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An Extensive Simulation Evaluation of Machine Learning Architecture Towards Human Face Recognition

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Abstract

Face recognition has been employed towards identification and verification of the person for secure authentication applications. Nowadays, despite of many advantageous of the face recognition system, it faces several challenges due to various aspects such as variations of pose, illumination, expression, resolution, and motion. In order to manage those challenges, machine learning and deep learning architecture has been proposed. In this article, extensive simulation analysis has been carried out to examine the architecture employed for the face recognition to tackle the above mentioned challenges using preparatory steps such as image segmentation, feature extraction, feature selection and feature classification. In particular, hybrid face recognition technique with respect to local binary pattern and support vector machine is analysed as it yields better features for classification in addition to enhancing the brightness of the features, Improved Adaptive Local Ternary Pattern based method with inclusion of support vector machine is high capable of discriminating the local features of the image effectively, discrete region infrared differential evolution based feature selection technique for face recognition incorporate the principle component analysis and ensemble classifier. Finally optimization of probabilistic neural network using grey wolf optimization for face recognition is high capable in handling the image with recognition and classification. A simulation result of these architectures provides the high accuracy and efficiency of the analyzed architectures on the evaluating the performance with respect to false acceptance rate and false rejection rate on changes of the thresholds. Finally it has been concluded that optimization of probabilistic neural network using grey wolf optimization outperforms all mentioned architectures on the Yale dataset.

Keywords: Face Recognition, Feature extraction, Feature Selection, Segmentation, Feature classification, False Acceptance Rate, False Rejection Rate, Yale dataset

1. Introduction

Face Recognition has attracted increasing attention among the industries for securing the high confidential application on utilization of effectively calibrated sensor in controlling the pose variation, illumination effects and background noises during image acquisition[1][2]. Computer vision technique is highly capable in discriminating the person to provide access control mechanism[3]. In order to discriminate the person automatically, machine learning[4] and deep learning model[5] are high capable enough to achieve the task. However to enhance the accuracy and efficiency face recognition on reducing or eliminating the false acceptance rate[6] and false rejection rate, image preprocessing has to be carried out. Especially noise reduction, image enhancement, image normalization[7], feature extraction[8], feature reduction, segmentation[9], and feature selection approaches have to be employed. Among above mentioned preprocessing step, feature extraction is considered as important mechanism as it is extract the feature to model the class membership function to the classifier. These functional steps attain the high classification and recognition accuracy[10].

Performance analysis of the various machine learning based face recognition techniques has been analysed with respect to feature extraction steps, feature selection and feature classification. The analysis of architectures to compute the best performing machine learning architecture on inclusion of feature extraction and feature selection techniques[11]. Initially hybrid face recognition technique with respect to local binary pattern and support vector machine is analysed as it yields better features for classification in addition to enhancing the brightness of the features[12], Improved Adaptive Local Ternary Pattern based method with inclusion of support vector machine is high capable of discriminating the local features of the image effectively[13], discrete region infrared differential evolution based feature selection technique for face recognition incorporate the principle component analysis and ensemble classifier[14]. Finally optimization of probabilistic neural network using grey wolf optimization for face recognition is high capable in handling the image with recognition and classification [15].

The paper is sectioned as follows. Section 2 describes machine learning architecture towards face recognition. Section 3 analyzes the architecture of the machine learning technique along the various feature extraction technique and feature selection technique for enhanced accuracy. Simulation analysis of the face recognition architectures has been analyzed along the performance comparison is described in section 4. Finally conclusions is provided in the section 5

2. Related work

In this section, various machine learning architecture for face recognition has been has been analyzed on various aspects has been detailed below

2.1. Face Recognition using Decision Tree Algorithm

In this model, face features are extracted using SURF technique yields the approximation components with most discriminative texture feature representation. The extracted features are analyzed for discriminative ability using the decision tree on various face image orientations [7]. Finally matching score determine the effective of recognition on extracted features using appearance of the node. Figure 1 represents the flowchart of decision tree based face recognition method.

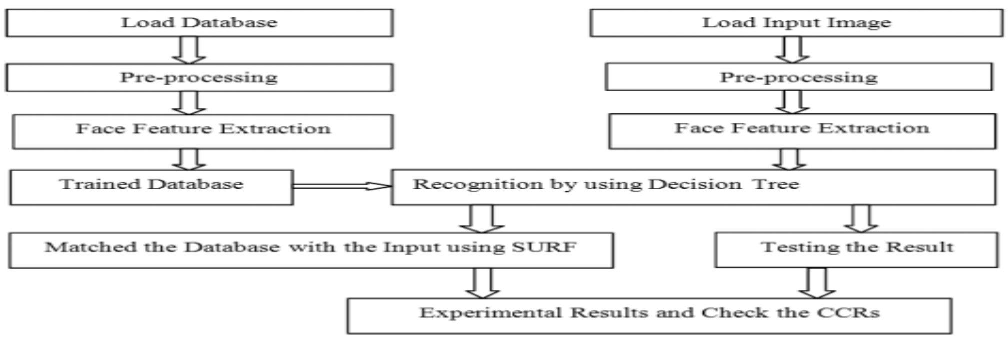
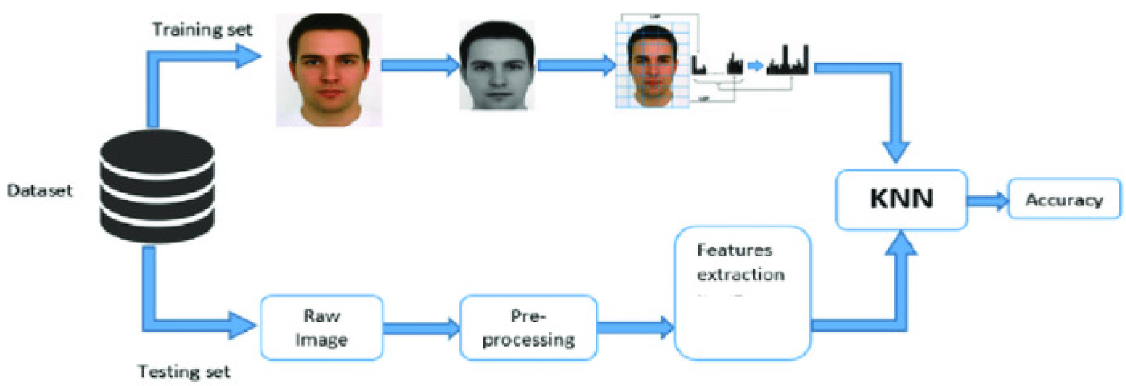


Figure 1: Flowchart of the face recognition using decision tree

2.2. Face Recognition using K Nearest Neighbour

In this model, feature is extracted using SURF [8] is processed in form matrix containing feature vectors. Those feature vectors has been processed with frequency estimation to discriminate features. It further enhances the discriminative ability of the global and local features through K-NN algorithm by computing the difference on the feature vectors with respect to each pixel and its neighboring pixel. Figure 2 represent the flowchart of KNN based face recognition method.



3. Analysis of Machine learning architectures for face recognition

The various machines learning architecture along feature extraction and selection technique has been analyzed on basis of design and working model of the architecture for face recognition which listed as follows

3.1. Face Recognition using Local Binary Pattern and Support Vector Machine

In this work, initially dataset is partitioned into training and testing. Training data is pre-processed for image resizing using viola Jones segmentation and scaling is done on segmented part, segmented resized images applied to texture based feature extractor technique termed as Local Binary Patterns , it extracts the features of the segment, those features finally recognition is carried out using support vector machine. Performance is evaluated using yale database against FAR, FER and accuracy metrics.

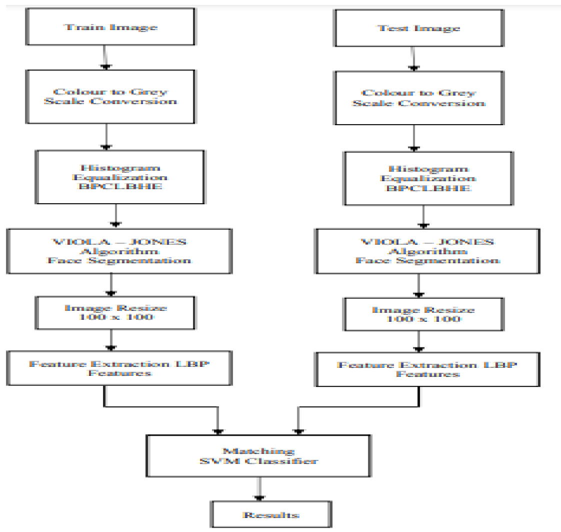


Figure 3: Face Recognition using LBP and SVM

3.2. Face Recognition using Improved Local ternary Pattern and Support Vector Machine

In this work, initially dataset is partitioned into training and testing. Training data is pre-processed for image resizing using viola Jones segmentation and scaling is done on segmented part, segmented resized images applied to feature extractor technique termed as Improved adaptive ternary Patterns, it extracts the features of the segment with informative patterns and reduces the dimensionality of the histogram image representation, those features finally recognition is carried out using support vector machine. Performance is evaluated using Yale database against FAR, FRR and accuracy. Figure 4 represent the architecture of the proposed model.

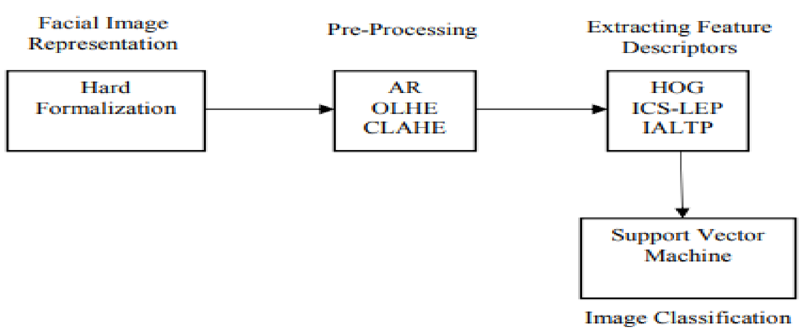


Figure 4: face Recognition using IALTP and SVM

3.3. Face Recognition using Differential Evolution and Ensemble technique

Discrete Differential Evolution (DDE) architecture has been proposed. The proposed architecture will employed after set of the primary image processing steps such as preprocessing, feature extraction and feature selection. Initially preprocessing of the images is performed with image normalization technique and image enhancement technique. Pre-processed image will explored to Linear Discriminant Analysis technique to extract the features of the image. Extracted features will contain some redundant and irrelevant information of the images, it has to eliminate and optimal feature has to be selected to the recognition task. Discrete Region Inferred Differential Evolution architecture is employed to feature selection. Extracted features will be consider as search space, objective function of the DDE generates the optimal features solutions with respect to fitness criteria. Finally recognition task is performed with optimal features using support vector machine is represented in the figure 5

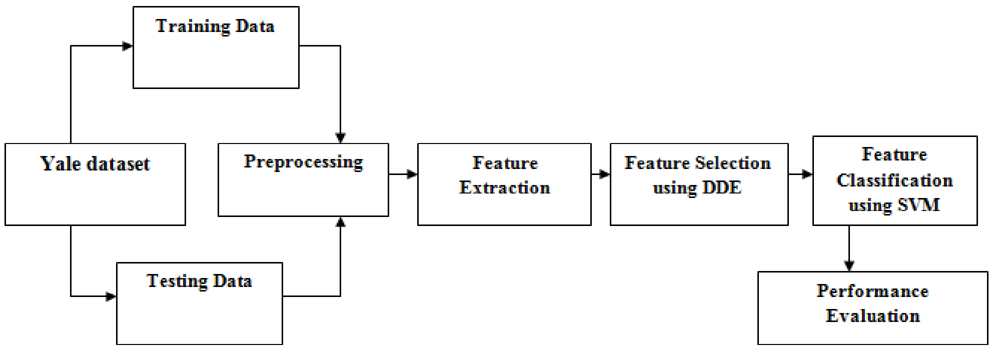


Figure 5: face recognition using ensemble classifier and Differential Evolution

3.4. A Unified Approach for Face recognition based on Probabilistic Neural Network using grey wolf optimization

In this work, Probabilistic Neural Network uses pattern layers and summation layer to classify the features of the test images with support of the radial basis kernel function. In this paper, image preprocessing is carried out using image enhancement and normalization through Contrast limited Adaptive Histogram Equalization (CLAHE). Pre-processed image is employed to viola Jones segmentation which segments the image into four segments and it is represented as integral image. Integral Image contains many Harr like features discriminators is extracted efficiently using principle component analysis. Features namely edges, line and four sided features is suppressed to generate the less no of optimal features for recognition using grey wolf optimization as multiple correlated tasks. Grey wolf optimization process the features with respect to fitness function on basis of the alpha (α), beta (β) and delta (δ). Finally Probabilistic Neural Network has been carried out with optimal invariant feature representing the landmark points, visibility factors, pose factor and gender factors as multitask approach. Class membership is established for recognition with losses mitigation through correction component on the optimal features. Figure 6 represents the architecture of the proposed model

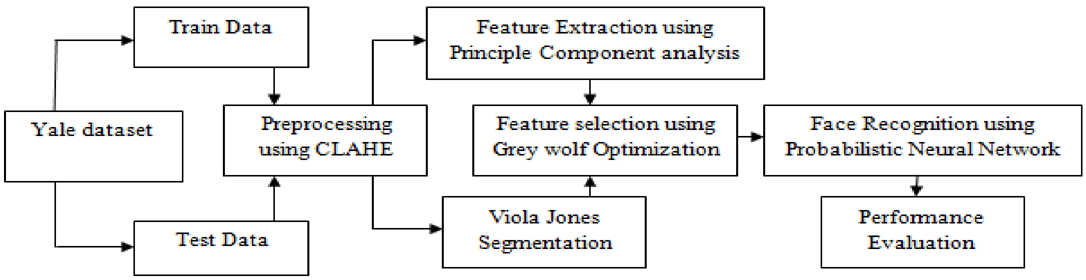


Figure 6: Face Recognition architecture using Probabilistic Neural Network

4. Simulation analysis of face recognition techniques

In this work, experimental analysis is carried out in Yale dataset for face recognition using probabilistic neural network on the feature selected using grey wolf optimization and principle component analysis. The experimental results have been computed and its performance has been evaluated on various test data through 5 fold cross validation is described against various state of art approaches is represented in following sections. The experiment was carried out using MATLAB R2018 on window 7 Intel Core i7 CPU with operating frequency of 2.53G Hz under different environment conditions. The dataset used in this work contains the face image of various subjects containing 1280x960 resolutions with various illumination conditions and six expressions. The model is applicable for various age groups on the parameter adjustment and training.

4.1. Dataset Description –Yale dataset

Yale Dataset [15] consists of 165 facial images of 15 persons which has 11 different images including expressions of each person on various time sessions. It considered as large public heterogeneous face database. In that, 120 face images with 8 different images of each person treated as Train dataset. Remaining 45 images are treated as test images, they are considered as out of the database images to measure FAR.

4.2. Training phase

On Training of the face recognition architecture with 80% of the sample images, face patterns are extracted using Principle Component Analysis, linear discriminant analysis and Local binary patterns. Those extracted feature has been employed to Feature selection and classification process using Grey wolf optimization and Probabilistic Neural Network. The state- of-the-art methods are compared by dividing them into non-training-based and training-based methods

4.3. Testing Phase

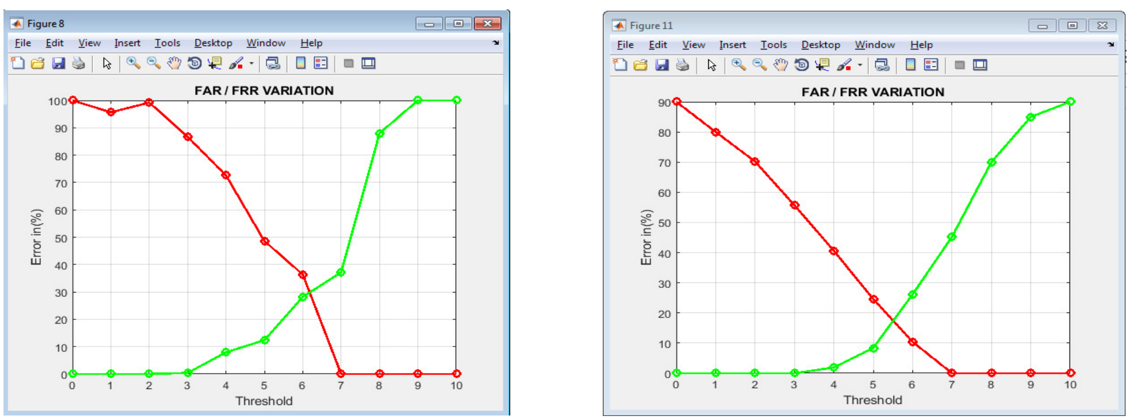
Testing of the face recognition architecture is carried out with 20% of the sample images for 5 fold validation on exchanging of images. Each fold validation undergoes the feature extraction, selection and classification process. Face patterns extracted using single dimensional feature vectors through PCA, LDA on classifier PNN and SVM.

5. Performance comparison of the face recognition technique

Performance analysis of face recognition technique is represented in terms of parameter setting for the feature extraction, selection and classification has been tabulated.

5.1. Analysis of False Acceptance Rate and False rejection Rate

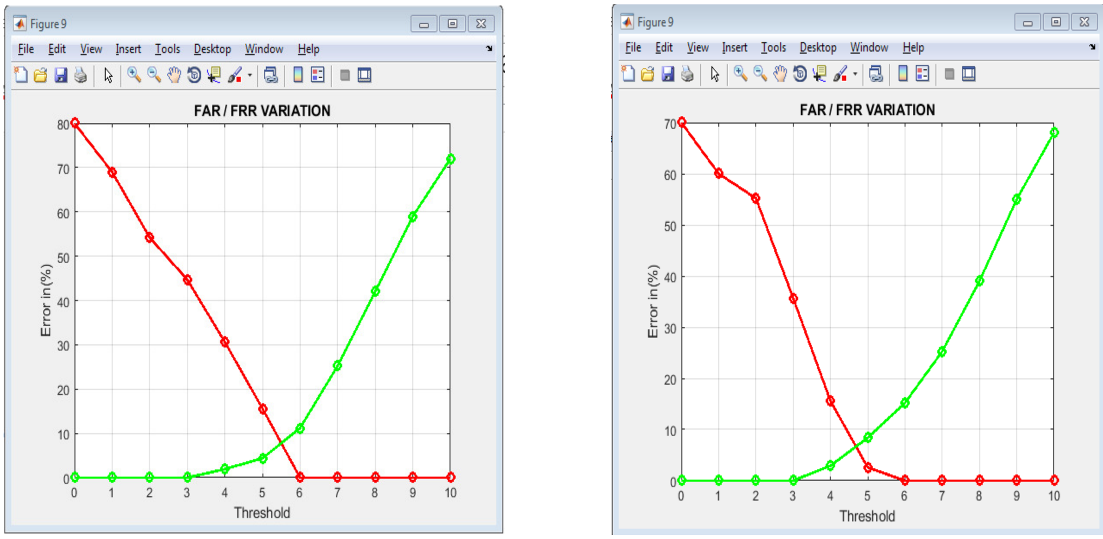
The effectiveness of the architecture with respect to false acceptance rate and false rejection rate is demonstrated in the figure 7. The performance of the recognition architectures are computed on basis of changes of the threshold. Probabilistic Neural Network model yields good FAR and FRR rate on varying various threshold values for face recognition on comparing against other architectures. Threshold considered to optimal face image for classification.



(a) (b)

Figure 7: False Acceptance rate vs. False Rejection Rate analysis (a) LBP+SVM (b) IALTP+SVM

Performance analysis of FAR and FRR with inclusion of feature selection on the feature extraction and feature classification is represented in the figure 8 for the architecture with grey wolf optimization and to architecture with differential evolution. Architectures with feature selection yields better FAR and FRR rate. Table 3 provides the performance of face recognition technique on various performances metric such as Accuracy, Recall and Precision along False acceptance rate and false rejection rate to the classification techniques as feature extraction technique was responsible for the recognition rates of the biometric images. Model is highly effective on recognition of the invariant feature of the dataset.



(a) (b)

Figure 8: False Acceptance rate vs. False Rejection Rate analysis (a) LDA+DE+SVM (b) PCA+GWO+SVM

These results suggest that a proposed architecture can alleviate the over-fitting problem on small training sets. As a result, the PNN over-fits this small-scale training set. When the low-rank constraint is imposed on the fully connected layer of the PNN, a significant difference is observed between the ROC curves of the PNN and SVM

Table 3: Performance comparison of classifier for face recognition on FAR and FRR

Technique	**Threshold**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**
LBP+SVM	FRR	0.78	0.64	0.60	0.51	0.45
	FAR	0.89	0.78	0.74	0.68	0.60
IALTP+SVM	FRR	0.36	0.30	0.24	0.20	0.15
	FAR	0.63	0.54	0.49	0.41	0.35
LDA+DE+SVM	FRR	0.29	0.21	0.19	0.15	0.11
	FAR	0.43	0.36	0.30	0.23	0.14
PCA+GWO+PNN	FRR	0.18	0.16	0.14	0.11	0.09
	FAR	0.24	0.18	0.12	0.09	0.05

5.2. Performance analysis of accuracy of architecture

Performance analysis of accuracy is computed with respect to cross fold validation on the validation data using confusion matrix. On computation of true positive, true negative, false positive and false negative, the accuracy of the architecture can be computed. The performance analysis of accuracy against various face recognition architecture along precision and recall has been illustrated in the figure 9

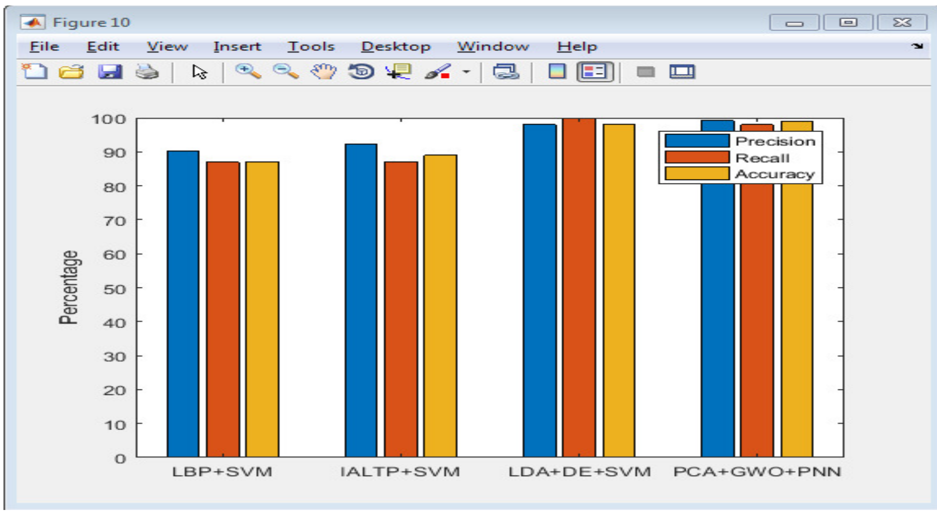


Figure 9: Performance analysis of various face recognition architectures

Performance evaluation of the face recognition architecture is tabulated in the table 4 for various measures. The PNN classifier is applied to feature selected using GWO to recognize the face images. Feature generated through GWO, produce the improved classification accuracy on increase of the samples, reduced computation time on training and testing.

Techniques	Precision	Recall	F-Measure
Local Binary Pattern +Support vector Machine –Methodology 1	90.23	87	87
Improved Adaptive Local Ternary Pattern+ Support vector Machine – Methodology 2	92.21	87	89
Linear Discriminant Analysis +Differential Evolution+ Support Vector Machine	98	100	98
Principle Component Analysis +Grey wolf optimization +Probabilistic Neural Network	99.23	98	99

In this different strategies of the various architecture, approximate recognition rates of the model is computed among that PNN classifier performances better compared with other architectures on basis of processing times and accuracy as it includes optimization criterion to face recognition.

Conclusion

We analyzed different face recognition architecture using feature extraction and optimization of feature selection technique on machine learning classifier has been analysed on various aspects such as false acceptance ratio, false rejection ratio and accuracy. However it has been analyzed on basis of design and implementation to ensure effectiveness and accuracy of the architecture on cross fold validation. To be more specific, hybrid face recognition technique with respect to local binary pattern and support vector machine is analysed as it yields better features for classification in addition to enhancing the brightness of the features, Improved Adaptive Local Ternary Pattern based method with inclusion of support vector machine is high capable of discriminating the local features of the image effectively, discrete region infrared differential evolution based feature selection technique for face recognition incorporate the principle component analysis and ensemble classifier. Finally optimization of probabilistic neural network using grey wolf optimization for face recognition is high capable in handling the image with recognition and classification. Finally it has been concluded that optimization of probabilistic neural network using grey wolf optimization outperforms all mentioned architectures on the Yale dataset.

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