



A Robust Approach on Rectification of Fingerprint Distortions Using MLM-SVM Classifier

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Abstract: - In the current Internet world engagement of trustable users is mandatory. Various authentication techniques are adopted in which fingerprint authentication is frequently used. Due to various reasons elastic distortion of finger print become a serious issue during identification of systems. The distortion in the fingerprints enable the system to make negative recognition in many applications. Due to duplication negative authentication create serious issues. The application of negative recognition provides additional weightage to the authentication process. The proposed system is focused on creating a robust methodology to correct the skin deformation. The presented approach detects the finger print orientation and maps the feature vectors using Hough transform and Multi-Level Morphology (MLM) for detection of distortion level. SVM classifier is used to train the reference images of fingerprints to manage the distortion pattern. During the testing phase the real time fingerprint images are fetched to check the level of distortion. The proposed algorithm creates distortion map where the real time images classified with the SVM classifier. In terms of improving the privacy preserving models where the fingerprint is utilized for authentication the proposed approach performs better comparing with the state of art approaches.

Keywords: *Fingerprint Identification System, Deduplication, SVM Classifier, privacy preserving.*

1. Introduction

Fingerprint act as one of the strong methods of biometric technique. Everyone holds unique identification pattern of fingerprint. Fingerprint contains ridges and valleys of patterns formulated into covariate patterns. Fingerprint contains combination of patterns formulated into Unique Identification of minutiae matching. The SVM process can detect the correlation between the training fingerprints and the testing fingerprints. Performance of the developed system is evaluated by comparing the database images with the different people. The Minutiae based algorithm is widely used for fingerprint authentication techniques. One of the significant parts of algorithm is that the numbers of fingerprints used are processed separately. Each identification is the complete steps of pre-processing, feature extraction using multi-level Morphology (MLM) and matching. Fingerprint needs high quality images [1].



Due to various external noises the fingerprint images are getting affected. The recording of fingerprint using the fingerprint scanning devices should be quality and highly precise.

Distorted fingerprint can make duplication of fingerprint images that will directly impact the authentication process. Distortion rectification is a process of regression problem in many existing systems regression algorithms are used to solve the problem [2].

An automatic fingerprints extraction system contains several iterative processes to make the pattern analysis between the training fingerprint under testing fingerprints. Various feature extraction techniques are used to get the alignment of the minutiae pattern. Convolutional neural network (CNN) models are used to develop a robust biometric authentication process. The presented approach considers the Hough transform and Minutiae extraction process using Multi- level Morphology and classification using support factor machine (SVM). The reference images are used to extract the estimated angle of deviation present with the reference fingerprint [3].

Elastic distortion in fingerprints has the negative impact on performance of fingerprint-based recognition systems where the negative effect provides duplication of fingerprints during authentication process. To prevent malicious user to enter the system the fingerprint needs to be authenticated properly. Duplicate uses can create artificial lines, and apply morphology for the reference fingerprint to enter the system. The accuracy of distortion parameters is important to rectify this problem. Deep convolutional neural networks (DCNN) are used to make the synthetic comparison of fingerprint patterns with various input reference fingerprint. It is been observed that cloud-based approaches have more impact than that of local approaches. The technique used to extract the fingerprint minutiae have special and temporal process. Data duplication technique is one of the complicated processes that allow multiple instances of users accessing the cloud data. Each frequency of fingerprint images is unique pattern need to be analysed in terms of frequency domain before making the encryption process [4].

The proposed model considers the FVC2004 DB1 and FVC2004 DB2 database contains 880 fingerprint images collected from 110 different fingers of participants. 8 different poses of finger prints are collected from each finger. Approximately 89 distorted finger prints are collected with various distorted poses.

The proposed model is created with deep fisher extraction through of transform and Minutiae extraction using multithread morphology technique. The classification process is implemented using support at our mission. 5-fold cross validation process implemented using neural network architecture which is used to make the decision process in a confident way. The result metric score provides the identification of distorted fingerprints as well as correction of fingerprints with reference to the database images using support with our classifier.



2. Background Study

M. Yang et al., (2020) the author who presented a fingerprint recruitment session system which using deep learning algorithm and multi feature fusion based traditional method of fingerprint extraction. The simulation process contains the smaller area of the finger prints and performs the identification of pattern using anonymous fingerprints are collected in the cloud. The large amount of fingerprint data is used here to improve the accuracy of the model. The parameters of deep learning model or adjusted to achieve optimal accuracy comparing with the existing state of art approaches [7].

S. Chen et al., (2022) In this paper, the author presented a new approach on that task for novel single to multiple partial finger print recognition system. The end-to-end delay planning model that extracts the fusion process and makes the comparison with appropriate fingerprint. The experiment indicate that the methodology has new insights of fingerprint recognition system comparing with other devices. Mobile based application is focused here. the fingerprint extraction process in mobile devices is considered as database images [8].

M. Micheletto et al., (2021) The author presented the fusion method for verifying the fingerprint process. This work approaches that considers NISD data set with various fingerprints of 12 matches lived at 2017 to 2019 data set as a state of art approaches. A PAD algorithm which is implemented here that straight forwardly compare the real time data with the training data. The overall verification performance is improved comparing with the existing state of approaches. The performance of simulation process is validated using the receiver operating characteristics and probalistic models for statistical parameters [9].

X. Zhou et al., (2021) The author who presented artificial noise adding algorithm to improve the robustness of existing regularized fingerprint recognition process. Verification algorithm based on generative Gaussian probalistic discriminant analysis (PDA) which is used to handle the unauthorized devices. The proposed approach verifies the fingerprint validation process using the hardware and a wireless transmitter using ZigBee. Reliable accuracy of 99.5% achieved with the long and short Line of Sight. The proposed process considers the noise as an important factor that make the distortions viable. Reducing the noise is focused on the presented system. The equal error rate (EER) of the verification process is achieved as low as 0.63% [10].

P. Terhorst et al., (2021) The author who presented a novel approach of minutia-based fingerprint quality extraction using MiDeCon arbitrary deep learning algorithm. The proposed approach extracts the complete miniature with higher quality and compares with the data bases. The presented approach considered FVC2006 data set and NEST NFIQ1, NFIQ2 data set for state of art comparisons. The proposed result is compared with both minute and fingerprint level process and matches higher accuracy [11].



Saeed et al., (2021) The author proposed a system of duplication process and novel effective mechanism bounded with hashing algorithm is discussed here. Utilization of Shah algorithm the size of the hash index is formulated. Using the fingerprint lookup strategy the hash process is used to encrypt the fingerprint before communication. The presented approach reduces the late and see and improve the accuracy of matching when combined with HASH process [12].

3. System Design

The major challenges in fingerprint correction process are it required adaptive references that need to be compared with the whole database. Further the latency taken to make complete iteration is delayed. The proposed system is rectifying the issue, by creating a cross-validation process in parallel. These processes accumulate the relative images and compare it with the test images hence; the processing time is getting reduced. The system design which is implemented by using MATLAB tool, using image processing toolbox. It contains the dedicated feature mapping commands, transforms and classification blocks available with neural network and statistics toolbox.

4. Methodology

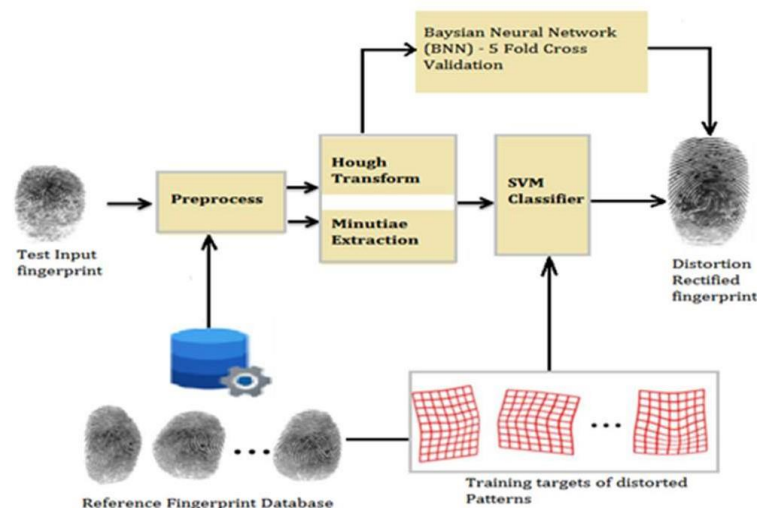


Figure 1: System architecture of Proposed Multi-feature enabled SVM (MFE-SVM)

Fig. 1. Shows the system architecture of the proposed multi-feature enabled Support vector machine for rectification of distorted fingerprints. A novel structure is created using pre-processing, feature extraction, classification, and validation process. Hough Transformer and miniature extraction technique with Multi-Level Morphology is implemented here.

The development of cross validation process using Bayesian neural network (BNN) enable the system to provide strong classification. The 5-fold cross validation process is implemented here



using neural networks. The statistical values estimated here using the presented images are contrast continuity and heterogeneity. The minute extraction process is implemented using MLM technique clearly depicts the differences also it is helpful to correct the distorted portions. From the reference fingerprint database, the training targets of distorted pattern or extracted. This distorted pattern is used to align the distorted fingerprints according to the reference images. The aligned images have numerous noise pixels present in it. SVM classifier is used to classify the relatively Matching Fingerprint with the database fingerprint. to make accurate fingerprint rectification the reference images or helpful to align the distorted pixels.

4.1 Hough Transform

The Hough transform is the mathematical model that detects the abnormal instances present in the input images. The variations in the points that is not coming under the alignment is extracted through Hough transform. Hence the transform is implemented to identify the distortions that is not viable to the references. The Hough transform follow the line formula shown below.

$$Y=ax+b \quad (1)$$

4.2 Bayesian neural network

The Bayesian neural network is the probabilistic model for representing the uncertain domain of randomly aligned nodes. It formulates the non-correlated node comparing all other nodes in the network. Bayesian networks have the adaptive nature that coherent with the knowledge gained with all the nodes connected with it. The time taken to evaluate the match score is less comparing with other neural network models.

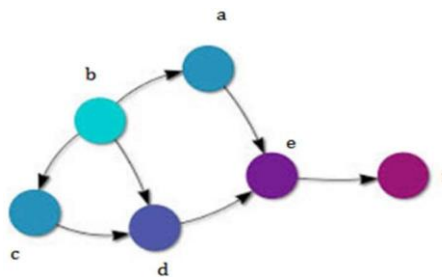


Figure 2: Network model of Bayesian network (BNN)

Fig. 2. Shows the network model of Bayesian network (BNN) with all the preceding nodes the combinational pattern of connectivity is done. The pattern comparison is held with all other nodes in the networks.



4.3 Support Vector Machine

Support vector machines are used to make the objective learning process to find N-dimensional points in the hyper-plane. The probabilistic function enable the system to separate the relatively correlated data within the plane. The hyper-plane determines the distorted and normal fingerprints. The SVM algorithm reduces the margin loss and detection latency. The SVM kernel takes the low-level input spaces and effectively separate the correlated and non-correlated points between the hyper-planes.

$$f(x) = \sum_i \alpha_i K(x_i, x) + b \quad (2)$$

Where K is the Radial basis function Kernel

x_i determines the input pattern features and x denotes distorted inputs as well.

5. Result and Discussion

5.1 Minutiae Extraction process

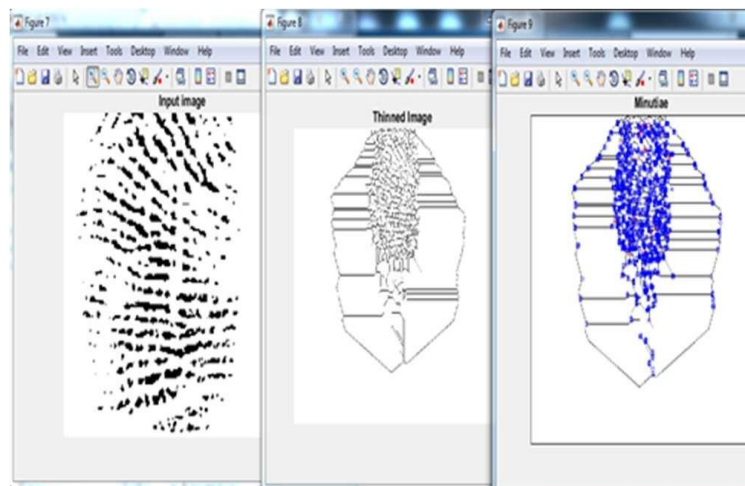


Figure 3: Process of Minutiae extraction



5.2 Hilbert Correlated envelope

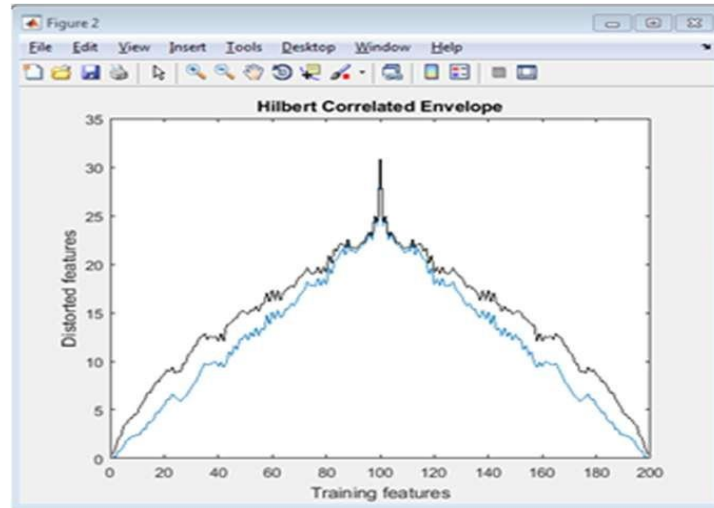


Figure 4: Hilbert Correlated envelope

Fig.4 shows the Hilbert Correlated envelope of training features and distorted fingerprint under test. The transform shows the correlation between the inputs.

5.3 Statistical analysis

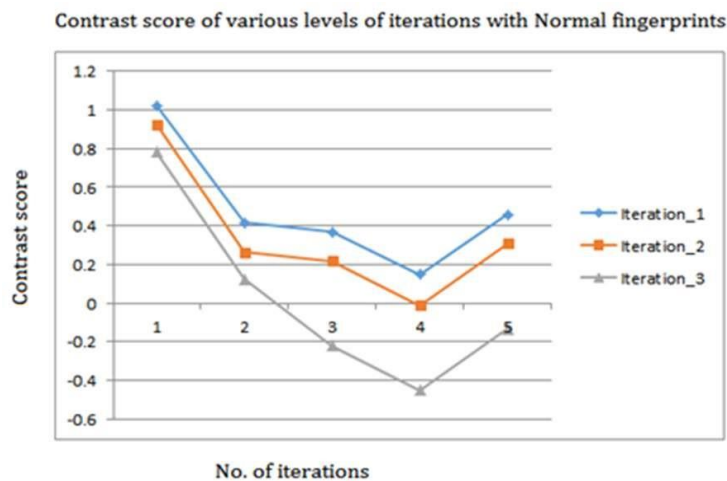


Figure 5: Contrast score analysis of Normal inputs

Fig. 5. Shows the system Contrast score obtained with normal finger prints before the proposed algorithm is being applied.



Contrast score of various levels of iterations with Distorted Fingerprints

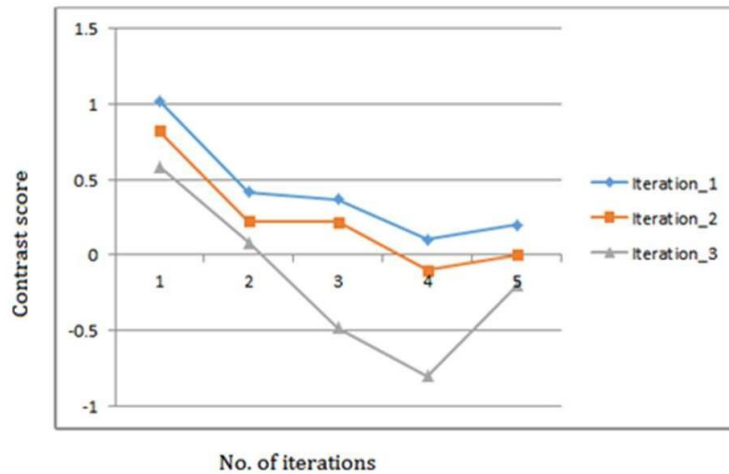


Figure 6: Contrast score analysis of distorted inputs

Fig.6. Shows the Contrast score analysis of distorted inputs.

Continuity score of various levels of iterations with Normal Fingerprints

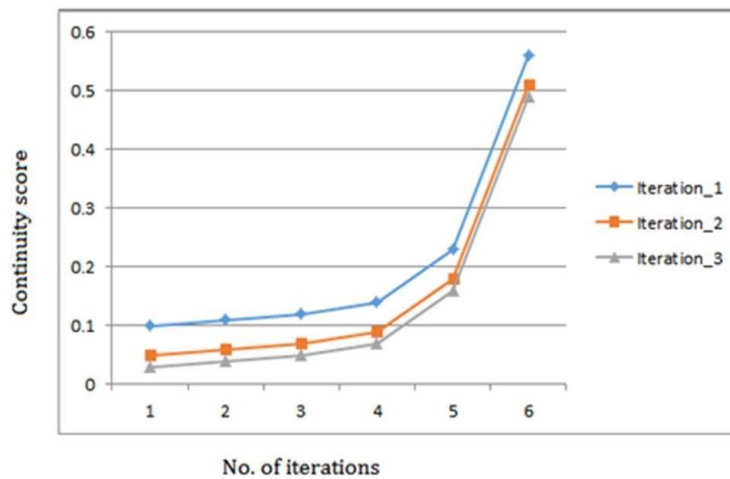


Figure 7: Continuity score analysis of Normal inputs

Fig.7. Shows the Continuity score analysis of Normal inputs.



Continuity score of various levels of iterations with Distorted Fingerprints

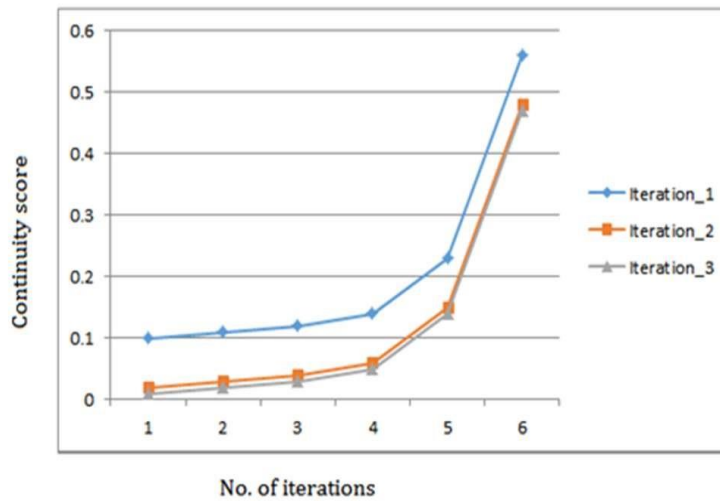


Figure 8: Continuity score analysis of Distorted inputs

Fig.8. Shows the Continuity score analysis of Distorted inputs. The distorted images have the deviated score comparing with the normal images.

Heterogeneity score of various levels of iterations with Normal Fingerprints

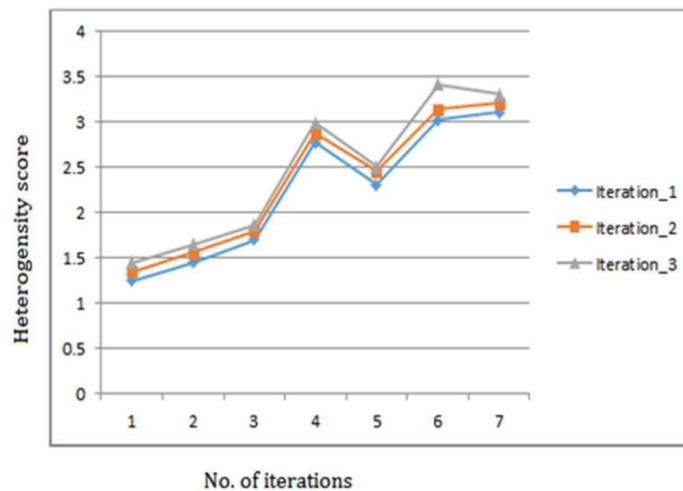


Figure 9: Heterogeneity score analysis of Normal Inputs

Fig.9. shows the Heterogeneity score analysis of Normal inputs.



Heterogeneity score of various levels of iterations with Distorted Fingerprints

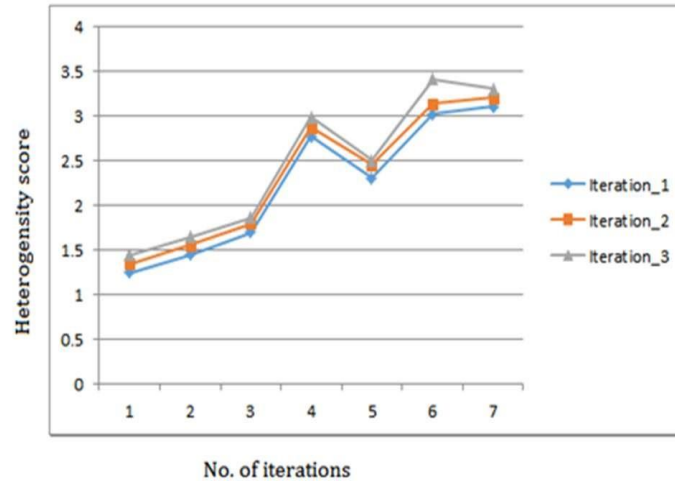


Figure 10: Heterogeneity score analysis of distorted

Inputs Fig.10. shows the Heterogeneity score analysis of distorted inputs.

Table. 1 Acquired Statistical measure

S No.	Reference fingerprints	Contrast	Continuity	Heterogeneity
1	Img001	0.785	0.12	1.245
2	Img002	0.124	0.14	3.021
3	Img003	1.024	0.478	3.112
4	Img004	0.415	0.44	1.445
5	Img005	0.369	0.14	2.779
6	Img006	0.147	0.23	1.698
7	Img007	0.458	0.56	2.308

Table. 1. Shows the obtained statistical measures collectively generated using the proposed approach.

One of the prime challenges in the system design is to handle the large dataset. fingerprint images are collected from scanning devices. Hence, the noise persists with the system need to be removed before fetching to the algorithm. Detection of small minutiae found difficult in certain cases.



6. Conclusion

A novel Fingerprint recognition system is required in recent days for making efficient authentication. Every person has a unique finger print pattern that need to be properly registered to the database. Due to various reasons the fingerprints are distorted and low-quality fingerprints are recorded. The proposed approach is focused on creating a robust architecture to detect the fingerprint distortions as well as to correct the fingerprint distortion using MLM-SVM technique discussed in the proposed model. The initial correction of fingerprint minutiae is implemented using Hough transform and multi-level morphology (MLM) process. The statistical value such as contrast continuity and heterogeneity is used to make the cross-validation process. Bayesian neural network (BNN) is implemented here to make 5-fold cross validation process to strength and the results. The final classification is implemented using SVM algorithm. The presented approach effectively compares the database images with the training images and make the distortions characters effectively compared with state of approaches.

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