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Touchless Palmprint Verification using Shock Filter, SIFT, I-RANSAC, and LPD

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Abstract: *Palmprint have some basic features. These basic features are unique and unchangeable in one's life. It is constant and not easy to fake. A palmprint contains three major lines that are called principal line, secondary line, and wrinkles. These lines give rich information for personal verification and have robust discernment. In this paper a new method proposed for palmprint verification. Shock filter is used in the proposed method for preprocessing. SIFT feature matching using I-RANSAC and LPD refinement are used for feature matching. The results of the preprocessed and without preprocessed palmprint images are displayed, compared, and discussed in this paper. The experiment is carried out using IITD palmprint database and CASIA palmprint database.*
Keywords *- Palmprint, I-RANSAC, SIFT, Shock Filter, Touchless.*

I. Introduction

The science of calculating and analyzing the biological, physiological data is known as biometric. The biometric system uses these types of data for validation and authentication of people. The palmprint verification system as a biometric technology becoming popular in the recent years because of its simplicity. Palmprint verification system achieves high accuracy and user friendly. The researchers have been working on low resolution palmprint images and high resolution palmprint images. High resolution image refers to 400 dpi or more and low resolution image refers to 150 dpi or less. The high resolution images mainly used in criminal detection and scientific purpose [8], low resolution images mainly used in automatic attendance, gate entry, and public authentication applications.

The intra-class variations due to the hand deformation are the main challenge in the contactless image acquisition. The SIFT (Scale Invariant Feature Transformation) feature of images won't change during image rotation, translation, and scale variations. I-RANSAC (Iterative Random Sample Consensus) achieves more matching SIFT points than the normal RANSAC algorithm. The contact acquisition has few limitations. In contact acquisition a CCD scanner is used because of its size. The scanner requires regular cleaning for each and every palmprint acquisition which takes more time. Contact based acquisition in public may create hygienic related issues. Contactless acquisition is carried out using a simple camera which consume less power than scanner and no need of frequent cleaning. Nowadays, the researchers work on biometric application using mobile devices with in-built camera for capturing the palmprint image.

The original SIFT technique has two main problems. First one is orientation-histogram-based where SIFT descriptors are insufficient to discriminate different key points on palmprint. Another one is for translation and rotation invariance. The original SIFT technique matches each key point of one image with all the key points of other image ignoring their topological relations, which is important to differentiate different stretched palmprint. To solve these type of problems in original SIFT proposed a touch less palmprint verification technique, with the matching refinement.

The Shock filter is morphological image enhancement and restoration method. Kramer and Bruckner introduced Shock filter in the year 1975 [3]. They presented an idea using dilation process near the maximum and the erosion process near minimum.

The decision of pixel belongs to a maximum or a minimum is made on the basis of the Laplacian. If the Laplacian is negative, then the pixel is considered as in impact zone of a maximum, while Laplacian is positive, then the pixel considered as in impact zone of a minimum. By iterating this procedure produces a sharp discontinuity at the borderline between two influence zones. Within each zone, a constant segment is created paper.

II. Related Works

Xiangqian Wu et al. [14] used circular Gabor filter for the preprocessing. Then they used SIFT (Scale Invariant Feature Transform) feature extraction and matching. Further they apply two stage refinement, first one is I-RANSAC (Iterative-Random Sample Consensus) and second refinement is LPD (Local Palmprint Descriptors).

Shahla Saedi et al [12] proposed a palmprint authentication technique, which is based on the discrete orthonormal S-Transform. For the texture analysis and calculation of feature vector they used 2-D DOST

(Discrete Orthonormal S-Transform). They also used ICA (Independent Component Analysis) for removal of redundant and dependent component which is given by feature vector. Nesrine et al. [9] proposed a bimodal biometric system. It is based on the combination of hand shape and palmprint. They find matching score by using SIFT (Scale Invariant Feature Transform) feature extraction, for the both hand and palmprint respectively.

Authors of [13] uses the Gabor filter for the feature extraction and use hamming distance for the comparison of two images. Authors in [15] used Gabor filter for calculation of local invariant features and they used KNN (K- Nearest Neighbor) as a classifier.

Romulus Terebes et al. [10] proposed a novel shock filter for image enhancement. They analyzed the partial differential equations (PDE) based filter and described the evolution of real and imaginary parts of an image.

III. Proposed Technique

The IITD and CASIA palmprint database are used for this experiment [1, 4]. The order of execution in the proposed method is shown in the following flow chart.

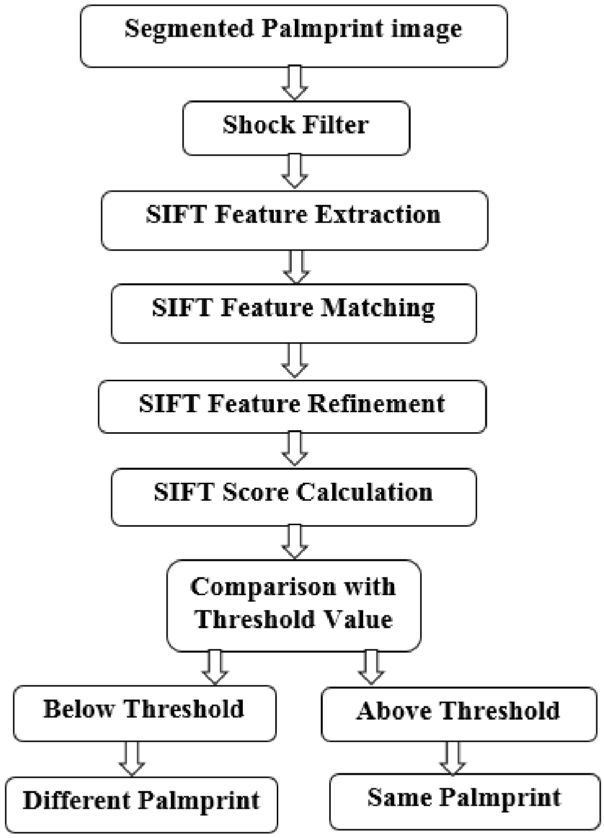

Fig.1: Flowchart of proposed method.

Shock filter is applied for the preprocessing of the segmented palmprint image. The shock filtering introduced by the Osher and Rudin in 1990 [11]. They introduced a continuous class of filters based on PDE (Partial Differential Equations).

Shock filters has many advantages. It divides clearly at the edges in image, within the particular area filtered signal becomes flat. Create segmentations using shock filters [6]. The shock filter do not increase the total variation in a signal. They also have inherent stability properties [5]. The Shock filter also satisfies a maximum and minimum principle stating that the range of filtered image remains within the range of the original image.

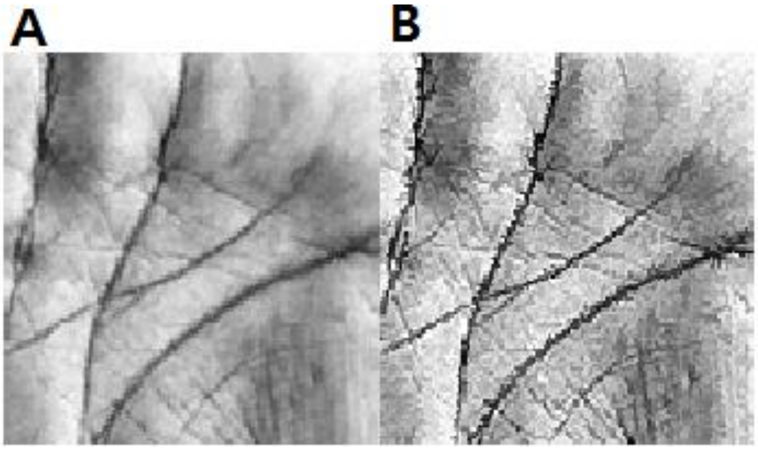

Fig.2: (A) Original palmprint image and **(B)** Result of preprocessing.

SIFT was introduced for the finding image features in different variant like image scaling, translation, and rotation [2]. This is done by choosing key locations at the local minima and local maxima in the difference of Gaussian function applied in scale space. The local minima and local maxima are constructed by continually down sampling the image. Maxima and minima of this scale space function are resolute by comparing each pixel with its neighbors. During matching, all the SIFT key points of first images are compared with second image. A SIFT point is matched when the distance between the point and its adjacent points is enough larger than the distance between point and another adjacent neighbor.

The following are the four steps for SIFT features extraction which is proposed by D. Lowe.

1. Scale space construction. Scale space construction is a first step, in this step the computation searches over all scales and image locations. It identifies the potential interest points by using difference-of-Gaussian function. The potential interest points are invariant to scale and orientation.
2. Keypoint localization: Key point localization is achieved in the difference of Gaussian images. The keypoints are obtained through calculation of their stability.
3. Orientation assignment: On the basis of directions of the local image gradient is assign single or multiple orientations to the keypoints. In the image data all the operations are performed and that has been changed relative to the assigned direction, scale, and location.
4. Keypoint descriptor: The local image gradients focused at a keypoint and is equally split into sub-blocks, from the each sub-block, the gradient orientation histogram is computed. The descriptor for the keypoint is obtained by the concatenating the gradient orientation histogram.

Figure 3 shows the result of SIFT points detection, in that (A) and (B) are detected points from figure 2 (A) and (B), respectively. There are 1145 points in original image and 3204 points in preprocessed image, this result show the detected points in preprocessed image has much more points than the original image.

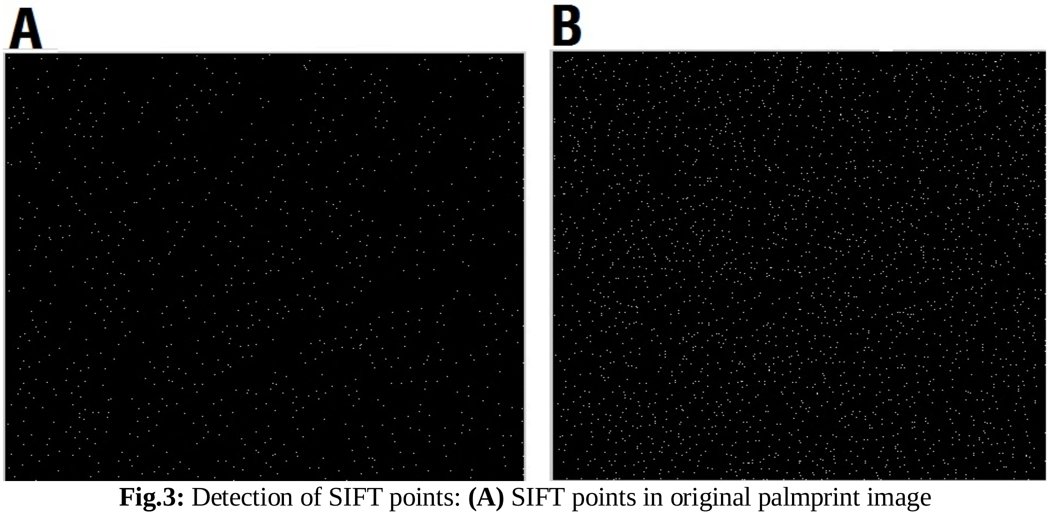

Fig.3: Detection of SIFT points: **(A)** SIFT points in original palmprint image
(B) SIFT points in preprocessed image.

The following figure 4 and figure 5 shows the shift points matching.

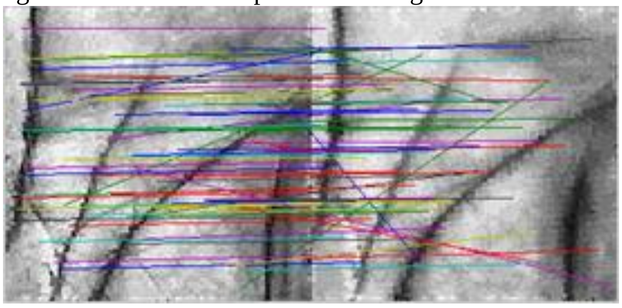

Fig.4: Shift Points matching with the same hand palmprint.

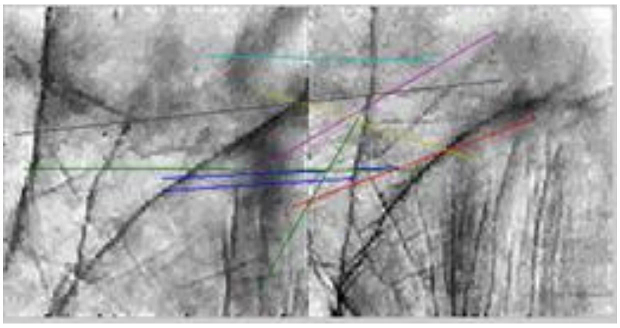

Fig.5: Shift Points matching with two different palmprint.

The RANSAC algorithm (Random Sample Consensus) was introduced by [7] M. Fischler and Bolles in the year 1981. It was developed as a method to estimate the parameters of an assured model starting from a set of data surrounding by large amounts of outliers. The Random sample consensus (RANSAC) is an iterative technique to estimate parameters of a mathematical model from a set of observed data. It was a non-deterministic algorithm in the sense that it produces a sensible result only with a certain chance, with this probability increasing as more iterations are allowed.

The I-RANSAC algorithm [7] which is frequently used for refining the matched SIFT points, estimates a transformation model (homography) according to all of the matched SIFT points and keep the points which comply with the model as inliers, and discard other points which fail to comply with the model as outliers. In contactless palmprint images non-linear deformations exist due to the variance of stretching degrees of hands. In such cases, it is very difficult to model these non-linear deformations using only one transformation model.

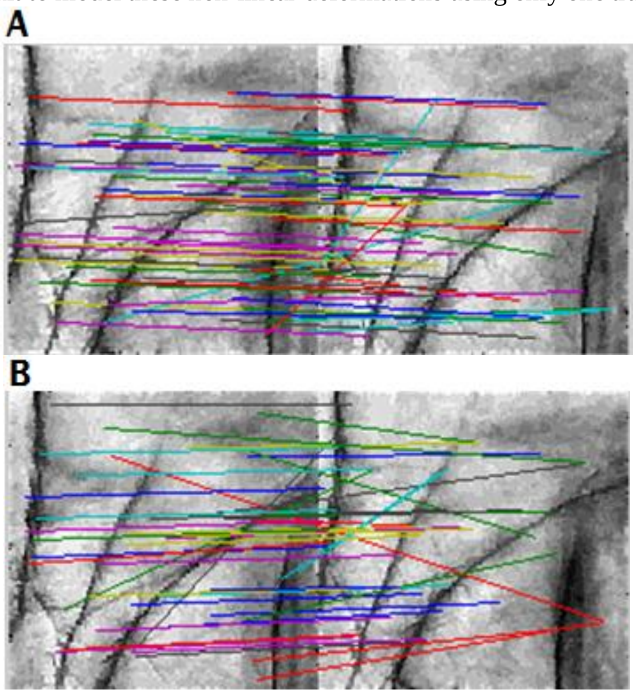

Fig.6: Matched SIFT point's finds with some mismatched points (A) Total 58 points (B) 44 points.

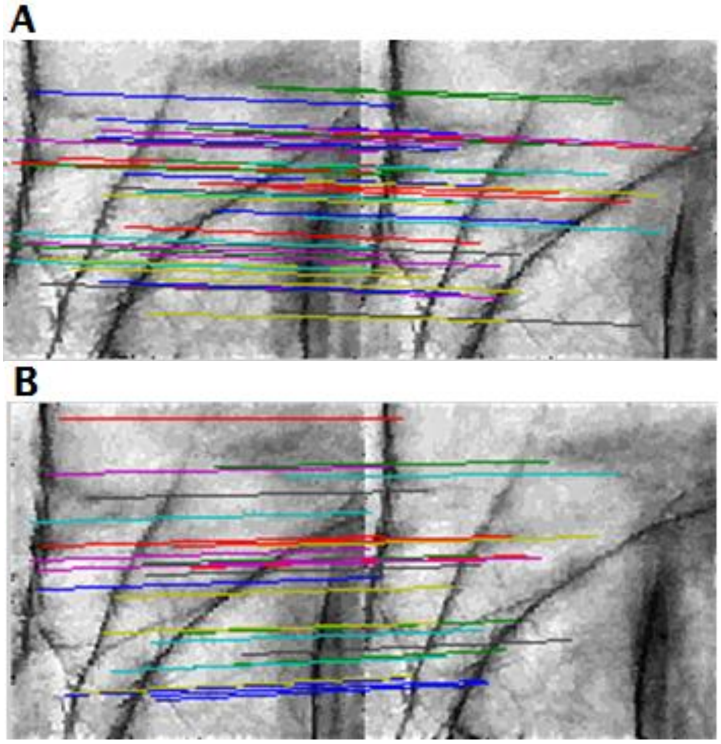

Fig.7: Refinement using I-RANSAC (A) Total refined 42 points of image 6(A). (B) Total refined 27 points of image 6 (B).

LPD algorithm [14] used for refinement of the SIFT matched points. Some mismatched points shown in figure 7(A) and 7(B), are removed using LPD shown in figure 9(A) and 9(B). The removal of mismatched points known as refining the SIFT points. In this refinement remove mismatched points by LPD. In each inlier set obtained by SIFT, the related points can well aligned by using the corresponding transformation model in LPD. The feature extractors used for corresponding LPD, and LPD don't have invariant in scale, rotation and translation variances.

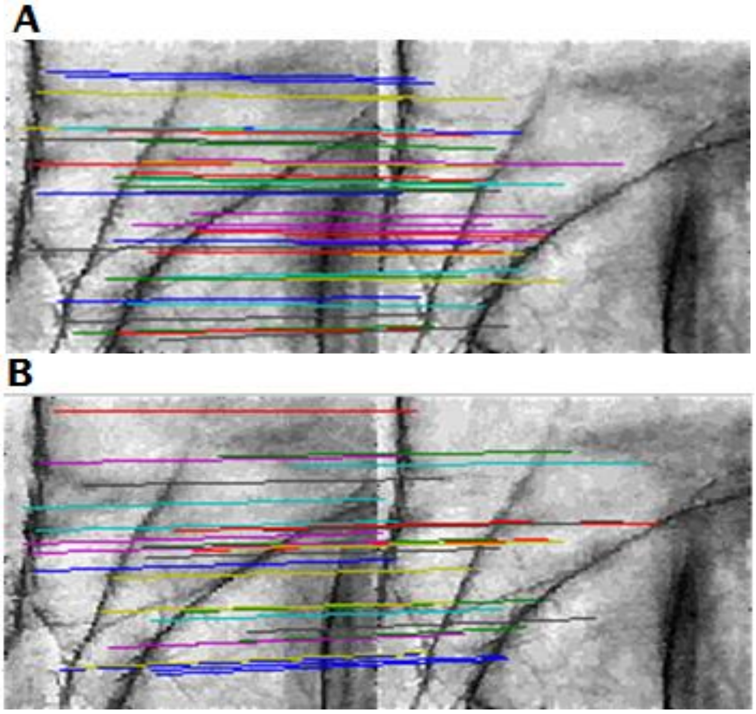

Fig.8: Refinement using LPD (A) Total refined 42 points of image 6(A). (B) Total refined 28 points of image 6 (B).

IV. Result And Discussion

IIT Delhi and CASIA palmprint database are used in this experiment. IIT Delhi palmprint image database contains left and right hand color images of 230 persons taken from age group 14–56 years. Each person has least six palmprint samples of both hands. All hand images of this database taken by contact less CMOS camera which is saved in JPG format [4]. The segmented hand image also provided in that database which is stored in BMP format at dimension 150X150 at gray scale. The CASIA palmprint Image Database contains 5,502 images of 312 different people and each person has 8-10 hand images of both hands. They use CMOS camera for palmprint image acquisition and stored in JPG format at 8 bit greyscale [1].

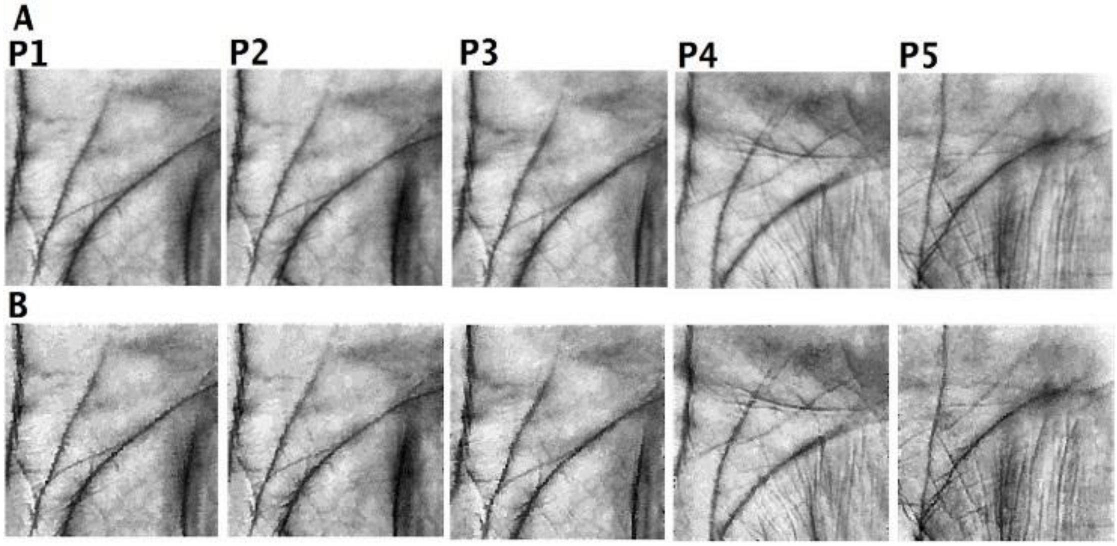

Fig.9: Segmented palmprint form IIT Delhi database (A) Without preprocessing, (B) Corresponding preprocessed image.

The images form IITD palmprint database show in figure 9(A) and the corresponding preprocessed image show in figure 9(B). Applied the proposed approach in these images and calculated the SIFT matching score. The TABLE 1 shows the SIFT matching score of preprocessed and without preprocessing image. The preprocessed image gives greater accuracy than the without preprocessing. The palmprint number P1, P2, and P3 are same hand which are taken by different angle. The palmprint P4 and P5 belongs to another person. A threshold value of 0.5 is assumed in this experiment. The palmprint of a person is matched with the same person palmprint then SIFT matching score is above the threshold value. The palmprint of a person is matched with another person palmprint then SIFT matching score is below the threshold value.

Table 1: IIT Delhi Palmprint Database SIFT Matching Score

Palmprint matched	SIFT Matching Score	
	Without Preprocessing	With Preprocessing
Palmprint P1 to P1	1.000	1.000
Palmprint P1 to P2	0.877	0.895
Palmprint P1 to P3	0.754	0.796
Palmprint P1 to P4	0.258	0.212
Palmprint P1 to P5	0.352	0.333

The images form CASIA palmprint database show in figure 10(A) and the respective preprocessed image show in figure 10(B) and P1, P2, P3, P4, and P5 are the number of palmprint images. Applied the proposed approach in CASIA images and calculated the SIFT matching score.

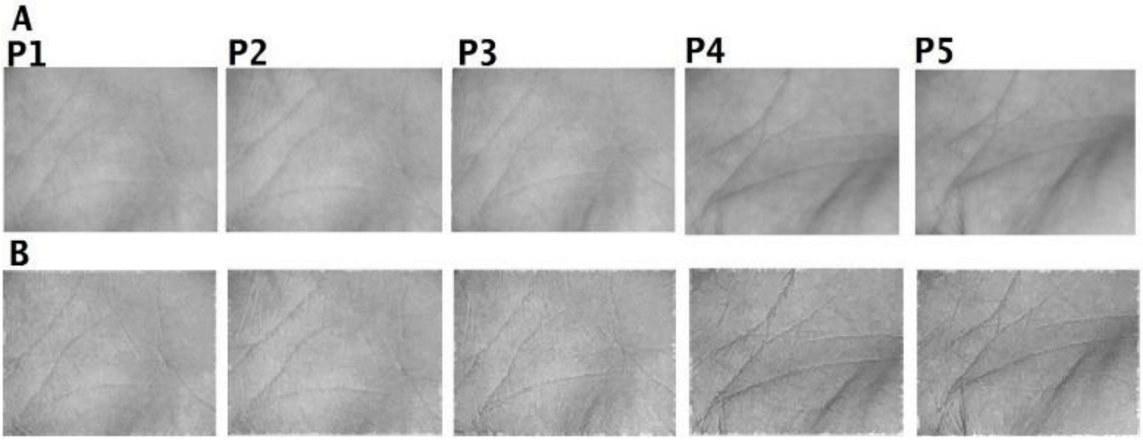

Figure 10: Segmented palmprint form CASIA palmprint database (A) Without preprocessing, (B) Corresponding preprocessed image.

The TABLE 2 shows the SIFT matching score of preprocessed and without preprocessing image. The preprocessed image gives greater accuracy than the without preprocessing. The palmprint number P1, P2, and P3 are belongs to same hand which are taken by different angle. The palmprint P4 and P5 are belongs to another hand. The palmprint of the same person matches which produces higher SIFT matching score than the threshold value.

Table 2: CASIA Palmprint Database SIFT Matching Score

Palmprint matched	SIFT Matching Score	
	Without Preprocessing	With Preprocessing
Palmprint P1 to P1	1.000	1.000
Palmprint P1 to P2	0.728	0.731
Palmprint P1 to P3	0.653	0.663
Palmprint P1 to P4	0.357	0.333
Palmprint P1 to P5	0.333	0.143

The experiment carried out using MATLAB 2014a on desktop computer having 3.3 GHz processing and 2 GB RAM. The average execution time of each steps are listed in TABLE 3. This proposed approach takes 1.6 sec for verification, experimental results shows that the proposed new method is suitable for the real time verification.

Table 3: Average execution time

Steps	Average execution time in second
Preprocessing	0.321
SIFT feature extraction	0.415
SIFT feature matching	0.282
I-RANSAC based refinement	0.254
LPD based refinement	0.337
Total	1.609

V. Conclusion

This paper presented a new novel method of touchless palmprint verification, that uses SIFT and shock filter with matching refinement. Initially, it uses the shock filter for preprocessing then SIFT feature extracted and matched. The few non-matching points are refined by I-RANSAC and LPD in parallel. After refinement SIFT matching score is calculated and compared with the threshold value. If the matching score is higher than the threshold value then the both palmprint are considered as from same hand otherwise considered as from different hands. The IITD database CASIA database are used in the experiment and the experiment results shows that the proposed novel method matches the palmprint 100% accuracy and in short time.

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