Journal of Theoretical and Applied Information Technology
20th August 2014. Vol. 66 No.2

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

SIFT FEATURE EXTRACTION COMBINING FACE AND FINGER KNUCKLE RECOGNITION PROCESS

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ABSTRACT

This paper addresses the novel way for biometric image identification using scale invariant feature transforms. We have split the authentication process into two phases starting with face detection using distance comparison measures followed by finger knuckle recognition phase. The data base chosen for this work uses the combination of face and figure knuckle of a same person with the data size of about 100 users. The SIFT features makes the similarity analysis of face and finger knuckle combined together to authenticate a person. The key point detector of SIFT combines the detector of face and finger knuckle and make fixed detector points in the training image data sets. The different Gaussian filters are applied on the various key point detectors with difference in scales.

Keywords: *Sift, Face Recognition, Finger Knuckle Recognition, Space Sift Comparison*

1. INTRODUCTION

Scale invariant feature transform is used to detect the scale and the various features of an image. The purpose of this algorithm is to detect image based on feature metrics. The latest update of this algorithm also produced potential result in biometric detection and classification of images based on the feature extraction.

Due to the wide application of biometric application such as face detection and finger print recognition in authentication process, still many unresolved problems are left in the system as the system deals with rigid and complex data. The accuracy of the result plays a vital role to characterize the authentication system as it vary based on the algorithm deployed in the system. The most intrinsic features from the image extracted using SIFT and compared with the nearest score credentials to get the exact match. The close encounter of the distance measures evaluated with the key point descriptor of face and finger knuckle image recognition.

Various algorithm were implemented earlier to detect bio metric images in either forms of face, finger like Eigen and Fisher faces for face detection [2][3] followed by Phase based finger matching using POC and BLPOC [6] algorithms. The working principle of the algorithm works based on feature extraction and classified before making the comparison. Overall the recognition of face and finger are classified based on its features and phase.

The variance factor of face and finger knuckle recognition is evaluated using different angle and its posture was placed in the authentication system. Mostly the algorithm used to recognize pattern suffers with the factors that affect its performance. The usage of SIFT in this approach provides effective mechanism using the feature based extraction method for getting the exact match. The additional properties supported along with the feature detection tend to provide exact match by comparing with the nearest best match. The nearest best match result was provided by the feature detection unless the best convincing result is achieved.

The result executed in this work uses image sets [FVC 2004] of 100 persons with the combination of their face and finger knuckle image data sets. The image is subjected to SIFT extraction for defining the key descriptor point on both face and finger knuckle images. The recognition phase would start from face recognition and by successful execution of face recognition will followed by finger knuckle recognition.

The comparison of result was done by combining the key description of face and finger knuckle which was further subjected to SIFT recognition process of face and finger knuckle recognition. The organization of this paper was

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organized as follows. The second section address the review literature followed by Proposed system with face recognition using SIFT in section 3 and finger knuckle recognition using SIFT in section 4, the combination factor was addressed in section 5, and section 6 and 7 address the result and evaluation and finally ends up in conclusion.

2. FACE RECOGNITION PHASE USING SIFT

The procedure for face recognition works based on the following steps.

Step 1: Select an image of a person from the Database

Step 2: Assign class id

Step 3: Store it in the database

Step 4: Repeat the step 1 to 3 for selecting another image

Step 5: Implement SIFT for retrieving the features

Step 6: Compare the feature index of both the images

2.1 APPLY SIFT IN FACE RECOGNITION

While selecting an image in the portal using step 1 as mentioned above, a class id is created with a positive integer value less than 5. The process is repeated for selecting an image which is either totally different or the same image with different posture. The SIFT feature is applied to such image data set for further recognition process.

The nearest image can be traced using SIFT feature comparison considering the boundary of SIFT region. To estimated the distance the Euclidean distance comparing the two image set where one is the source and other is the destination.

$$d(x,y) = \sqrt{\Sigma_i (x_i - y_i)^2} \quad (1)$$

If the distance has to be calculated within sift block then

$$d(x,y) = \Sigma_i |x_i - y_i| \quad (2)$$

If the feature has to be traced within the SIFT region then

$$d(x,y) = \frac{x.y}{\|x\|z\|y\|z} \quad (3)$$

Such method will detect nearest neighbor by considering SIFT as the major factors. In the above formula $\|x\|2$ and $\|y\|2$ are the distance between two features, maximum the distance within images deals with maximum deviations and minimum results in the close feature comparison.

The Fig 1 to Fig 4 shows the SIFT impact on image face recognition.

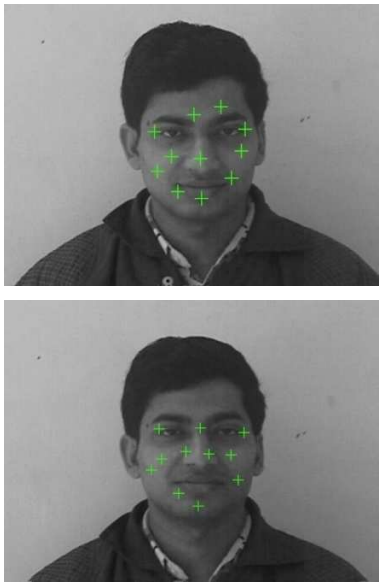

Fig1: SIFT in Face recognition with Image Set 1

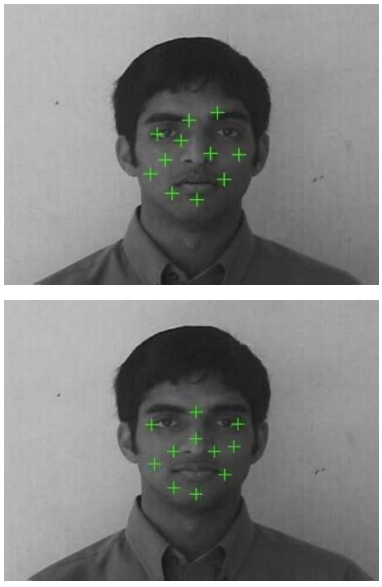

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Fig 2: SIFT in Face recognition with Image Set 2

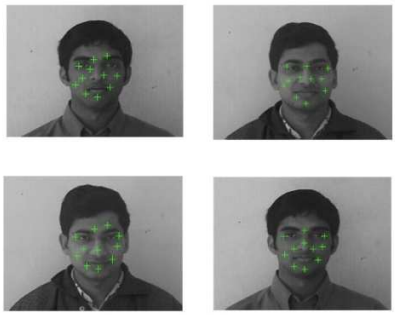

Fig 3: Face compared with alternate image using SIFT extraction

Fig 4: Class mean value of two image data sets

The results in terms of class mean value for the above mentioned images (using image datasets 1 and 2 taking only sample images)

The nearest class is number : 1

With a distance equal to : 1.6053e+008

The distance from Face Space is : 2.0339e+012

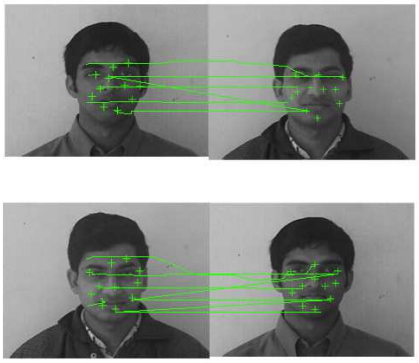

Fig 5: SIFT comparison between same and alternate images of different class value

3. FINGER KNUCKLE RECOGNITION USING SIFT

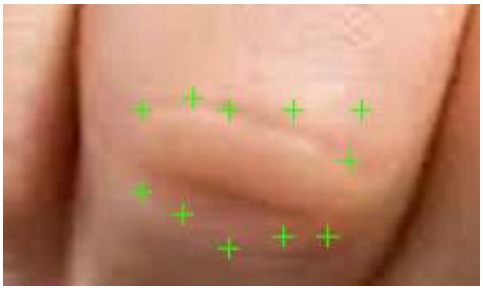

Fig 6: Finger knuckle reading using SIFT targeted area

Fig 6 shows the finger knuckle targeted area that is to be checked for recognition process. This is the phase II of our work. While the phase I covers the face recognition process which deals with face identification. Once after the successful identification process the image set is stored in the data base with the valid class id. The purpose of the class id is to ensure the person face identification and the further identification of the process is stored with the same class id. The understanding is that when the class id is given for evaluation the entire recognition process of the concern person is retrieved. With this evaluation we proceed to phase II.

As mentioned in the Fig 6, the knuckle recognition process is done with the image data sets available in the image data sets provided in the link [1]. The data sets are organized with the input of 140 users along with their face as input image of different postures. The totally data set covers around 140*8 for face input images were 140 is the user number and 8 is the posture (angle) count. Adding to this the knuckle print of the same person is been evaluated with the

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knuckle image store available in the link [7] are used with the combination of valid input knuckle image taken during the course of recognition process. The following are the steps followed for evaluating the knuckle reading.

Before starting the knuckle recognition process ensure the following

Step 1: Select the valid class id of face recognition process

Step 2: Select the knuckle image from the data sets

Step 3: Implement SIFT process

Step 4: Once the process is done it is stored in the valid class id

Step 5: Check the SIFT scores that makes with the valid class id

Step 6: If matches store it in the class id or else try another set unless better match is found

Step 7: The process is done until the SIFT matches with the Face and finger knuckle recognition

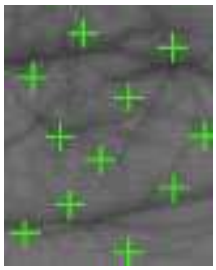
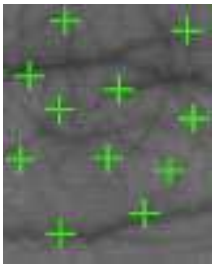


Fig 7: Finger Knuckle recognition Image set 1



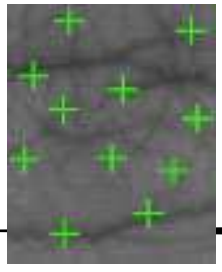


Fig 9: Finger Knuckle recognition of Image set 3

Fig 8: Finger Knuckle recognition Image set 2

The SIFT targets the finger knuckle region identified in relevant to the class id of face recognition. The matching of region is done using the SIFT comparison as shown in Fig 10.

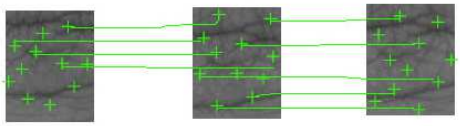


Fig 10: Finger Knuckle recognition with SIFT comparison with class id

The line connection all the image by considering either of the two image sets for comparison provides the result in terms of class id regenerated for face recognition. The overall procedure of this work was shown in the flow diagram.

4. FACE AND FINGER KNUCKLE RECOGNITION

The process output of face recognition along with the valid class id is stored in the data base before starting the process of finger knuckle recognition. Once after the completion of finger knuckle process the class id is stored by comparing with the existing class id. The value of class id is created based on SIFT index that provide the exact match between two face images in terms of face recognition and followed by finger knuckle comparison.

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4.1 Working With Sift Class Id Generation

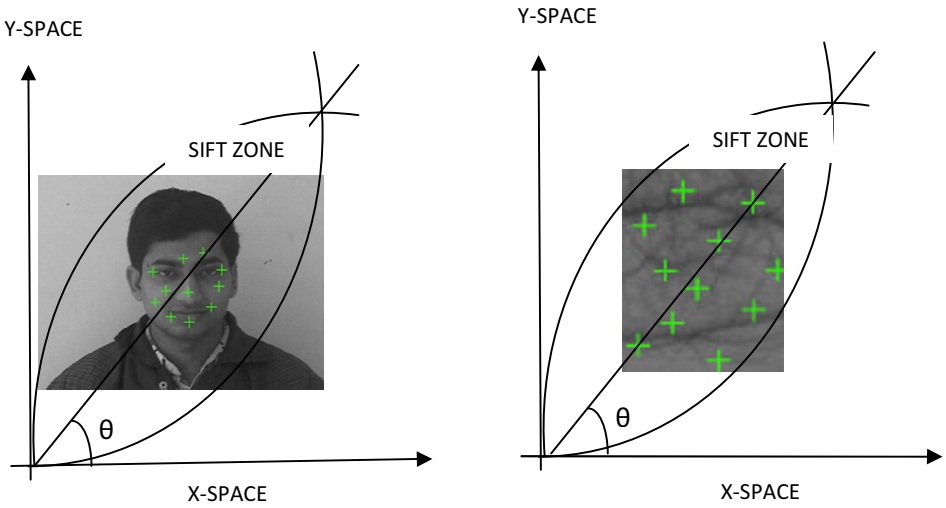

*Fig 11: SIFT angle based on image posture and **finger** knuckle recognition of Image set 1*

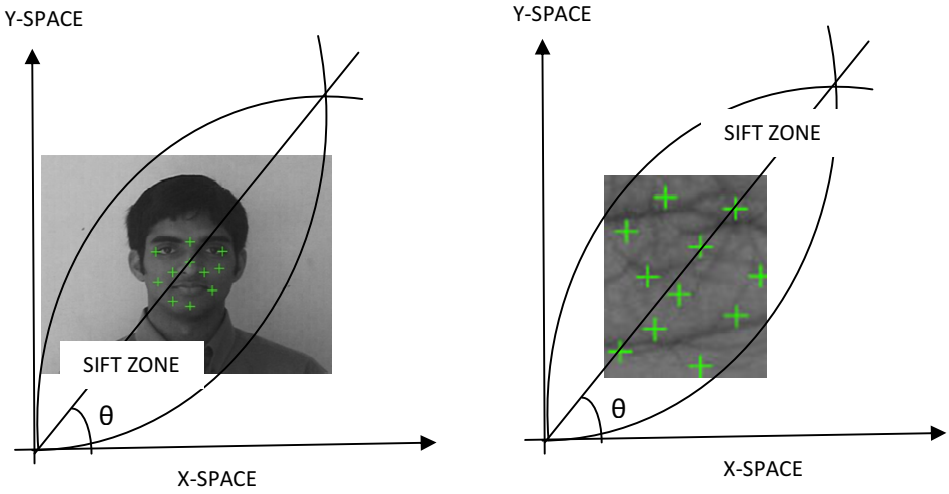

Fig 12: SIFT angle based on image posture and finger knuckle recognition of Image set 2

Fig 11 and 12 sets the SIFT region for face and finger knuckle recognition. The angle θ defines the SIFT boundary and by drawing the tangent line that cuts the portion in two half by split the recognition boundary. The boundary set within the curves is the targeted zone and generally it assists for recognition the image where the recognition zone falls within the space followed by the SIFT zone that is compared along with the class is based on the spilled location.

The observation made after getting the sample results, states that the related class id falls on the same SIFT comparison zone on both the occasion when dealing the results in terms of face and finger knuckle recognition.

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4.2 FEATURE, DIRECTION AND NEIGHBORHOOD COMPARISON USING SIFT

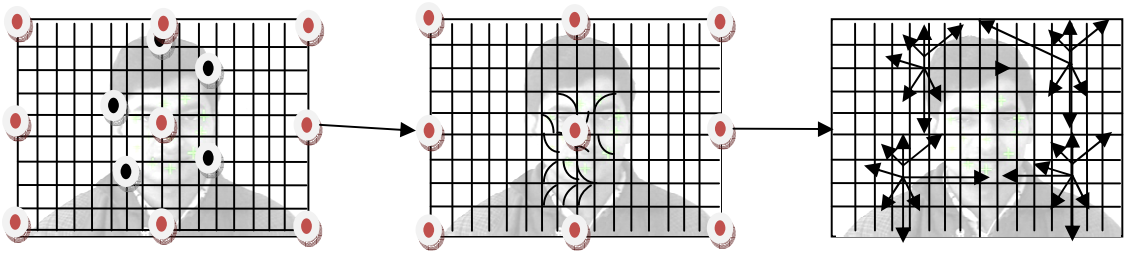

Fig 13: SIFT feature, direction and neighbor extraction based on Face recognition image

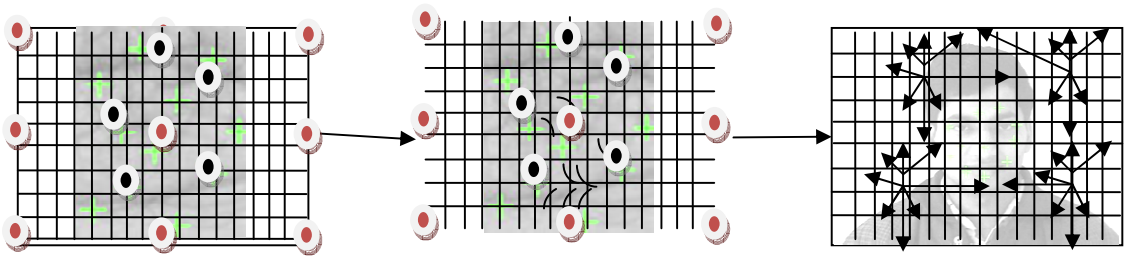

Fig 14: Combining Face and Finger Knuckle extraction using SIFT for Finger knuckle image sets

Fig 13 and 14 shows the SIFT comparison of Face and Finger knuckle independently to start with and concluded the result by combining both the process.

5. RESULTS AND OBSERVATIONS

Table 1: Space with SIFT comparison

	Mean	Median	Minimum	Maximum
Class_number	1.4444	1.0000	1.0000	2.0000
Sample_Space	1.3540e+012	1.5092e+012	16.920	1.8092e+012
Distance	1.6569e+008	1.6734e+008	1.3732e+008	2.0735e+008
	Std. Dev.	C.V.	Skewness	
Class_number	0.52705	0.36488	0.22361	
Sample_Space	5.2779e+011	0.38982	-2.1161	
Distance	2.6816e+007	0.16185	0.33641	
	IQ range	Missing obs.		
Class_number	1.0000	0		
Sample_Space	2.5000e+011	0		
Distance	5.3058e+007	0		

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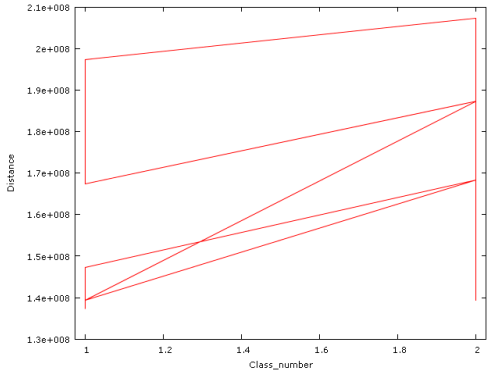

Fig 15: Class Id with SIFT in terms of Difference measures

Fig 15 shows the line chart that connects the class id with the nearest image matches and its corresponding distance. This is done with the positive class id score used for storing the image in the data sets. Class id comprises of both face and finger knuckle images.

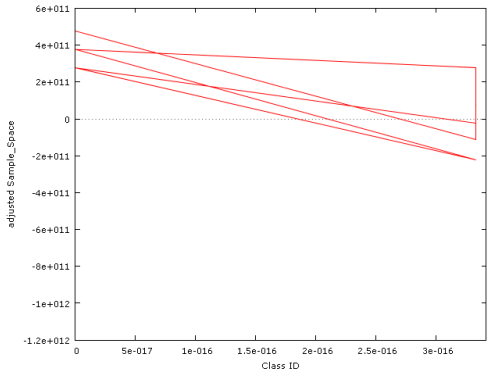

Fig 16: Adjusted sample based on the SIFT recognition

Fig 16 shows the adjusted sample space for tracing the best match based on the image recognition process of face and finger knuckle. The adjusted sample is the best retrieved image of close neighbor using SIFT score justifying best match.

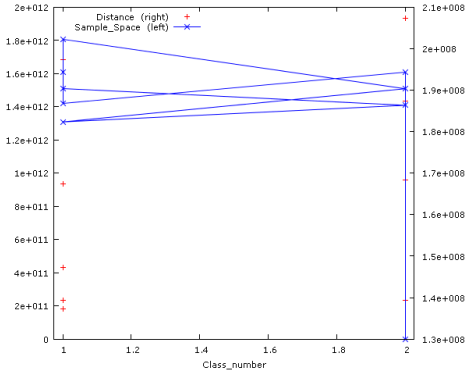

Fig 17: SIFT Distance vs. Sample Space and its deviations

Fig 17 shows the distance and sample space comparison for showing the deviations when match not found. The Table 1 depicts the value and the score is reached 0 for missing objects that are retrieved when the result goes utmost wrong.

The Fig 18 Shows the overall process of this research work and its independent work flow followed by the conditional measure that assist in decision making with/without match found.

While applying SIFT the condition is checked for nearest or the exact match and the steps to be taken during the course of the result. The SIFT is compared with the nearest image SIFT score for making the comparison process until the match found. Once match found it will be stored in the data base with a valid class id as mentioned in the beginning of this paper.

5.1 MATCHING CRITERIA

Table 2: Images and matching factor

Image Template per Person	Total Training Images	Total Test Images	Time Taken For Matching (sec)
2	660	330	76.6
4	1320	330	152.5
6	1980	330	230.2
8	2640	330	307.7
10	3110	660	352.2
12	4000	720	380.2
14	5000	780	402.5
16	6000	800	413.5

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

The table 2 shows the image classification combining both face and finger knuckle image for recognition a person. The research result shows the estimate average image of 140 persons along with their different angled images that are considered for the recognition process and shown in total training images that was split into two equal portion of face and finger knuckle images. Total test image for the per person template of 2 has the score 330 which means nearly 165 image of face images and the remaining 165 image of finger knuckle images are used to get the matching score 76.6 (on an average per seconds). Using SIFT feature comparison while increasing the per person score the time taken is 413.5 for 16 person which is half the score achieved when using either Face or finger knuckle image data sets. The average time is reduced as the image data sets grows in terms of number and by using SIFT features average time is reduced as stated in the data sets.

6. FUTURE WORK AND CONCLUSION

This work we have combined the process of face and finger knuckle recognition by staying different in using traditional finger print recognition. To an extend we have succeeded in achieving the closest result by making the missing object to zero score which mean the match found exactly with the image that is compared. The phase I of face recognition and phase II of finger knuckle recognition combined together to provide unique solution for tracing the exact user using biometric operation. The extension of this work will be tried with different facial gesture and finger knuckle exposing technique as we have dealt with image and angle based result.

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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

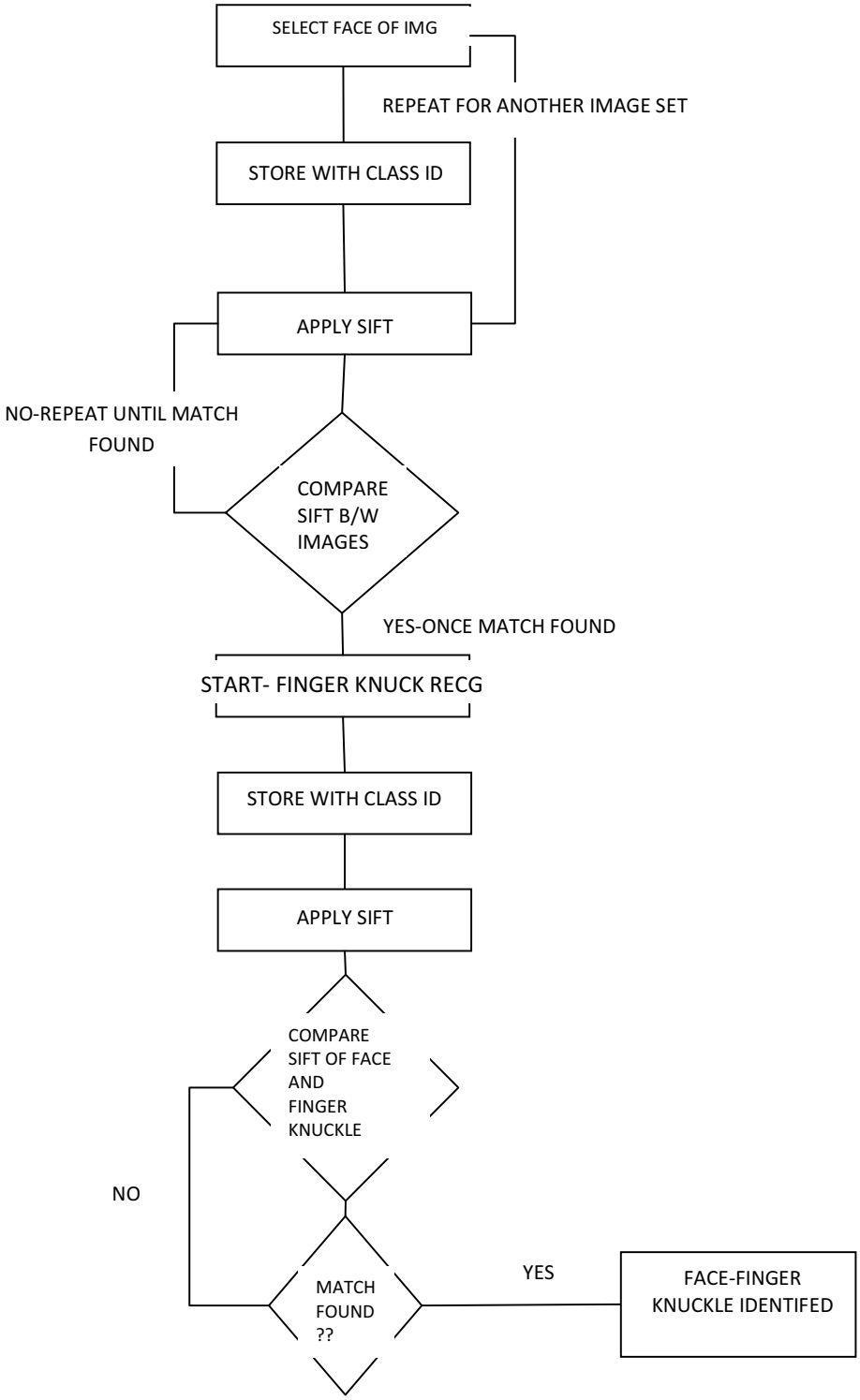

Fig 18: Face and Finger knuckle recognition process