A Hybrid Face Recognition Method based on Face Feature Descriptors and Support Vector Machine Classifier

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Abstract

Face recognition is a technique used to identify/verify human identity based on their facial features. A technique allows, based on facial features to authenticate / identify a person. However, for human identification or identity authentication based on face recognition technology, the appropriate determination of the face features plays a crucial role, since the identification of the Human is given directly by the classification of these characteristics.

In this paper, we propose a new face recognition method based on face feature descriptors and Support Vector Machine (SVM) algorithm. The face feature descriptors are used to extract and select the statistical features, whereas, the SVM algorithm is employed to classify the different features and to obtain optimal Human face recognition.

The feature extraction step is the major phase of the recognition cycle. It is employed to extract the features for any human face located in the first step. The accomplishment of this step controls the success of subsequent steps. For that, the main objective of this work is to determine of the best method of feature extraction.

To do the indexation of person's face, the Histogram of Oriented Gradient features (HOG), Gabor features and Discrete Cosine Transform features (DCT) are employed to extract the feature vectors for any human face.

In addition, the face recognition method, proposed in this paper, is conceptually different and explores a new strategy. In fact, instead of considering an existing face recognition procedure, the proposed technique rather explores the benefit of combining several approaches.This method is a hybrid face recognition technique, which integrates both the results of the HOG, and the SVM technique, in which the HOG method is used as the initial seed for the classification procedure.

Experimental results from the proposed method are validated and the face recognition rate for the "ORL" and cropped "Yale B" datasets is evaluated, and then a comparative study versus existing techniques is presented. The highest face recognition rate of the used dataset is obtained by the proposed method. In addition, the use of the proposed HOG_SVM method to build face recognition systems can achieve excellent results when the dataset size is large, and therefore it can be used in different security and authentication systems.

Keywords: Face Recognition, Feature Extraction, HOG, SVM, DCT, Gabor, and Classification.

1. INTRODUCTION

The authentication is the security function which consists in providing and checking the proof of the person identity, the message sender, the software, the logical server, or the device. Different

identification methods have been proposed for exchanging safety-related information (Mohamed et al., 2013) (Alamriet al., 2021). The biometric is classified as the most relevant technology to identify and authenticate person, based on unique biological characteristics reliably and rapidly.

The biometric technologies are based on how everyone can be uniquely identified through one or more biological characteristics, such as fingerprint, hand morphology, retina and iris or signatures. In addition, Biometric authentication is the application of these biometric technologies to identify a person as part of a user validation process to access a system.

Face recognition is the process of automatically identifying the human face from database images (Anagha et al., 2013), (Manoj et al., 2015). Recently, the development of biometric applications, such as face recognition, Fingerprint recognition, iris recognition (Gupta et al., 2018) etc., becomes very important in smart cities, where scientists have increasingly worked to find robust and accurate algorithms for these systems (Manoj et al., 2015).

Face recognition is one of the most important systems currently used in personal identification, verification and security applications (Wanxin et al., 2019). In addition, it is used in identification of criminals, verification of credit cards (Kortli et al., 2020) etc.

Many of the previous research in face recognition systems focused on discovering individual features such as the eye, nose, mouth, and outline of the head, in addition to that, defining the face model by location, size, and relationships between these features (Srivastava et al., 2017), (Wanxin et al., 2019).

There are many challenges facing the face recognition process, the most important one is the ability to calculate all possible differences in appearance due to changes in illumination, occlusions, facial features (Anagha et al., 2013) (Lenc et al., 2015), etc.

There are many techniques that are widely used to extract facial features (Shaukat et al., 2015), the most important one are HOG (Manoj et al., 2015) (Li et al., 2018), independent component analysis (ICA) (Manoj et al., 2015), Haar wavelets (Manoj et al., 2015), scale-invariant feature transform (SIFT) (Manoj et al., 2015) (Li et al., 2018),(Slim et al., 2022), Eigen face (Manoj et al., 2015) (Jalaja et al., 2022), Gabor filter (Manoj et al., 2015), local phase quantization (LPQ) (Manoj et al., 2015), Fourier transforms (Manoj et al., 2015), linear discriminant analysis (LDA) (Manoj et al., 2015) and local binary pattern (LBP) (Manoj et al., 2015),(Pooja et al., 2015).

Different kinds of classifier systems are used to recognize the identity of human in the human face image, most notably support vector machine (SVM), Hidden Markov Model (HMM), nearest neighbor classifier (NNC), neural networks (Coşkun et al., 2017), and Bayesian classifier (Pooja et al., 2015). Deep Neural Networks (DNNs) is the state-of-the-art face recognition system, which generally outperforms other methods due to its great ability to learn (Pradip et al., 2018).

In this context, (Gupta et al., 2018) have used the Eigen faces method for facial recognition. In their recognition process, challenging details like background, eyes, beard, mustache and glasses were taken into account. Firstly, the Eigen faces for the specified face image are calculated, and then the Euclidean distances between the Eigen faces and the previously stored Eigen faces are determined. Finally, the Eigen face with the smallest distance that most closely resembles the desired person is selected (Al-Amin., 2016).

With the same objective, (Slim et al., 2022) have presented a face recognition system using support vector machine. TheYale dataset is used to evaluate the proposed recognition system, 50% of images are used in the training process and 50% are used in the test process. Each image is resized to (25x25) pixels, which is equivalent to 256 features used as input to the SVM algorithm.

The results showed that the recognition system using support vector machine (SVM) outperforms the system that used the principle component analysis (PCA). In addition, this system was faster than PCA method because not applied any prepossessed techniques on the images.

(Manoj et al., 2015), have proposed a face recognition system based on the principle component analysis (PCA) as feature extractor and the support vector machine (SVM) as classifier algorithm(Pradip et al., 2018). They used ORL face database, which consists of 400 pictures of 40 persons, which contains a very high degree of contrast in the expression, composition, and facial details. The authors have provided a comparison among three different kinds of SVM system, which are Linear (LSVM), Polynomial (PSVM), and Radial Basis Function (RBFSVM). The experimental results showed that Polynomial and Radial Basis Function (RBF) SVMs overcomes Linear SVM on the ORL Face Dataset. In addition, the results prove that SVMs outperforms Eigen face approach using Multi-Layer Perceptron (MLP) Classification method.

Anagha et al., (2013), have presented a Feed Forward Neural Network (FFNN) algorithm for facial recognition. The authors utilized the Principal Component Analysis (PCA) to reduce the image dimensionality and the Neural Network as classifier algorithm. They used 200 facial images from Yale dataset to evaluate the proposed recognition system. The results showed that the proposed system is fast and the acceptance ratio of the system was more than 90%.

(Wanxin et al., 2019) have presented a hybrid recognition system using a convolutional neural network (CNN) and a Logistic regression classifier (LRC). The CNN is used to detect and recognize facial images, and the LRC is used to distinguish features learned by CNN. Moreover, the back propagation gradient descent algorithm is used to train CNN.

Experimental results of the proposed method on the Yale database showed that use the CNN as a feature extraction method, allows normalizing the data and allows the system to overcome topics such as pose and lighting variations. In addition, the results showed that using a simple logistic regression method as a classifier overcame other machine learning algorithms with the highest classification precision and the lowest classification time.

(Garg et al., 2019) have presented an analysis of the performance of different facial recognition techniques. Linear Binary Pattern (LBP), Gabor Wavelet, Oriented Gradient Histogram (HOG) techniques were used for feature extraction and principal component analysis (PCA) is used for selection of characteristics and to match the similarity to the images. The similarity measurement is based on different distance measurements functions such as Cosine, Euclidean, Correlation, City block, Spearman and Minkowski. However, the experimental results showed that utilizing Gabor with PCA gives better accuracy results than LBP and HOG on both databases.

In another study, (Kamal et al., 2020), have proposed a quantum face authentication method. The proposed method phases are detection face boundaries, image resizing, remove noisy, feature extraction, matching and decision. Their proposed method uses QFWT (Quantum Fast Wavelet Transform) and QFT (Quantum Fourier Transform) in extraction phase. In addition, (Kamal et al., 2017)have proposed facial emotions recognition system based on Deep Belief Networks and Quantum Particle Swarm Optimization. Firstly, the input image is preprocessed by cropping the Region of Interest (ROI) in order to get the desired region and discard non-significant parts. Secondly, the ROI is divided into many blocks and then the integral image is utilized to determine the superior (most efficient) blocks. Thirdly, the image down sampling algorithm is adapted to reduce the size of the new sub image in order to improve the system performance. Finally, the emotion's class is identified using the DBN.

Since there is a different type of information that can be extracted from a human face. However, instead of using the Discrete cosine transform (DCT) and scale invariant feature transform (SIFT) as features extractors (Kamel et al., 2019), we apply several methods for feature extraction which are Gabor feature, Discrete cosine transform (DCT), and Histogram of Oriented Gradient (HOG).

In this paper, we present an analysis of human face image recognition systems based on Face Feature Descriptors and SVM Classifier. The Histogram of Oriented Gradient features (HOG), Gabor features and Discrete Cosine Transform features (DCT) are employed to extract the feature vectors of the human faces. Once the characteristics the human faces are determined, the SVM algorithm is applied to merge and classify the different features in order to increase the quality of the information and to obtain optimal Human face recognition.

Section 2 introduces the proposed face recognition method. The experimental results are discussed in Section 3, and the conclusion is given in Section 4.

2. THE PROPOSED METHOD

Face recognition is a method of identifying or verifying the identity of an individual using their face. Face recognition systems can be used to identify people in photos, video, or in real-time. Face recognition has become more significant and relevant in recent years owing to it potential applications.

Since the faces are highly dynamic and pose more issues and challenges to solve, many approaches have been proposed by researchers in the domain of pattern recognition, computer vision and artificial intelligence to reduce such difficulties so as to improve the robustness and recognition accuracy.

Basically, there are three major approaches in automatic recognition of faces by computer: global feature approach (face-based recognition), local feature approach (constituent-based recognition), and hybrid approaches.

In this work, we are interested to identity a person using their face. The proposed system includes major components such as feature extraction, and face recognition. In this context, face recognition using optimal Face Feature Descriptors and Support Vector Machine Classifier appears to be an interesting method.

However, the proposed method is a hybrid face recognition technique, which integrates both the results of Face Feature Descriptors and the SVM technique, in which the features extracted from the face images are used as the initial seed for the classification procedures. Meaningfully, the proposed method is divided into two stages. At the first stage, the characteristics of the human are extracted from each original image to construct feature vectors, and then, in the second stage, the SVM technique is then used to obtain the face recognition results. The main components of the proposed face recognition system are illustrated in the Diagram shown in Figure 1.

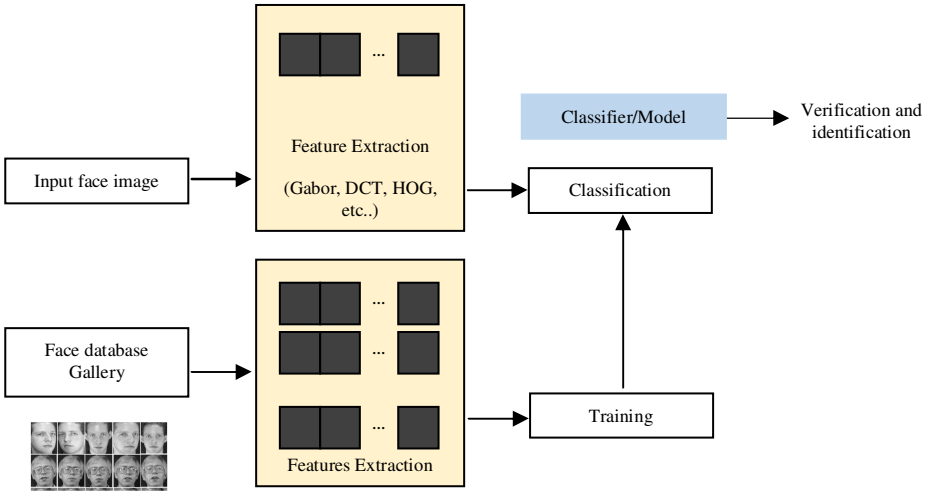


FIGURE 1: The Diagram of the Proposed Method.

2.1 Feature Extraction

Encoding or feature extraction consists in extracting from the face the most discriminating and relevant characteristics, necessary and useful for its identification. To do this, the Face Feature Descriptors such as Histogram of Oriented Gradients (HOG), Gabor Wavelet and Discrete Cosine Transform (DCT) are applied to the input face images. The process of face encoding therefore consists of representing the signature of the face.

a. Histogram of Oriented Gradients (HOG)

The Histogram of Oriented Gradients (HOG) is a feature-based descriptor that used in image processing mainly for detecting objects; it is solid and has no sensitivity against light or geometric changes (Li et al., 2018).

HOG descriptors describe the appearance and shape of the face in an image. The implementation of these descriptors can be achieved by dividing the image into small, connected regions called cells, and for the pixels within each cell, a histogram of gradient directions or edge orientations is calculated. Consequently, the combination of these histograms represents the characteristics vector. Algorithm 1 shows the feature extraction technique using the Histogram of Oriented Gradients.

Algorithm 1: Feature Extraction using HOG Algorithm.

1. Calculate Gradient and Magnitude direction using:

$$G = \sqrt{g_x^2 + g_y^2} \quad (1)$$

$$\theta = \arctan\frac{g_y}{g_x} \quad (2)$$

2. Bin and form histogram on the basis of gradient direction.
3. Normalize gradient magnitude in the cell.

The determination of the gradient is a critical step in the formation of descriptors. The correctness of the orientations, and the histograms, depends on this step and the results are therefore closely related to the method used to calculate the gradient in the image. The fast calculation of the gradient can be done by simple derivation masks $1D$ center $[1\ 0, 1]$ and not centred $[-1, 1]$), by $2D$ operators of Sobel, or even by recursive operators of Deriche.

In the proposed method, we use the Sobel algorithm. This is one of the simplest operators, which uses convolution matrices. The (3×3) size matrix is convoluted with the original image to calculate the horizontal and vertical approximations.

However, the horizontal and vertical approximations of an image I denoted respectively by G_x and G_y are calculated as follows:

$$G_x = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} * I \quad (3)$$

$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * I \quad (4)$$

b. Gabor Feature

Gabor filter (Nazari et al., 2013) is one of the most established image descriptors introduced by Gabor in 1946. It is applied to extract features by analyzing the frequency domain of the image. Gabor filter is basically a Gaussian function modulated by complex sinusoidal of frequency and orientation. It is used to extract the face features by analyzing the frequency domain of the image using different frequencies and orientations.

The 2-D Gabor filter consists of a Gaussian function modulated by complex sinusoidal of frequency and orientation. It is computed by:

$$G(x,y) \equiv e^{-\frac{(x-x_0)^2}{2\sigma_x^2}-\frac{(y-y_0)^2}{2\sigma_y^2}} e^{j(\omega_{x0}x+\omega_{y0}y)} \quad (5)$$

where:
ω_{x0}, ω_{y0}: represent respectively the center frequency of x and y directions which is the frequency in which the filter produces the greatest response.

σ_x, σ_y: represent respectively the standard deviation of the Gaussian function along x and y directions. x, y is the pixel position of the image.

Several parameters of the Gabor filters are defined in our experiment. The number of all orientations, $L = 8$ orientations are applied for the Gabor filter. Then, the orientation bandwidth is calculated as, $\Delta\theta = \frac{360}{8} = 45^\circ = 0.7857$ rad. Thus, the orientation, θ used in this experiment are $0^\circ, 45^\circ, 90^\circ$ and 135°.

The center of the frequency i can be computed as follow:

$$\rho_i = \frac{w_i + w_{i-1}}{2} \quad (6)$$

In our experiment, 16 Gabor filters are used to determine the features of the face images.

c. Discrete Cosine Transform (DCT)

DCT is considered the most used transform in the image processing applications as feature extractor. The approach mainly consists of performing the transformation of the whole image, then splitting the relevant coefficients. DCT represents energy compaction; the frequency components of the DCT of an image include some detail and information. These components mainly are three: low, middle and high. Generally, the average intensity of an image is included in the low frequency.

The 2-D DCT is a direct extension of the 1-D case. Consequently, the 2-D basis functions can be generated by multiplying the horizontally oriented 1-D basis functions with vertically oriented set of the same functions. The 2-D function is given for $u, v = 0,1,2,\dots,N-1$by:

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right] \quad (7)$$

Where $\alpha(u)$ and $\alpha(v)$ are defined respectively by:

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}} & \text{for } u = 0 \\ \sqrt{\frac{2}{N}} & \text{for } u \neq 0 \end{cases} \quad (8)$$

$$\alpha(v) = \begin{cases} \sqrt{\frac{1}{N}} & \text{for } v = 0 \\ \sqrt{\frac{2}{N}} & \text{for } v \neq 0 \end{cases} \quad (9)$$

The inverse transform is defined for $x, y = 0,1,2, \dots, N-1$ as:

$$f(x,y) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u,v)\cos\left[\frac{\pi(2x+1)u}{2N}\right]\cos\left[\frac{\pi(2y+1)v}{2N}\right] \quad (10)$$

2.2 Classification using Support Vector Machines (SVM)

Support Vector Machines considers as a supervised learning algorithm that depends in defining decision boundaries on the concept of decision planes(Lahaw et al., 2018). SVM separate data of different classes as a hyperplane maximizing the margin of separation and minimum classification error. The general idea for nonlinear classifiers is mapping the input data to a high dimensional space and separating it by a linear Classifier.

According to the characteristics extracted previously, a similarity measure must be introduced in order to estimate the difference between two faces. Several methods are used for comparing faces. We find in the literature: distance calculation, calculation of similarity. Other methods are based on the classification of the characteristics by using a single classifier such as SVM, Bayesian classifier, etc.

The input to a SVM algorithm is a set $\{(f_i, y_i)\}$ of labeled training data, where Ji is the feature vectors and $y_i = -1$ or 1 is the label. The output of a SVM algorithm is a set of M support vectors s_i, coefficient weights α_i, class labels y_i of the support vectors, and a constant term b. The linear decision surface is:

$$wz + b = 0 \quad (11)$$

Where:

$$w = \sum_{i=1}^{M} \alpha_i y_i s_i \quad (12)$$

SVM can be extended to nonlinear decision surfaces by using a kernel $K(.,.)$ that satisfies Mercer's condition [18]. The nonlinear decision surface is

$$sum\sum_{i=1}^{M} \alpha_i y_i K(s_i, z) + b = 0 \quad (13)$$

So, the steps of the proposed face recognition technique using SVM algorithm combined with the Histogram of Oriented Gradients (HOG) are presented in Algorithm 2. In addition, the pseudocode of the proposed method is presented in Figure 2.

Algorithm 2. THE PROPOSED FACE RECOGNITION TECHNIQUE.

1. Input: Face image
2. Output: Face recognition
3. Step 1: The Face database is created. The size of face image is 92 × 112
4. Step 2: The HOG algorithm is applied on preprocessed image to generate the features of each human face image.
5. Step 3: The PCA is used to select the features based on relevance and redundancy characteristics.
6. Step 5: The features of test image are compared with features of database images using SVM technique

```
Load database

Start
Read the training images
  A=loaded Image (:240)
Apply the HOG Algorithm

Choose randomly the test image
  Random_Image=loaded_Image(:,random_Index)
Compute the feature vector
Apply the SVM classifier
End
```

FIGURE 2: The pseudo code of the proposed method.

3. EXPERIMENTAL RESULTS

In this section, several simulation results on the face recognition, which illustrate the ideas presented in the previous section, are given. The images originally are stored in gray level format, take 8 bits and has the intensity range from 0 to 255. The ORL and Yale-B cropped face databases are considered for performance analysis. In fact, to evaluate the efficiency and accuracy of the proposed face recognition method, the results are compared versus existing methods, as described earlier. The efficiency evaluations for these different methods are carried out on the Matlab software.

In this study, standard ORL images (10 poses for each of 40 people) were converted into JPEG image format without changing their size and Yale-B cropped database are used for performance analysis. Five individuals with ten images for each person of the ORL face images are showed in Figure 3.Concerning the Yale-B Cropped Face Database, it contains images for 38 persons having 65 unique images for each one, total images in database are 2470 images. The images were taken mainly under varying lighting conditions (dark lighting conditions, bright lighting conditions, medium lighting conditions). Sample of images from Yale-B Cropped database is shown in the Figure 4.

FIGURE 3: Samples of ORL database.

FIGURE 4: Samples of Yale-B cropped database.

To evaluate our method, the performance of face recognition system based on classifier (SVM) and different feature extraction methods (HOG, Gabor and DCT) with different poses dataset and variations in illumination dataset was evaluated. The outcomes of face recognition systems are presented. For overall analysis performed in this research, 80% of dataset is used for training phase and 20% is used for testing. So, we have adopted the inductive reasoning to analyse the data and to draw out conclusions.

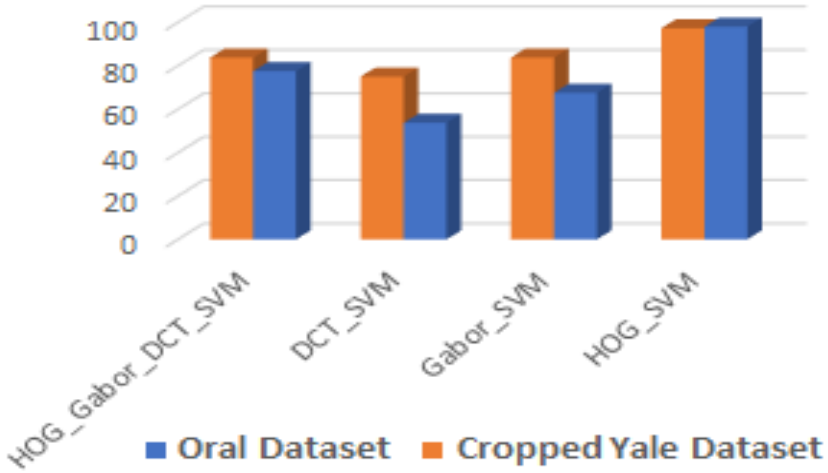


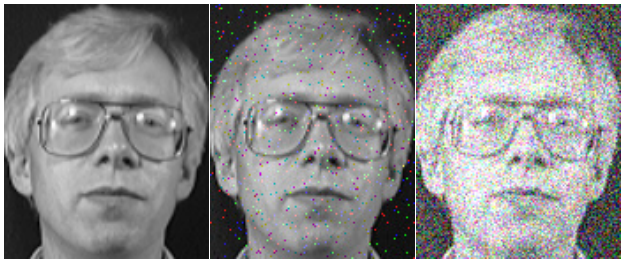
FIGURE 5: Accuracy of the proposed recognition Models for Oral and Cropped Yale B Datasets.

TABLE I: Accuracy of the proposed methods.

Model	Classifier	Input feature	Accuracy (%)	
			Oral Dataset	Cropped Yale dataset
HOG_SVM	SVM	HOG Features	98	97.3
Gabor_SVM	SVM	Gabor Features	67.5	83.8
DCT_SVM	SVM	DCT Features	53.7	75
HOG_Gabor_DCT_SVM	SVM	(HOG, Gabor, DCT) Features	77.5	83.4

In this section, we explore the results of our proposed models based on the oral dataset and cropped Yale B dataset. Firstly, we present the results obtained by the proposed face recognition method on the oral and cropped Yale B dataset.

Figure 5 shows a comparison of the results between the proposed face recognition methods HOG_SVM, Gabor_SVM, DCT_SVM and HOG_Gabor_DCT_SVM. It can be seen from Table 1, that 98% of accuracy were obtained by the proposed HOG_SVM model using Oral dataset. In addition, the DCT_SVM method has achieved the worst accuracy for the ORL and Yale-B Cropped database dataset.



(a) (b) (c)

FIGURE 6: (a) Original image with gray level, (b) Original image disturbed with a “salt and pepper” noise, (c) Original image disturbed with a “Gaussian” noise.

TABLE 2: Comparison between our proposed methods versus existing methods in term of accuracy (%).

Methods	Accuracy (%)			
	Oral Dataset (with presence of a "salt and pepper noise ")	Cropped Yale B dataset (with presence of a "Gaussian noise")	Oral Dataset	Cropped Yale B dataset
HOG_SVM	93	88	98	97.3
Gabor_SVM	61.3	74.85	67.5	83.8
DCT_SVM	44.28	62.77	53.7	75
HOG_Gabor_DCT_SVM	66.42	75.14	77.5	83.4
Gabor_PCA_City block (Garg. Mittal & Umar, 2019)	84	72	97	84.6
VGG_Face model (Wani, Bhat Afzal & Kan, 2020)	82.5	81	99	85.3

The accuracy results of oral dataset and cropped Yale B dataset are presented in Figure 5. As shown in Fig. 5, the HOG_SVM model can achieved 98% accuracy. This suggests that a good classification can be taken using HOG features with SVM without significant loss of performance. Figure 4 shows an ORL sample image with Salt and pepper and Gaussian noise. Figure 6(b) represents the original image I where a Salt and pepper noise of D density was added. This affects approximately (D×(n×m)) pixels. The value of D is 0.02. Figure 6(c) represents the original image I where a Gaussian white noise of mean M and variance V was added. The values of M and V are 0.2 and 0.03, respectively.

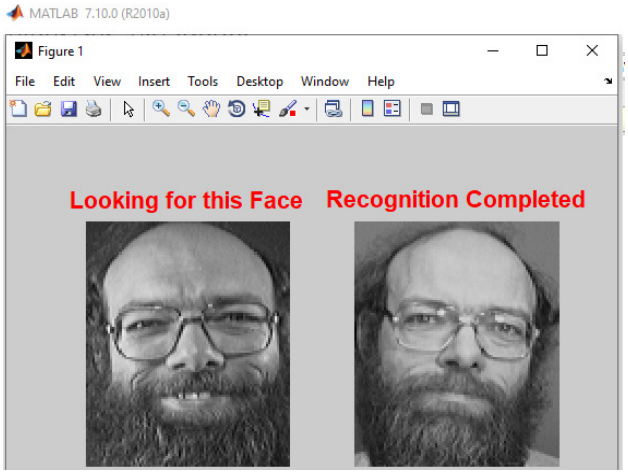


FIGURE 7: Example of Face recognition result.

TABLE 3: The Execution time of applied technique according to the number of training images.

The proposed method	Number of training images/(number of test images)
	320/80
Execution time [s]	74

Table 2 summarizes the accuracy for our method compared to other published methods in literature. As shown in Table 2, our system achieves close accuracy using HOG_SVM model for ORL dataset compared with the system proposed in(Wani et al., 2020). In addition, our system outperformed systems proposed in (Garg et al., 2019) and (Wani et al., 2020) when using CNN model for cropped Yale B dataset.

As seen on Table 2, the proposed method still gets the best performance on the ORL dataset, even in the presence of a noise (without the filtering step) is recorded. Figure 7 shows an example of face recognition result obtained by the proposed method.

However, the proposed method requires a lot of computation time (see Table 3), due to the large number of iterations and the number of operations (multiplications, addition and exponent) that are necessary for the computation of the feature vectors, the training step and also for the classification based on the SVM classifier. In addition, the implementation time for the proposed method is long, due to the number of images per individual in the training step.

4. CONCLUSION

The face recognition system is a technique that is designed to verify the identity of a person due to the increasing number of applications that need security identity verification such as smart card, security, image database investigation, etc.

In this paper, we address the importance of applying the system of face recognition on different kind of datasets. We also demonstrate the relevance of our findings by performing several supervised classification experiments using the supporting vector machine (SVM) with different feature methods. Different systems are tested using two standard dataset ORL and Cropped Yale B. Three different technique HOG, Gabor and DCT are applied for extracting features and the SVM classifier is used for face recognition. In fact, the novelty of this work is to improve the face recognition cycle. The feature extraction step is the major phase of the recognition cycle. It is employed to extract the features for any human face located in the first step. The accomplishment of this step controls the success of subsequent steps. For that, the main objective of this work is to determine of the best method of feature extraction.

In addition, the face recognition method, proposed in this paper, is conceptually different and explores a new strategy. In fact, instead of considering an existing face recognition procedure, the proposed technique rather explores the benefit of combining several approaches.This method is a hybrid face recognition technique, which integrates both the results of the HOG, and the SVM technique, in which the HOG method is used as the initial seed for the classification procedure.

The experimental results demonstrates that the proposed face recognition model based on HOG and SVM gives the best accuracy results compared with other existing methods. The proposed method can be useful for face recognition.In addition, this idea will be applied in the airport. The objective is to identify the human iris and linking the data together by using artificial intelligence system to identify the flight number, the dedicated gate, the seat number on the plane, departure and arrival time, the weight of the travel bag and how many kilos is reserved, and the vaccination doses.

5. ACKNOWLEDGMENT

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6. REFERENCES

ALAMRI J., R. HARRABI, S.BEN CHAABANE. (2021). Face Recognition based on Convolution Neural Network and Scale Invariant Feature Transform. (IJACSA) International Journal of Advanced Computer Science and Applications,12(2), 644-654.http://Face Recognition based on Convolution Neural Network and Scale Invariant Feature Transform (thesai.org)

Anagha A. Shinde, Sachin D. Ruikar. (2013). Face Recognition using PCA and Eigen Face Approach. International Journal of Computer Applications (0975 – 8887) International Conference on Recent Trends in engineering & Technology, 7-12. http:// Face Recognition using PCA and Eigen Face Approach (ijcaonline.org).

Coşkun, M., Uçar, A., Yildirim, Ö., & Demir, Y. (2017, November). Face recognition based on convolutional neural network. IEEE: International Conference on Modern Electrical and Energy Systems (MEES), 376-379. http:// Face recognition based on convolutional neural network | IEEE Conference Publication | IEEE Xplore.

Garg, S., Mittal, S., & Kumar, P. (2019). Performance Analysis of Face Recognition Techniques for Feature Extraction. Journal of Computational and Theoretical Nanoscience, 16(9), 3830-3834. http:// Performance Analysis of Face Recognition Techniques for Feature E...: Ingenta Connect.

Gupta, P. (2018). Deep Neural Network for Human Face Recognition. International Journal of Engineering and Manufacturing (IJEM), 8(1), 63-71. http:// International Journal of Engineering and Manufacturing (IJEM) (mecs-press.org).

Kamal A. Abdelraouf El Dahshan, Eman K. Elsayed, Ashraf Aboshosha and Ebeid Ali Ebeid. (2019). Feature selection for face authentication systems: Feature Space Reductionism and QPSO, Int. J. Biometrics, 11(4), 328--341. http:// Inderscience Publishers - linking academia, business and industry through research.

Kamal A. El Dahshan, Eman K. Elsayed, Ashraf Aboshoha, Ebeid A. Ebeid, (2020). Recognition of Facial Emotions relying on Deep Belief Networks and Quantum Particle Swarm Optimization. IJIES (International Journal of Intelligent Engineering and Systems), 13(4),90-101. http:// 2020083109.pdf (inass.org).

Kamal A. ElDahshan, Eman K. Elsayed, Ashraf Aboshoha, Ebeid A.Ebeid. AP.(2017). APLYING QUANTUM ALGORITHMS FOR ENHANCING FACE AUTHENTICAION. Al Azhar Bulletin of Science, 9, 83-93. http:// (PDF) APPLYING QUANTUM ALGORITHMS FOR ENHANCING FACE AUTHENTICAION (researchgate.net).

Kortli Y., Jridi M. Falou A.A. and M Atri. 2020. Face Recognition Systems: A Survey. Sensors MDPI, 20(2), 342–362. http:// (PDF) Face Recognition Systems: A Survey (researchgate.net).

Pooja Rani. (2015). Face Recognition using Feed Forward Neural Network. IOSR Journal of Computer Engineering (IOSR-JCE), 17(5), 61-65. http:// J017526165.pdf (iosrjournals.org).

Lahaw, Z. B., Essaidani, D., &Seddik, H. (2018, July). Robust Face Recognition Approaches Using PCA, ICA, LDA Based on DWT, and SVM Algorithms. IEEE: 2018 41st International Conference on Telecommunications and Signal Processing (TSP), 1-5. http:// Robust Face Recognition Approaches Using PCA, ICA, LDA Based on DWT, and SVM Algorithms | IEEE Conference Publication | IEEE Xplore.

Lenc, L. and P. Král (2015). Automatic face recognition system based on the SIFT features. Computers & Electrical Engineering , 46, 256-272. http:// Automatic face recognition system based on the SIFT features - ScienceDirect.

Li, Xiang-Yu and Zhen-Xian Lin (2018). Face recognition based on HOG and fast PCA algorithm. Springer International Publishing, pp. 10–21. http:// Face Recognition Based on HOG and Fast PCA Algorithm | springerprofessional.de.

MANOJ, V., K SWATHI. (2015). Enhanced Face Recognition based on PCA and SVM. International Journal of Computer Applications (0975 – 8887), 117(2), 40-42. http:// (PDF) Enhanced Face Recognition based on PCA and SVM (researchgate.net).

Md. Abdur R., Md. Shafiul Azam, Nazmul Hossain & Md. Rashedul Islam.(2013). Face Recognition using Local Binary Patterns (LBP). Global Journal of Computer Science and Technology Graphics & Vision, 13 (4), ISSN: 0975-4172. http:// Face Recognition using Local Binary Patterns (LBP) (core.ac.uk).

Md. Al-Amin Bhuiyan. (2016). Towards Face Recognition Using Eigenface. (IJACSA) International Journal of Advanced Computer Science and Applications, 7(5), 25-31. http:// Towards Face Recognition Using Eigenface (thesai.org).

Nazari, S., &Moin, M. S. (2013, May). Face recognition using global and local Gabor features. In 2013 21st Iranian Conference on Electrical Engineering (ICEE), 1-4. IEEE. http:// Face recognition using global and local Gabor features | IEEE Conference Publication | IEEE Xplore.

Pradip Panchal, Hiren Mewada. (2018). Robust Illumination and Pose Invariant Face Recognition System using Support Vector Machines. International Journal of Applied Engineering Research, ISSN 0973-4562, 13(16), 12689–12701. http:// 61393-IJAER (ripublication.com).

Shaukat, A., Aziz, M., &Akram, U. (2015, August). Facial expression recognition using multiple feature sets. IEEE: 5th International Conference on IT Convergence and Security (ICITCS), 1-5. http:// Facial Expression Recognition Using Multiple Feature Sets | IEEE Conference Publication | IEEE Xplore.

Slim Ben Chaabane, Mohammad Hijji, Rafika Harrabi, HasseneSeddik. (2022). Face recognition based on statistical features and SVM classifier. Multimedia Tools and Applications,81(6), 8767-8784.http://Face recognition based on statistical features and SVM classifier | SpringerLink.

Srivastava A., Mane S. Shah A. Shrivastava N. and B. Thakare (2017). A survey of face detection algorithms. International Conference on Inventive Systems and Control 2, pp. 1– 4. http:// A survey of face detection algorithms | IEEE Conference Publication | IEEE Xplore.

V. Jalaja, G.S.G.N. Anjaneyulu. (2022). Face Recognition by Using Eigen Face Method. INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, 9(3), 961-966. http:// Face-Recognition-By-Using-Eigen-Face-Method.pdf (ijstr.org).

Wani, M. A., Bhat, F. A., Afzal, S., & Khan, A. I. (2020). Supervised deep learning in face recognition. Springer, Singapore, Advances in Deep Learning, 95-110. http:// Download Wani M.A., Bhat F.A., Afzal S., Khan A.I. Advances in Deep Learning [PDF] - Sciarium.

Wanxin Cui; Wei Zhan; Jingjing Yu; Chenfan Sun; Yangyang Zhang . (2019). Face Recognition via Convolutional Neural Networks and Siamese Neural Networks. International Conference on Intelligent Computing, Automation and Systems (ICICAS), 746 – 750. http:// Face Recognition via Convolutional Neural Networks and Siamese Neural Networks | IEEE Conference Publication | IEEE Xplore.

Yi Sun, Ding Liang, Xiaogang Wang, Xiaoou Tang. (2015). DeepID3: Face Recognition with Very Deep Neural Networks. http:// Computer Science: Computer Vision and Pattern Recognition, 1. 1502.00873.pdf (arxiv.org).