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Hand Geometric Recognition System based on Support Vector Machines (SVM)

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Abstract: The use of biometric technologies for identity verification is growing rapidly, and the hand geometry is most widely used for person identification in the recent years, they gaining high acceptance in the security applications. This research aims to build a recognition system using Hand Geometric System based on Support Vector Machines (SVM), so as to overcome the problems of the possibility of fraud and forgery in the traditional identification methods.

Keywords: support vector machine, Biometric authentication, False Rejection Rate, False Acceptance Rate, security, pattern recognition, image processing, hand geometry.

I. INTRODUCTION

Biometrics is the tool which measure individual's unique physical orbehavioural characteristics to recognize or authenticate their identity and it ismost secure and convenient authentication tool. Biometric measures cannotbe borrowed, stolen, or forgotten and forging one is practically impossible.Common physical biometrics includes fingerprints, hand or palm geometry,retina, iris, and facial characteristics. Behavioural characteristics includesignature, voice, keystroke pattern, and gait. Biometrics is the science ofusing human measurements to identify people.Biometric is automated methods of identifying a person or verifying theidentity of a person based on a physiological or behaviouralcharacteristic. Examples of physiological characteristics include hand or finger images,facial characteristics. Behavioural characteristics are traits that are learnedor acquired. Dynamic signature verification, speaker verification andkeystroke dynamics are examples of behavioural characteristics[3].

Hand geometry recognition systems are based on a number of measurements taken from the humanhand, including its shape, size of palm, and length and widths of the fingers. The technique is very simplerelatively easy to use, and inexpensive. Environmental factors such as dry weather or individual anomalies suchas dry skin do not appear to have any negative effects on the verification accuracy of hand geometry-basedsystems. The hand images can be obtained by using a simple setup including a web cam, digital camera.However, other biometric traits require a specialized, high cost scanner to acquire the data. The useracceptability for hand geometry based biometrics is very high as it does not extract detail features of theindividual. An individual's hand does not significantly change after a certain age[2].

Biometric technologies capitalize upon unique, permanent, andscannable human characteristics. A unique characteristic is one that noother person shares. This characteristic should also remain the same overtimes.All biometric devices take a number of measurements from an individualthen digitally process the result of these measurements and save thisrepresentation of the individual's traits into a template. Templates are thenstored in a database associated with the device or in a smartcard given tothe individual[3].

Among all the biometrics, hand geometry is one of theeffective system for identification or verification of human.Hand geometry biometric system is the use of geometricshape of the hand for recognition purposes. This method wasrather popular several years ago but nowadays it is seldomused. The method is based on the fact that the shape of thehand of one person differs from the shape of the hand ofanother person and does not change after certain age. Handgeometry as a biometric recognition can be used inIdentification mode, where the system identifies a personfrom the entire enrolled population by searching a databaseof hand for a match based solely on the hand biometric [9].

II. BASICS OF SUPPORT VECTOR MACHINES (SVM)

SVMs are a new technique suitable for binary classification tasks, which is related to and contains elementsof non-parametric applied statistics, neural networks and machine learning. Like classical techniques,SVMs also classify a company as solvent or insolvent according to its score value, which is afunction of selected financial ratios. But this function is neither linear nor parametric. The case of a linear SVM, where the score function is stilllinear and parametric, will first be introduced, in order to clarify the concept of margin maximisation in asimplified context. Afterwards the SVM will be made non-linear and non-parametric by introducing akernel. This characteristic makes SVMs a useful tool for credit scoring, inthe case the distribution assumptions about available input data cannot be made or their relation to the PDis non-monotone[10].

SVMs use an implicit mapping $\Phi$of the input data into a high-dimensional feature space defined by a kernel function, i.e., a function returning the inner product $\langle\Phi(x),\Phi(x')\rangle$ betweenthe images of two data points x, x'in the feature space. The learning then takes place in thefeature space, and the data points only appear inside dot

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products with other points. Thisis often referred to as the "kernel trick" (Scholkopf and Smola 2002). More precisely, if a projection $\Phi: X \rightarrow H$ is used, the dot product $(\Phi(\mathrm{x}), \Phi(\mathrm{x}'))$can be represented by a kernel function k

$$k(x, x') = (\Phi(\mathrm{x}), \Phi(\mathrm{x}')), \qquad (1)$$

Which is computationally simpler than explicitly projecting $xandx'$into the feature space H.One interesting property of support vector machines and other kernel-based systems is that,once a valid kernel function has been selected, one can practically work in spaces of anydimension without any significant additional computational cost, since feature mapping isnever effectively performed. In fact, one does not even need to know which features are beingused.

Another advantage of SVMs and kernel methods is that one can design and use a kernel for aparticular problem that could be applied directly to the data without the need for a featureextraction process. This is particularly important in problems where a lot of structure of thedata is lost by the feature extraction process [11].

III.RELATED WORK

Hand geometry recognition system based on support vector machines is gaining widespread application in a number of security systems. It can be operating in either verification or identification mode, there are numerous researches in this area. The exploring and evaluating a new approach based on support vector machines with universal kernel for addressing this problem. Also compare its performance with some other kernel functions and common classifiers including rule based and decision-tree based classifiers was proposed by El-Alfy, E.-S.M. , Bin Makhashen, G.M [1]. Mrs. Sampada A. Dhole andProf.Dr.V.H.Patil was proposed study of personal identification using hand geometry features. Hand geometry features consist of the length & width of fingers, length & width of palm, deviations, and angles. Image acquisition done without using pegs. The identification is done using Euclidian distance [2]. Amit Taneja andSimpel Jindal, was presented a biometric user recognition system based on hand geometry. It explores the features of a human hand, extracted from a color photograph which is taken when the user is asked to place his/her hand on a platform especially designed for this task [3]. The novel methodology for using feature selection in hand biometric systems, based on genetic algorithms and mutual information is presented. A hand segmentation algorithm based on adaptive threshold and active contours is also applied, in order to deal with complex backgrounds and non-homogeneous illumination was proposed by R. M. Luque, D. Elizondo, E. Lopez-Rubio and E.J. Palomo [4]. Siddharth S. Rautaray and Anupam Agrawal, was proposed effort centralizes on the efforts of implementing an application that employs computer vision algorithms and gesture recognition techniques which in turn results in developing a low cost interface device for interacting with objects in virtual environment using hand gestures[5]. The combination of hand geometry and palmprint verification system was being developed by SulabhKumra. Tanmay Rao [6]. Juan-Manuel RAMIREZ-CORTES, and others werepresented a hand-shape biometric system based on a novel feature extraction methodology using the morphological pattern spectrum or pecstrum [7]. S.Sumathi and R.RaniHemaMalini, was proposed method Hand geometry and selected window size palm print features computed from same image is used for authentication. Discrete Wavelet Transform (DWT) is used for feature extraction and Support Vector Machine (SVM) is proposed for classification [8]. Issam El-Naqa, Yongyi Yang, Miles N. Wernick, Nikolas P. Galatsanos, and Robert M. Nishikawa, were investigated an approach based on support vector machines (SVMs) for detection of Microcalcification (MC) clusters in digital mammograms, and propose a successive enhancement learning scheme for improved performance [12].

IV.PROPOSED SCHEME

In this paper we build a system for Hand geometry recognition based on support vector machines, the proposed scheme moves through three phases. The first phase include three initial stages, the first stage is image loading, on this they done the cutter of the imageand scaled to appropriate sizes, the second stage is pre-processing, on this the image converted to grayscale color and purifying it, and the third stage is the feature extraction, they drawn out the most distinctive features, such as Finger Lengths, Finger Width, Palm Width, Palm Length, Finger Top Regions. After finishing of these stages, the features will be obtained, that could be used in future by the system for recognition and training and process. The second phase is the training, the system will be trained on existence categories on the system, that their features was extracted in the previous phase. The third phase is the recognition, they used to sureness the identity. The images used on this system belong to COEP Palm Print Database, they contains 1344 picture of the right palm for 168 person, has been used 160 picture of them, versus 8 different images for each person. The supportvectormachinesalgorithm were used totrain the system, which they dividesthe entered datato thevarieties,and formation the "Support Vectors" and "Hyper planes"between dataitems. Also the same algorithm have been used later in the process of classifying data for person recognition. The general structure of the system as shown in Fig. 1.

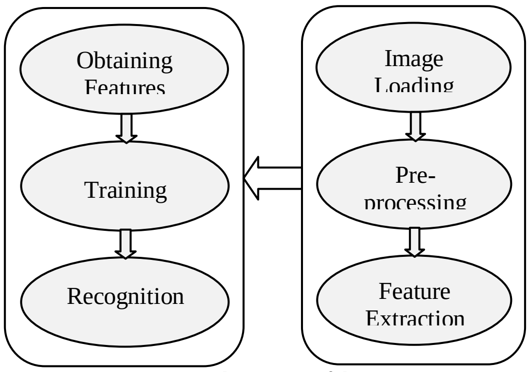

Fig. 1. General structure of the system

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The Fig. 1 above describes the steps included on the proposed system, which contains:

A. Image Loading

It's the system inputs, and act as the required pattern to train on it, they entered in JPG format.

B. Pre-processing

This phase related to samples configuring of the palm, the image will formatted and optimized, in order to take the optimal shape for training or classifying, they include (Formatting, Cropping, Resizing, Gray scaling, Filtering)

C. Feature Extraction

The main geometric features of the palm will be extracted, such as Finger Lengths, Finger Width, Palm Width, Palm Length, and Finger Top Regions).

D. Training:

The system were trained on 160 image of the right palm for 20 person, versus 8 images for each person, these image making 20 class, and each class contain 8 image, as shown in the Table 1.

TABLE 1: IMAGE USED IN TRAINING PHASE

IMG_0011	Class(11)	IMG_001	Class(1)
IMG_0012	Class(12)	IMG_002	Class(2)
IMG_0013	Class(13)	IMG_003	Class(3)
IMG_0014	Class(14)	IMG_004	Class(4)
IMG_0015	Class(15)	IMG_005	Class(5)
IMG_0016	Class(16)	IMG_006	Class(6)
IMG_0017	Class(17)	IMG_007	Class(7)
IMG_0018	Class(18)	IMG_008	Class(8)
IMG_0019	Class(19)	IMG_009	Class(9)
IMG_0020	Class(20)	IMG_0010	Class(10)

E. Classification

On this phase they taken a decision, where the recognition is done, and identification of the entered image to which specific class it belong, by using the data resulted from the training process.

Then entered pattern will be compared with features of the 20 class that exist on the system by using support Vector Machines algorithm.

V. RESULTS OF TESTING THE SYSTEM ON COEP PALM PRINT DATABASE

A. *Recognition of group 1*

After testing the image of the group number 1, the system was recognized to 8 sample out of 8, as shown in the Table 2 and Fig 2.

TABLE 2: RECOGNITION OFGROUP 1

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

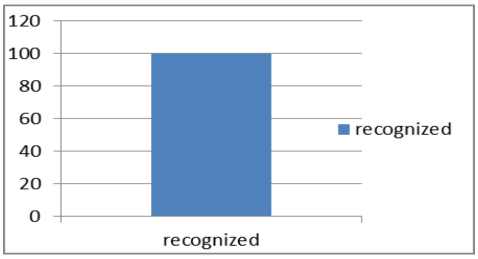

Fig 2. Recognition of group 1

B. *Recognition of group 2*

After testing the image of the group number 2, the system was recognized to 8 sample out of 8, as shown in the Table 3 and Fig 3.

TABLE 3: RECOGNITION OF GROUP 2

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

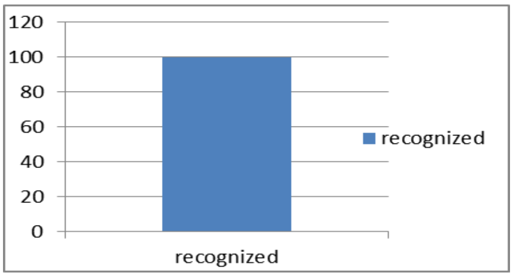

Fig 3. Recognition ofgroup 2

C. *Recognition of group 3*

After testing the image of the group number 3, the system was recognized to 8 sample out of 8, as shown in the Table 4 and Fig 4.

TABLE 4: RECOGNITION OF GROUP 3

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

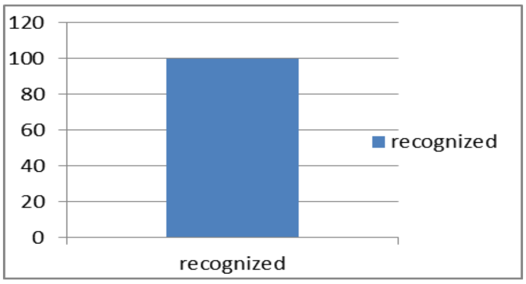

Fig 4. Recognition of group 3

D. *Recognition of group 4*

After testing the image of the group number 4, the system was recognized to 8 sample out of 8, as shown in the Table 5 and Fig 5.

TABLE 5: RECOGNITION OF GROUP 4

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

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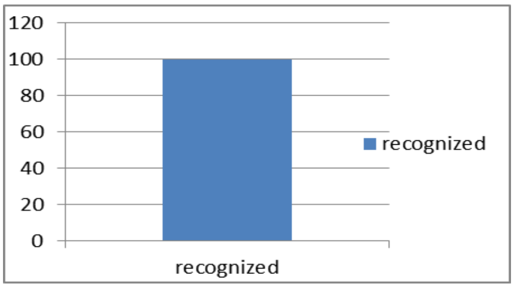

Fig 5. Recognition of group 4

E. *Recognition of group5*

After testing the image of the group number 5, the system was recognized to 8 sample out of 8, as shown in the Table 6 and Fig6.

TABLE 6: RECOGNITION OF GROUP 5

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

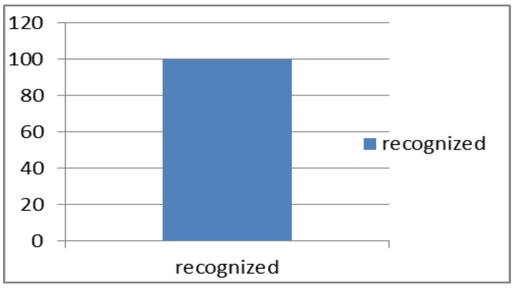

Fig 6. Recognition of group 5

F. *Recognition of group 6*

After testing the image of the group number 6, the system was recognized to 8 sample out of 8, as shown in the Table 7 and Fig 7.

TABLE 7: RECOGNITION OFGROUP 6

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

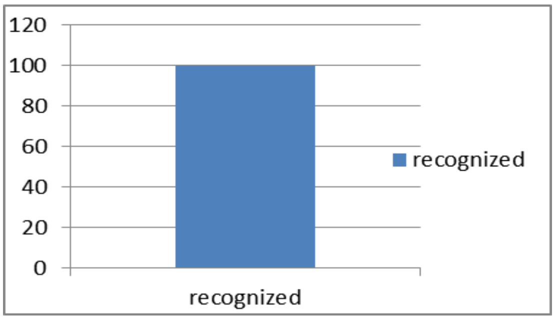

Fig 7. Recognition of group 6

G. *Recognition of group 7*

After testing the image of the group number 7, the system was recognized to 8 sample out of 8, as shown in the Table 8 and Fig 8.

TABLE 8: RECOGNITION OFGROUP 7

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

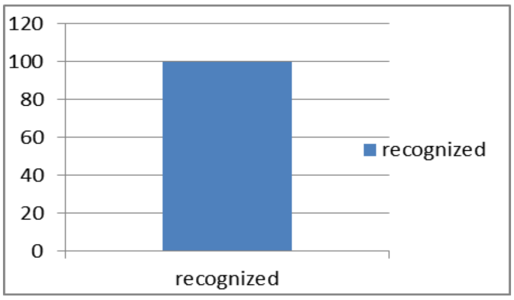

Fig 8. Recognition of group 7

H. *Recognition of group 8*

After testing the image of the group number 8, the system was recognized to 8 sample out of 8, as shown in the Table 9 and Fig 9.

TABLE 9: RECOGNITION OFGROUP 8

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

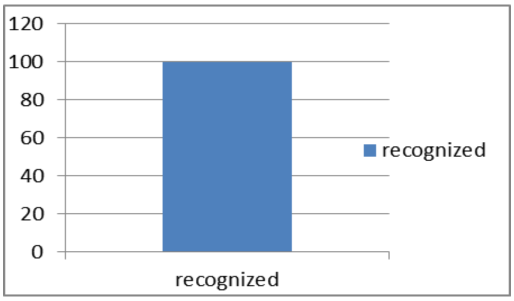

Fig 9. Recognition of group 8

I. *Recognition of group 9*

After testing the image of the group number 9, the system was recognized to 8 sample out of 8, as shown in the Table 10 and Fig10.

TABLE 10: RECOGNITION OFGROUP 9

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

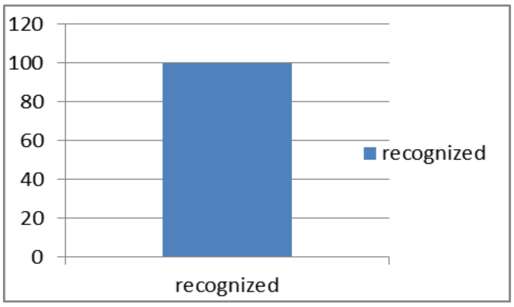

Fig 10. Recognition of group 9

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J. *Recognition of group 10*

After testing the image of the group number 10, the system was recognized to 8 sample out of 8, as shown in the Table 11 and Fig 11.

TABLE 11: RECOGNITION OFGROUP 10

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

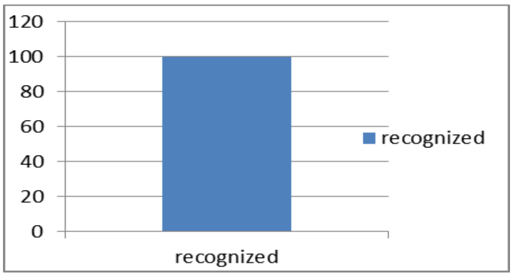

Fig 11. Recognition of group 10

K. *Recognition of group 11*

After testing the image of the group number 11, the system was recognized to 8 sample out of 8, as shown in the Table 12 and Fig 12.

TABLE 12: RECOGNITION OFGROUP 11

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

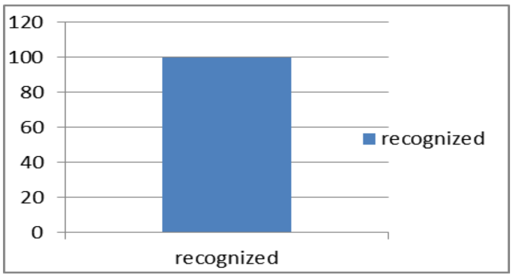

Fig 12. Recognition of group 11

L. *Recognition of group 12*

After testing the image of the group number 12, the system was recognized to 8 sample out of 8, as shown in the Table 13 and Fig13.

TABLE 13: RECOGNITION OFGROUP12

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

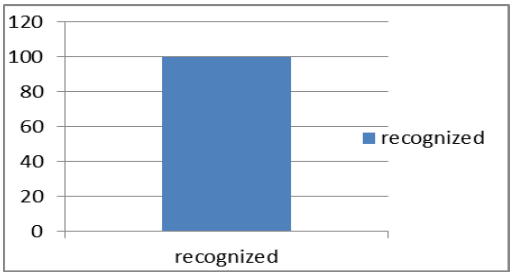

Fig 13. Recognition of group12

M. *Recognition of group 13*

After testing the image of the group number 13, the system was recognized to 8 sample out of 8, as shown in the Table 14 and Fig 14.

TABLE 14: RECOGNITION OFGROUP 13

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

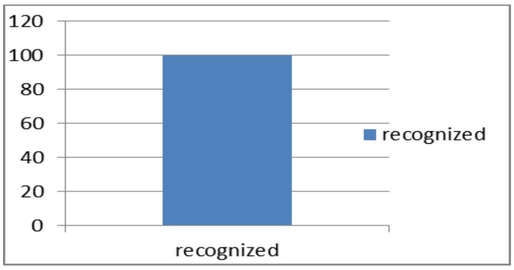

Fig 14. Recognition of group 13

N. *Recognition of group 14*

After testing the image of the group number 14, the system was recognized to 8 sample out of 8, as shown in the Table 15 and Fig 15.

TABLE 15: RECOGNITION OFGROUP 14

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

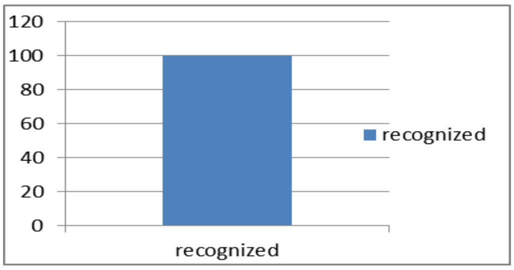

Fig 15. Recognition of group 14

O. *Recognition of group 15*

After testing the image of the group number 15, the system was recognized to 8 sample out of 8, as shown in the Table 16 and Fig 16.

TABLE 16: RECOGNITION OFGROUP 15

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

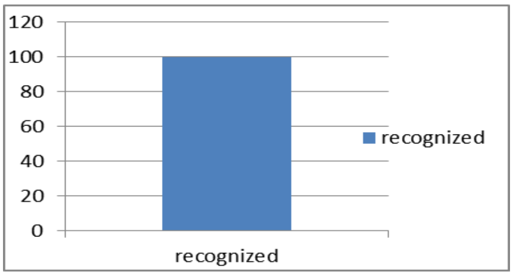

Fig 16. Recognition of group 15

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P. *Recognition of group 16*

After testing the image of the group number 16, the system was recognized to 8 sample out of 8, as shown in the Table 17 and Fig 17.

TABLE 17: RECOGNITION OFGROUP 16

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

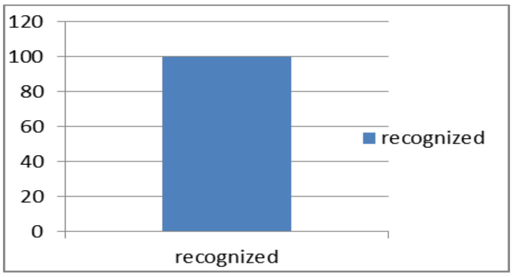

Fig 17. Recognition of group 16

Q. *Recognition of group 17*

After testing the image of the group number 17, the system was recognized to 8 sample out of 8, as shown in the Table 18 and Fig 18.

TABLE 18: RECOGNITION OFGROUP 17

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

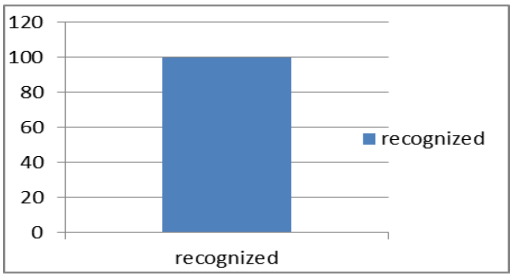

Fig 18. Recognition of group 17

R. *Recognition of group 18*

After testing the image of the group number 18, the system was recognized to 8 sample out of 8, as shown in the Table 19 and Fig 19.

TABLE 19: RECOGNITION OFGROUP 18

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

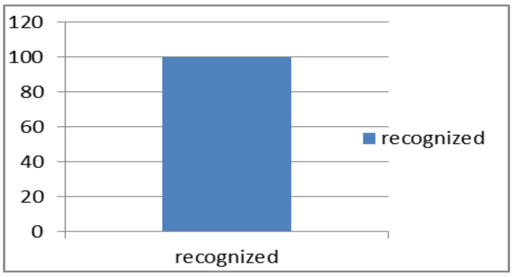

Fig 19. Recognition of group 18

S. *Recognition of group 19*

After testing the image of the group number 19, the system was recognized to 8 sample out of 8, as shown in the Table 20 and Fig 20.

TABLE 20: RECOGNITION OFGROUP 19

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

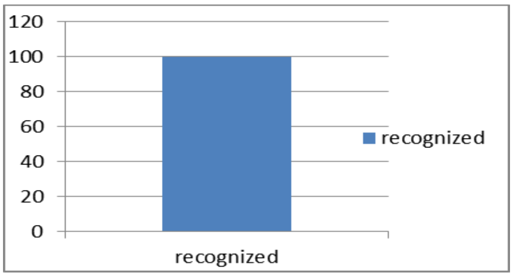

Fig 20. Recognition of group 19

T. *Recognition of group 20*

After testing the image of the group number 20, the system was recognized to 8 sample out of 8, as shown in the Table 21 and Fig 21.

TABLE 21: RECOGNITION OFGROUP 20

		Frequency	Percent	Valid Percent
Valid	Valid	8	100.0	100.0

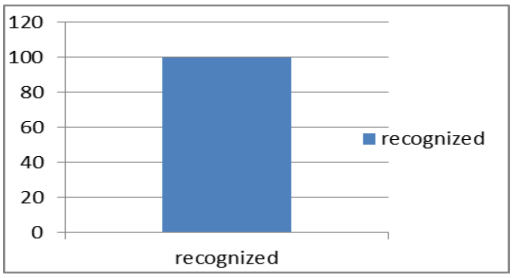

Fig 21. Recognition of group 20

U. *Recognition of all groups*

After testing the images of all groupsthe system recognized to 160 sample out of 160, as shown in the Table 22 and Fig 22.

TABLE 22: RECOGNITION OF ALL GROUPS

		Frequency	Percent	Valid Percent
Valid	Valid	160	100.0	100.0

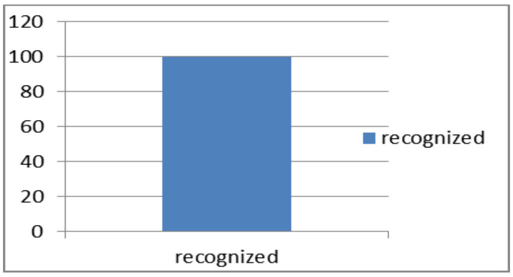

Fig 22. Recognition of all groups

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VI. CALCULATING THE FALSE ACCEPTANCE RATE AND THE FALSE REJECTION RATE

They selected 30 sample to measure the performance of recognition system through hand geometric, 15 palm image to testing the False Acceptance Rate and 15 palm image to testing False Rejection Rate, the result as shown in theTable 23.

TABLE 23: CALCULATION OF FALSE ACCEPTANCE & FALSE REJECTION RATE

No	False Acceptance	No	False Rejection
1	T	1	T
2	F	2	F
3	F	3	F
4	F	4	F
5	F	5	F
6	F	6	T
7	F	7	F
9	T	8	T
9	T	9	T
10	T	10	T
11	F	11	T
12	F	12	T
13	F	13	T
14	F	14	T
15	F	15	T

The False Acceptance Rate (FAR) = 5/15*100= 33.3%, %, the number of false acceptance is equal 5, as shown in Table 24and Fig 23.

TABLE 24. FALSE ACCEPTANCE RATE

		Frequency	Percent	Valid Percent
Valid	invalid	5	33.3	33.3
	valid	10	66.7	66.7
	Total	15	100.0	100.0

The False Rejection Rate (FAR) = FRR= 11/15*100 =73.3%, the number of false rejection is equal 11, as shown in ableand Fig 23.

TABLE 25. FALSE REJECTION RATE

		Frequency	Percent	Valid Percent
Valid	invalid	11	73.3	73.3
	valid	4	26.7	26.7
	Total	15	100.0	100.0

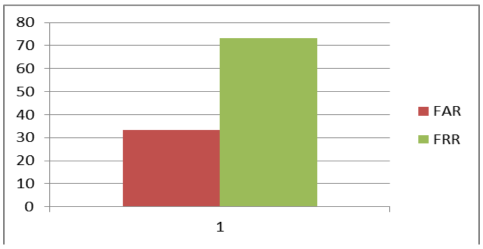

Fig 23. Result of False Acceptance & False Rejection Rate

VII. CONCULSION

The system was competence to demonstrate the efficiency of the classifying process of the persons, where they gave excellent results with a high a rate on the COEP Palm Print Database. The False Acceptance Rate (FAR) is 33.3%, and the False Rejection Rate (FRR) is 73.3%. These indicate the success of the recognition process of all persons in the database. The increasing of extracted features gives best results, with on condition that no more categories exist on the system. Increasing the number of patterns in the training phase negatively affects the system performance speed.

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