Biometric Authentication via Facial Recognition

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ABSTRACT: *Security has become a vital need throughout the globe. An underdeveloped country Pakistan wants a reliable security system to prevent from the increasing threats of terrorism. A tool of artificial intelligence-biometric authentication can be a solution for such a problem. By implementing authentication system based on facial recognition in highly crucial areas of the country, the terror attacks can be controlled notably. Supervised learning can support this methodology. In this paper we used Principal Component Analysis (PCA) as a feature descriptor and for dimension reduction, K-Nearest Neighbor (KNN) as a main classification technique for the facial identification. The results of this combination applied on MIT face database are reported. We got up to 98.66% accuracy in detection rate using this combination.*

Keywords: Biometric Authentication, Facial Recognition, Eigen Faces, Normalization, K Nearest Neighbour, Euclidean Distance, Feature Space

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1. Introduction

Crime rate in Pakistan is growing day by day. Every organization wants a secured security system to prevent from any terror damage from an unknown intruder. We suggest to use an automatic biometric authentication [1]-[2] system based on facial recognition [3]-[5] for the cure**.** In the field of pattern recognition [6]-[8] it is one of the most difficult tasks because of the challenges of illumination conditions, facial expression, head pose, aging effects and facial accessories of the subject. In this paper we selected the standardized database of MIT and applied the combination of PCA [9]-[14] and KNN [16] for face identification. In our database we preferred images with limited variations in facial expressions, pose and appearance in the training and test data set. In segment 2 of this paper a concise introduction to face recognition will be given with PCA as a feature descriptor, segment 3 explains the structure of the classifier and discusses the parameters that will affect the performance of the classifier. The experimental results are given in the segment 4 and the conclusion and references are given in the segment 6 and 8 respectively.

2. Facial Recognition and PCA

Face recognition explains the automatic method of recognition of a particular person depending upon the information such as features enclosed with in his image. We can use PCA technique for the feature extraction from the images along with the KNN for better classification. It is an automatic feature descriptor that works on the bases of calculating Eigen faces of every coming input image. As the figure 1 represents the process started from managing the MIT face database and categorizing it into known faces and unknown faces. We selected a ratio of 70% and 30% images for the distribution of train and test faces for the two individual categories respectively. The complete detail of our selected database is represented in the table (1) and (2). Digital image processing is done on the test and train faces that include gray scaling, resizing to 50x50 and normalizing the faces. After that the face images are composed in the vector form and then PCA is applied on them to calculate Eigen faces. Each Eigen face for a particular face represents specific variance value that is different from the others. PCA selects those principal components i.e. Eigen faces which are most significant for the variance value and neglects the remaining ones. Mostly the initial components show maximum variance and hence they are elected as features for the face classification. Hence PCA [15] also helps us in the reduction of dimensions to reduce complexity in facial recognition. These selected features for each individual test or train face image are then subjected to feature space and classification is made using KNN classifier.

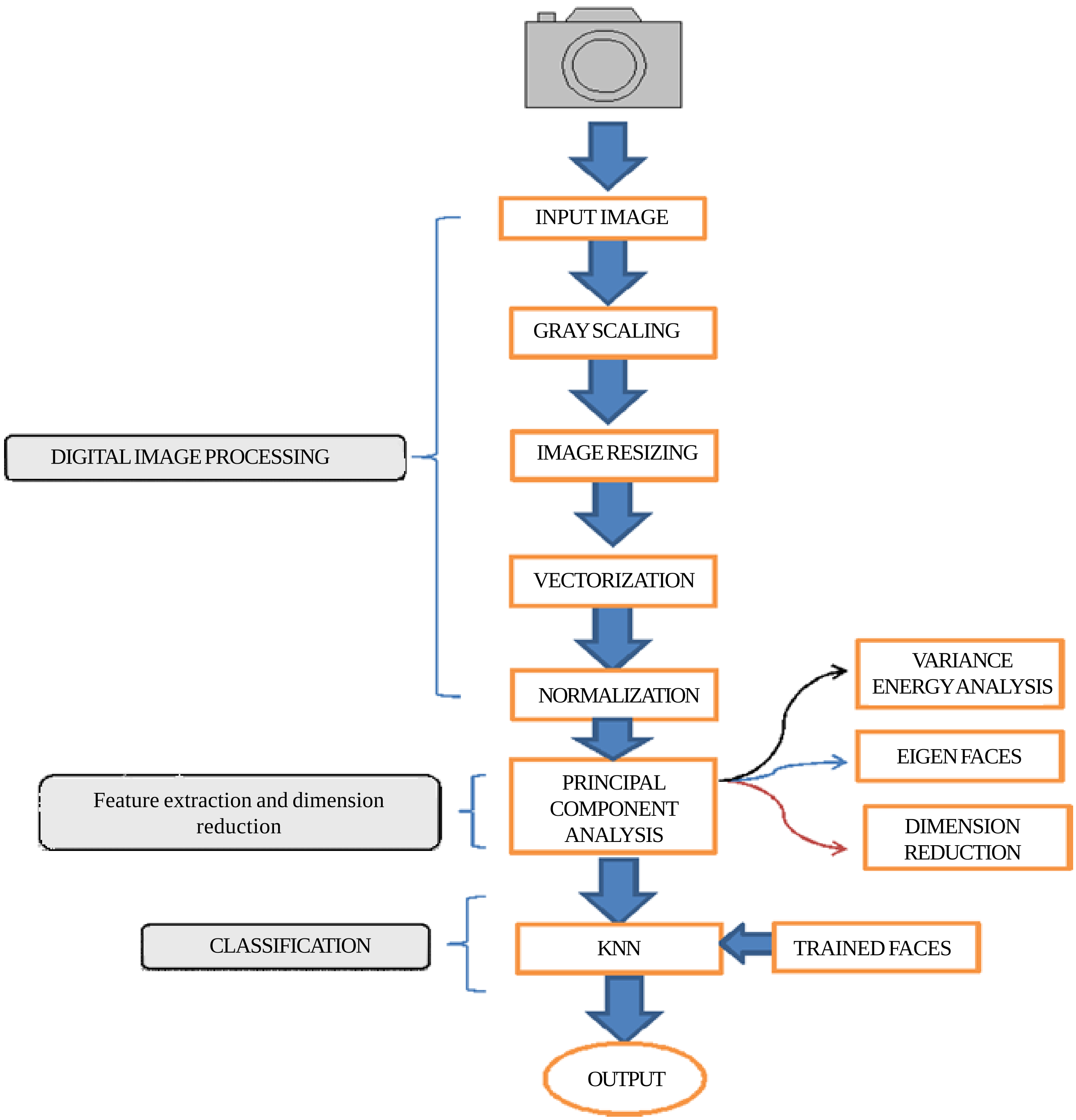

Figure 1. The Process Flow Chart

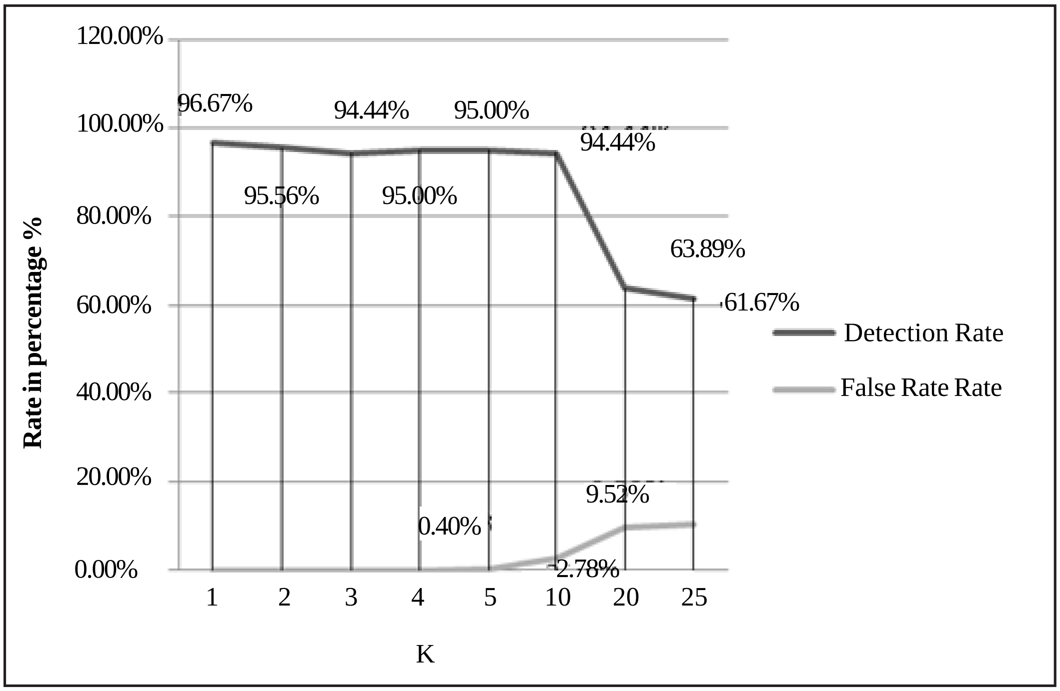

Figure 2. At 60% Energy Level

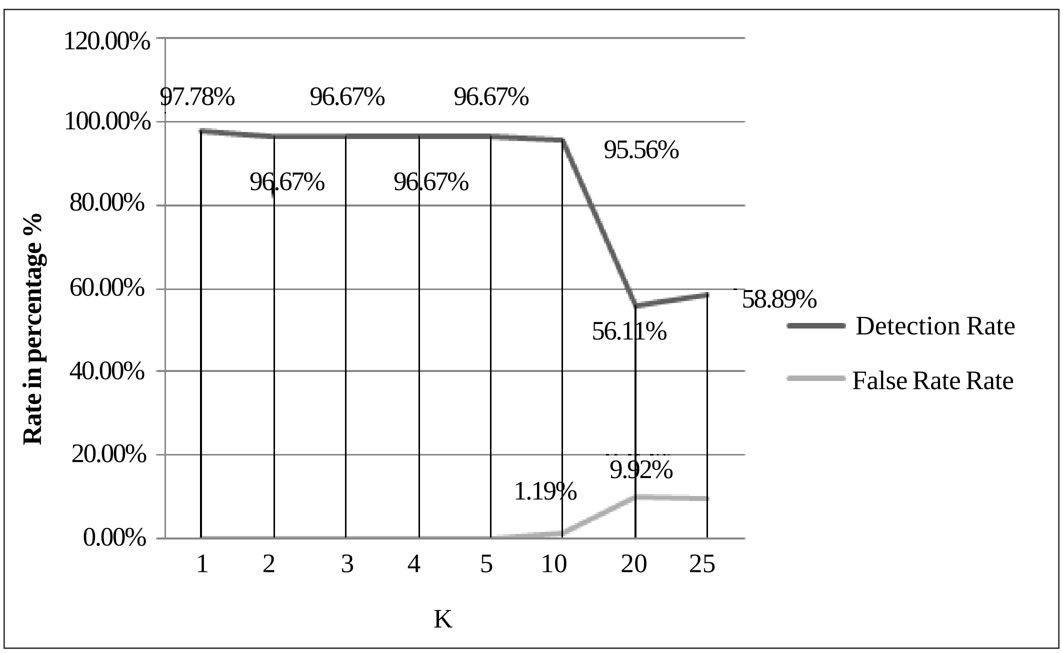

Figure 3. At 65% Energy Level

3. K Nearest Neibhour

KNN [17] is one of the basic classifier that takes decision on the bases of the voting system. It is an extension to the nearest neighbour (NN) [18]. Its decisions are considered to be non-parametric. Every Input image is analysed on the bases of the distance between the selected features from the input and that of the trained images in the database. The nearest neighbour will be that image whose distance between its features and that of the input is minimum in the feature space. Euclidean distance can be used for the measure of this distance between the features Equation (1).

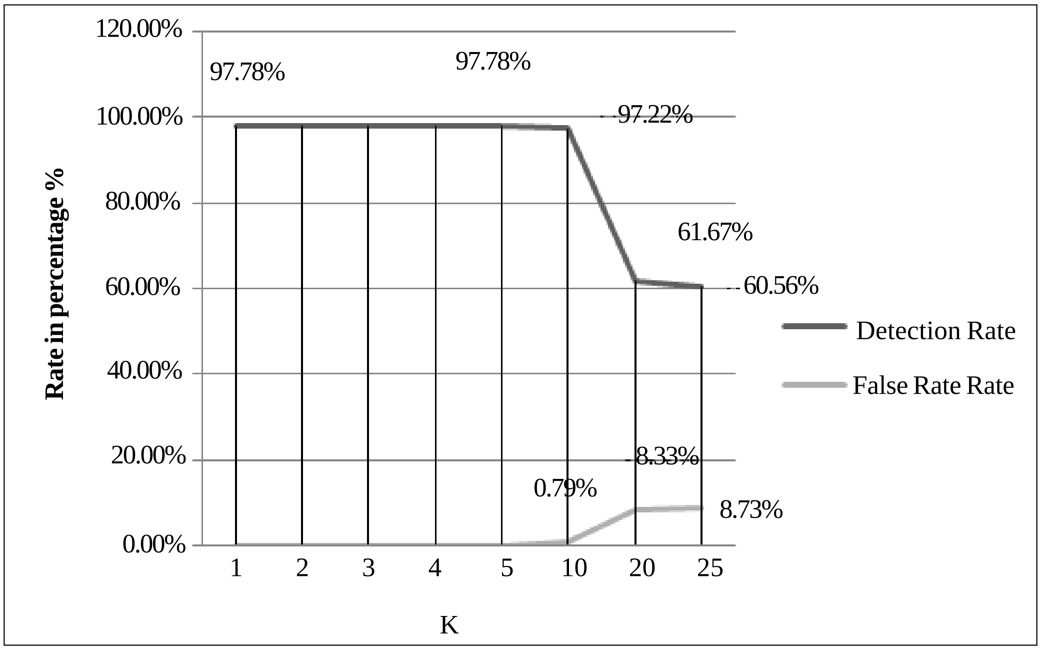

Figure 4. At 70% Energy Level

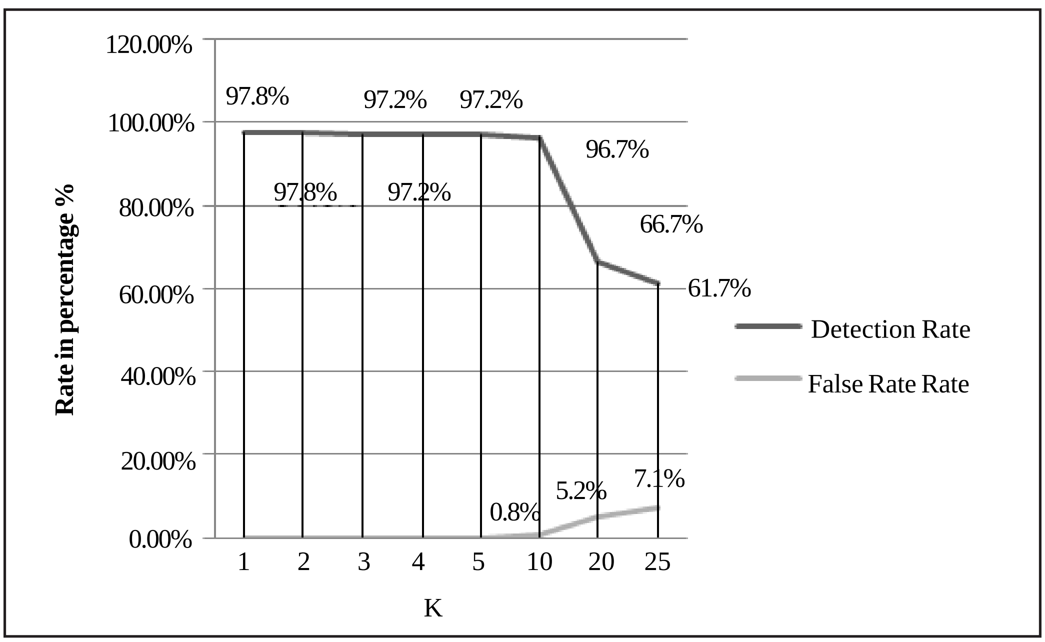

Figure 5. At 75% Energy Level

$$d(p,q) = d(q,p) = \sqrt{d(q_1 - p_1)^2 + (q_2 - p_2)^2 + \ldots + (q_n - p_n)^2} = \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2} \quad (1)$$

Faces	No. of persons	Images per person
Known	60	12 = 3 + 9
Unknown	84	12 = 3 + 9

Table 1. Face Categories

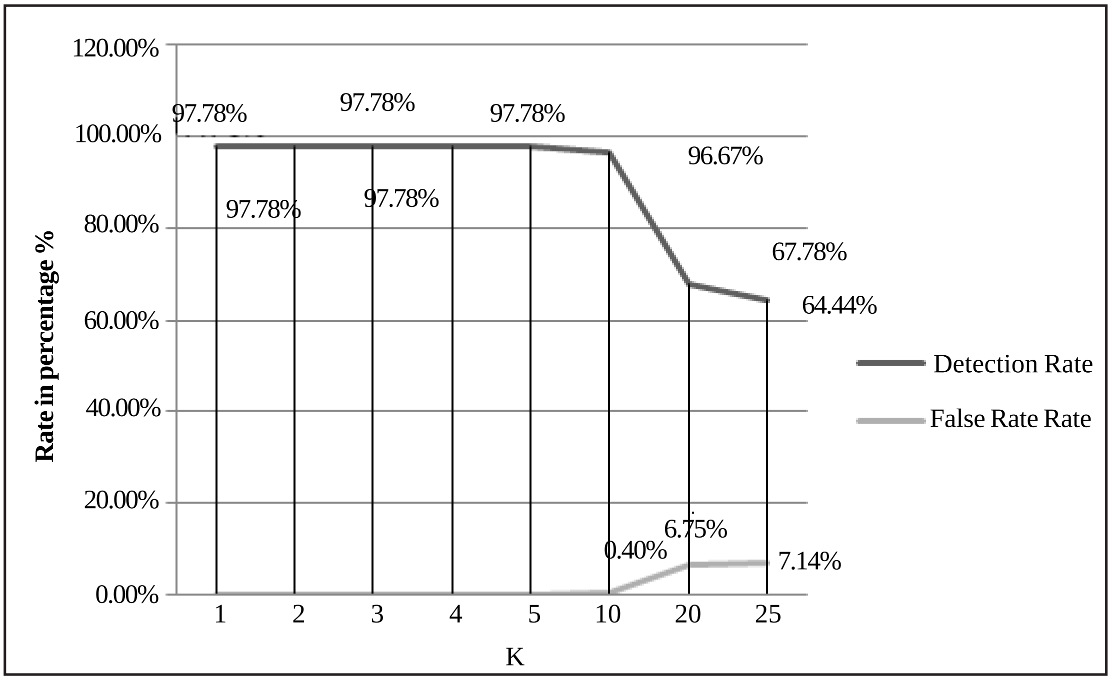

Figure 6. At 80% Energy Level

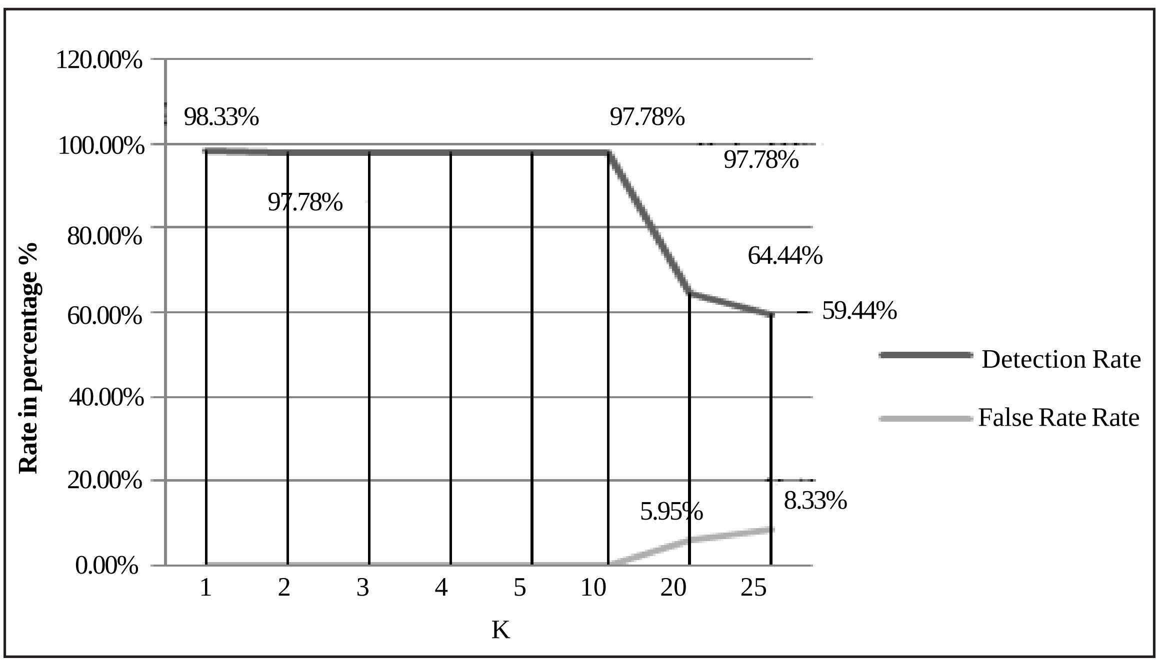

Figure 7. At 85% Energy Level

KNN uses K closest features of the input image. Each of these features belongs to a specified class. The input image is categorized to that class which has the maximum of occurrences among the K features. The performance of the KNN classifiers highly related to value of the k, the number of the training samples and their variance through the feature space.

4. Results

For the analysis of the performance of the KNN classifier combined with the PCA as feature descriptor we used a standardized

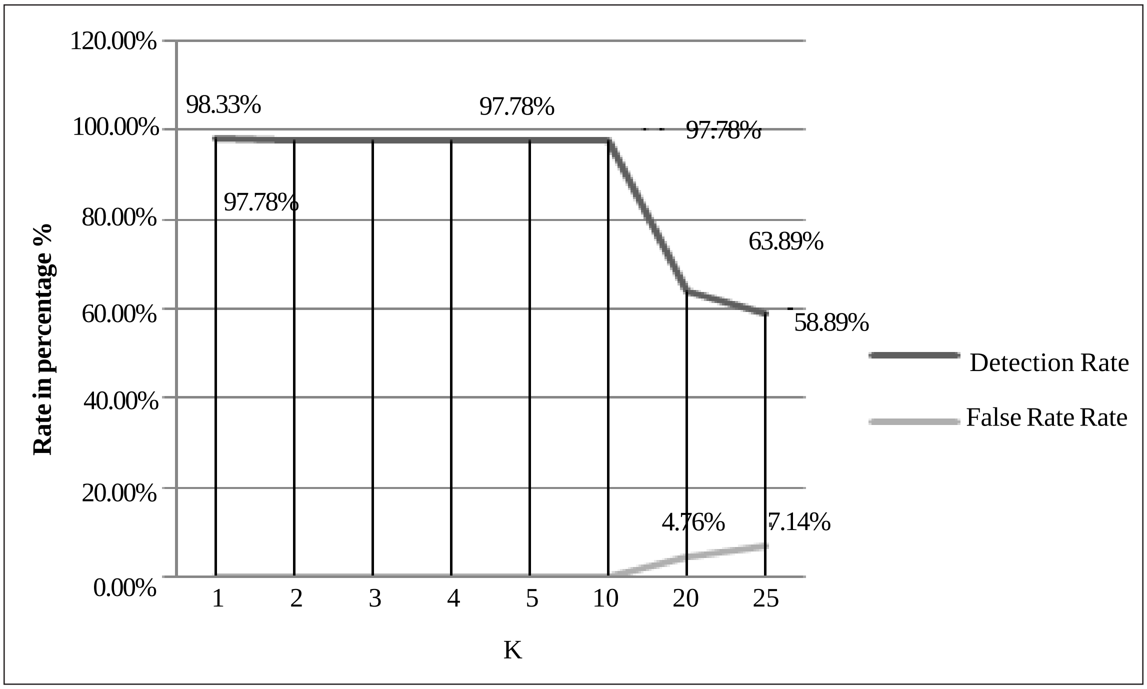

Figure 8. At 90% Energy Level

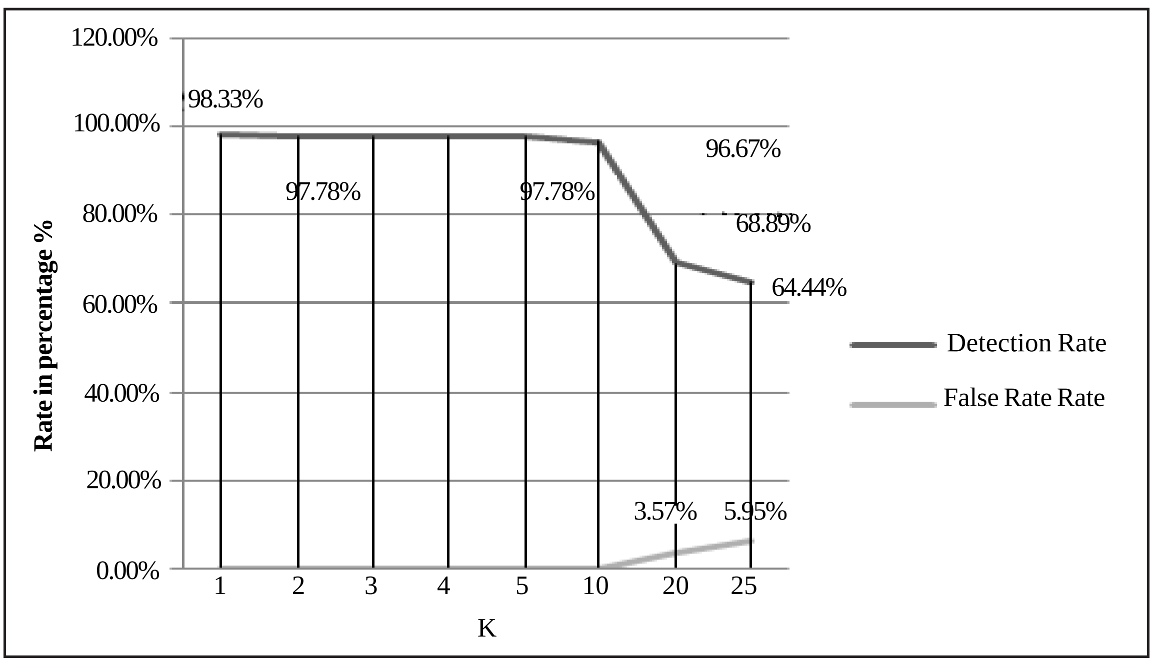

Figure 9. At 95% Energy Level

MIT database consisted of the following selections. Table (1) and Table (2).

We selected the feasible number of principal components of the images depending upon the variance energy. We performed the recognition process on different energy levels. The feasible numbers of features or components are selected for a desired energy level by using the energy level analysis. This gives the following configuration.

After applying PCA along with KNN on the above configuration of database by increasing K from 1 to 25 gradually for different

	Old database		New database		
	Known	***Unknown***	***Known***	***Unknown***	***Size***
Test	75	108	180	252	180×200
Train	209	323	540	756	180×200

Table 2. Database contents

Energy		
Percentage %	**Test**	**Train**
60	6	7
65	8	9
70	12	12
75	16	16
80	23	24
85	33	34
90	49	53
95	80	93

Table 3. Energy level analysis

energy levels ranging 60%-95% we obtained the following results.

6. Conclusion

From the above analysis we can conclude that the detection rate increases with the increase in variance energy level. Using KNN increase in Euclidian Radius K decreases the detection rate gradually with the increase in false alarm rate. The combination of PCA with KNN works efficiently with the limitations of environmental conditions. Pose variation, illumination change, facial expression and aging may cause the detection rate to reduce. Hence at the lower level we can initiate development of this form of biometric authentication system more efficiently using basic algorithms like PCA and KNN to implement it in the critical areas of Pakistan.

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