S.Prem Kumar "Detection and Rectification of Distorted Fingerprints" International Journal of Computer Engineering In Research Trends, Volume 3, Issue 1, January-2016, pp. 19-22

[4] Antara Vaidya "Rectifying the Elastic Distortion of Fingerprints for Better Recognition" IJARCSMS Volume 3, Issue 11, November 2015

[5] Andrew SENIOR and Ruud BOLLE "Improved Fingerprint Matching by Distortion Removal" IEICE Trans. Inf. & Syst., Vol.E84–D, No.7 July 2001

[6] Fanglin Chen, Xiaolin Huang, Jie Zhou, "Hierarchical Minutiae Matching for Fingerprint and Palmprint Identification", IEEE Transactions On Image

[7] Carsten Gottschlich, "Curved-Region-Based Ridge Frequency Estimation & Curved Gabor Filters for Fingerprint Image Enhancement", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 21, NO. 4, APRIL 2012, page 2220-2227

[8] Josef Ström, Bart°unˇek, , Mikael Nilsson, Benny Sällberg, & Ingvar Claesson, "Adaptive Fingerprint Image Enhancement With Emphasis on Preprocessing of Data", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 22, NO. 2, FEBRUARY 2013, page 644-656

[9] Feng Liu, David Zhang, Changjiang Song, & Guangming Lu, "Touchless Multiview Fingerprint Acquisition & Mosaicking", IEEE TRANSACTIONS ON INSTRUMENTATION &

MEASUREMENT, VOL. 62, NO. 9, SEPTEMBER 2013 page 2492-2502
[10] NIST especial Database 14, Mated Fingerprint Card Pairs 2 [Online]. Available: http://www.nist.gov/srd/nistsd14.cfm
[11] Biometric System Laboratory Team, FVC-on Going [Online]. Available:https://biolab.csr.unibo.it/FVCOnGoing/UI/Form/Home.aspx
[12] Rosario Gil, Gabriel Díaz Orueta, Mohamed Tawfik, Felix Garcia-Loro, Alberto Pesquera Martín, Elio Sancristobal, Sergio Martín, , & Manuel Castro, "Fingerprint Verification System in Tests in Moodle", IEEE JOURNAL OF LATIN-AMERICAN LEARNING TECHNOLOGIES, VOL. 8, NO. 1, FEBRUARY 2013, page 23-30
[13] NIST especial Database 27, "Fingerprint Minutiae From Latent & Matching Tenprint Images" [Online]. Available: http://www.nist.gov/srd/nistsd27.cfm
[14] MATLAB Manuals, http://in.mathworks.com/academia/
[15] NIST especial Database 14, Mated Fingerprint Card Pairs 2 [Online]. Available: http://www.nist.gov/srd/nistsd14.cfm
[16] Biometric System Laboratory Team, FVC-on Going [Online]. Available:https://biolab.csr.unibo.it/FVCOnGoing/UI/Form/Home.aspx
[17] Rosario Gil, Gabriel Díaz Orueta, Mohamed Tawfik, Felix Garcia-Loro, Alberto Pesquera Martín, Elio Sancristobal, Sergio Martín, , & Manuel Castro, "Fingerprint Verification System in Tests in Moodle", IEEE JOURNAL OF LATIN-AMERICAN LEARNING TECHNOLOGIES, VOL. 8, NO. 1, FEBRUARY 2013, page 23-30
[18] NIST especial Database 27, "Fingerprint Minutiae From Latent & Matching Tenprint Images" [Online]. Available: http://www.nist.gov/srd/nistsd27.cf
[19] D. Petrovska-Delacrétaz, G. Chollet, and B. Dorizzi, "Guide to Biometric Reference Systemsand Performance Evaluation", Springer-Verlag, 2009.
[20] J.Yang, N. Xiong, and A. V. Vasilakos, "Two-stage enhancement scheme for low-quality fingerprint images by learning from the images", IEEE transactions on Human-Machine Systems, vol. 43, no. 2, pp. 235-248, Mar. 2013.
[21] A. K. Jain, "Fundamentals of Digital Image Processing", Englewood Cliffs, NJ: Prentice Hall, 1989.