Multi-layered Artificial neural network and kernel based principal component analysis (PCA) for Face Recognition

Pawanjit Kaur , Anita Suman, Parveen Kumar
Mtech scholar, Assistant Prof. ,Associate Prof.
Department of ECE, BCET Gurdaspur, Punjab

ABSTRACT: Face recognition play a significant role in real time imaging systems for various applications. This approach is much popular in many of the fields the main and the important one is recognition or can say as the security or authentication purpose. To implement the objective of this dissertation, initially region of interest (ROI) technique is used to extract the faces from the images. Thereafter, Kernel Principal component analysis (KPCA) is used to replace the traditional PCA feature extraction process. Artificial Intelligence based multi layered neural network is then implemented for classification of faces. The proposed and the existing technique is tested on the MATLAB 2013a tool with the help of image processing toolbox. Extensive experiments have been done by considering benchmark and real-life images. It has been found that the proposed technique outperforms existing techniques in terms of the F measure, Sensitivity, Specificity, Accuracy, and G-accuracy. Therefore, the proposed technique is more efficient for real-time imaging systems.

KEYWORDS: Face recognition**,** multi-layered neural network, PCA and feature extraction.

I. INTRODUCTION

Face recognition is a process of identifying a person's face in a digital image or a video. It mainly works on the principle of object recognition, i.e.., where a system can recognize and discriminate between different objects, it has been trained to recognize. It uses computer vision and machine learning to its maximum advantage. It is most active area in Image processing as well as Object recognition. Object recognition is a sub discipline of pattern recognition. Face recognition has many applications out of which commonly used are video surveillance, to match the faces in the footage to the existing facial database. It also used as biometric passwords in smart phones as fingerprint passwords used. Recently, it is used in social networking sites to tag the pictures of people automatically. There are a lot of challenges in facial recognition such as illumination, Variations in facial expression, angle between face and camera, wearing glasses, changing facial hair and hairstyles, Noise and Occlusion. To recognize a face, we need to train a system to extract feature of human faces from a facial database and draw conclusions from that database. From these conclusions, one needs to model the classifier which discriminate the facial features to other features.

Nowadays, there are large amounts of images and videos, especially from the Internet. How to get the images or videos we are interested in are important. However, interpretation and searching of images and videos are not that easy and require accurate and efficient algorithms. A variety of machine learning and deep learning algorithms are being used to help the interpretation and searching of these complexes, real-world entities. In this context, searching by numerical similarity rather via structured relations is more suitable [16, 7]. Using the similarity could find the most similar content to a picture, or find the vectors that are most similar. State of the art similarity search methods like NN Descent [4] have a large memory overhead on top of the dataset itself and cannot readily scale to billion-sized databases, such as MS-Celeb-1M[9, 8].

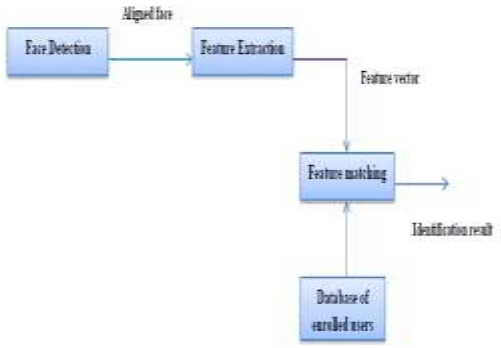

Figure.1. A typical face recognition system.

To boost the performance of face recognition, there are many strategies, such as using very large scale training data [23], metric learning [25, 23, 33, 22, 32] and deeper and wider neural networks [10, 35]. However, these strategies are not that appropriate in the condition of face recognition 1: N when N is a too large number. In some cases, the base search datasets may contain some error-labeled face images or non-face images. Otherwise, the internal structure and contact of base search datasets is a good clustering reference, which is significant for face recognition in billion-sized datasets. In the condition of searching faces when base dataset is billion-sized, it is necessary to adopt some strategies to speed up the searching while keeping high accuracy. In face verification or face recognition, similarity score is mostly used to indicate the similarity of two faces.

2. RELATED WORK

In this section, the literature work related to the research is reviewed in detail. Since the research mainly works with pre-processing concept, feature description and classification, we have reported the literature about all the mentioned concepts, and the description of the literature work is given below:

In 2016, Kanika Lakhani et al. [7] has implemented two renowned 'edge detection' models for 20 radiographs and have also assessed the pixels count. Further, they have applied Gaussian filter for the smoothening of images, which have highlighted the tooth's defect. They have sharpened the images' edge using 'Laplacian edge detection' model. The important objective of their work was the detection of discontinuities in radiographs and has highly succeeded in their work. In 2015, A.R.Lamichhane and C.S.Chen [8] have derived explanations were numerically applied for solving the problem of boundary value with the use of particular solutions as well as localized model of corresponding solutions. They have illustrated two examples in both 2d and 3D for reviewing the efficiency of derived solutions. In 2015, Seba Susan et al. [1] have proposed a adopted a novel fuzzy sift classifier for the purpose of face recognition, that too in a complex scenario without the use of face cropping tools. Further, they have incorporated entropy weights, which ensure the role of feature at the process of decision making. In 2010, Chunlin Tan et al. [2] have presented a scheme named 'Star Styled Window Filter- SIFT (SWF-SIFT)' for the improvement of infrared human face recognition by purifying the incorrect matches. This would highly improves the performance, and they have compared the proposed SWFSIFT algorithm with SIFT algorithm. The experimentation was done with the aid of distinctive infrared human face database, and results have proved the superiority of proposed algorithm. In 2016, Quan Zhou et al. [3] have addressed the problem of face recognition in a challenging scenario, in which the samples (testing and training) were subjected to poses 'deviations', 'misalignments', 'expressions' and so on. They have employed the SIFT matching as a general transformation that would align samples (training). Then they have identified the input images through an enhanced model, which was on the basis of aligned training samples. The developed model was compared to conventional models, and the experimentation results have demonstrated the efficiency of proposed model for face recognition. In 2015, A. Azeem et al. [4] have made an effort in designing 'Hexagonal sampled SIFT feature descriptor for face recognition application. The using image coordinates have normally grants 'sharp edge response' and those have also highlighted 'low contrast region of face. The corresponding characteristic consent SIFT for the marking of typical 'facial features'. Furthermore, they have outlined 'Fisher Canonical Correlation Analysis' on the basis of differentiate procedure for providing better results for classification. The experimentation was carried out in well-known datasets and the results have shown betterments of proposed model in correspondence with feature extraction. In 2013, Yuan Luoet al. [9] has developed a hybrid model of 'Principal Component Analysis (PCA)' as well as 'Local Binary Pattern (LBP)' was introduced to enhance PCA process. The developed model highly contributed in facial expression recognition, and has used 'Support Vector Machine (SVM)' for the same. The experimentation was also conducted and the results have proved that the SVM model has the capability to highly classify various expressions and also it could get increased recognition rate over the conventional recognition models. In 2014, H. Boughraraet al. [12] has presented a study on the modification of constructive training algorithm for 'Multilayer Perception (MLP)' that was applied for the problem of face recognition. They have employed a training procedure, in which the patterns of training were learned effectively. The efficiency of proposed model was proven by comparing it with 'fixed MLP architecture'. In 2017, Daniela Sánchez et al. [13] have discussed a new optimization technique for the design of 'Modular Neural Network (MNN)' with the use of 'granular computing' and 'firefly' algorithm. The developed model was tested with human recognition, which was on the basis of benchmark ear as well as 'face databases' for the verification of efficiency of the developed model. In order to find the perfect optimization approach, they have conducted a comparison over the techniques and against hierarchical genetic algorithm. This would show which of the techniques offers better results especially for human recognition. Simulation results have proved the effectiveness of the developed model. In 2014, Jing Lu et al. [14] have developed classifier employs both right and left projecting vector for the replacement of high dimensional weights. They have adopted idea of 'NN with random weights (NNRW)' for the learning purpose. Experimentation was carried out using some renowned databases and from the results they have validated that the developed classifier can represent the image's character, and also has attained good recognition. In 2017, XingchengLuoet al. [15] has proposed a 'deep convolution NN' that has more than nine layers. Further, they have employed a vehicle data set that was collected from many perspectives, and for verification, they have utilized a framework namely 'Caffe'. The proposed algorithm was compared to other existing vehicle recognition model, and the results have shown the superiority of proposed work. In 2015, KankanDaiet al. [16] has implemented a learning approach with the aid of 'NN with random weights (NNRWs)'. They have employed a base component named '2D feed forward NN (2DFNNs) with random weights. Moreover, they have derived an analytical solution for the mentioned parameters. The series of experimentation were performed, and the results have outperformed other conventional methods. In 2017, Amin Jalaliet al. [17] have proposed a sensitive convolutional NN that makes slight change in the input image by blurring them, which also enables great results in feature extraction. The experimentation was carried out for the analysis of performance of developed sensitivity term. In 2011, Yan Xuet al. [18] have progressed feature extraction by eigen face model, which was based on 'Karhunen-Loeve transform'. At last, for the purpose of face recognition, multilevel functions were used. The QNN was trained as well as tested with the use of face databases. The comparison result has shown the feasibility and efficiency of proposed model. In 2013, AltafAhmadHuqqaniet al. [19] have developed two new training models for 'Back propagation NN'. They have focused on two distinct parallelization environs with the utility of 'one hand Open Map'. With the basis of experimentation results, they have

given guidelines for effective parallelization on GPU architecture.

In 2013, Poonam et al. [20] has presented model, and for the extraction of features, they have used enhanced series of 'local Gabor binary pattern histogram'. For classification purpose, they have used 'generalized NN' as an activation function. In the developed model, initially the face was decomposed into multi-resolutions, and this would definitely enhance local binary pattern (LBP).

3. PROPOSED WORK

As problem in traditional face recognition system is discussed in above section, I have observed that there is a need to develop a efficient face recognition system which can overcome the drawbacks of traditional work. Therefore, the proposed work implements the Kernel PCA mechanism for feature extraction as Kernel PCA just performs PCA in a new space. It uses Kernel trick to find principal components in different space (Possibly High Dimensional Space). KPCA finds new directions based on kernel matrix. It can extract n (number of observations) eigen values. Along with this, the proposed work implements the feature extraction from the region of interest only. The selection of ROI enhances the proficiency by eliminating irrelevant information from the images. For the purpose of classification, the artificial intelligence based Multi Layered Neural Network is implemented. The purpose behind selecting the multi layered neural network is to overcome the issues of traditional KNN classification approach.

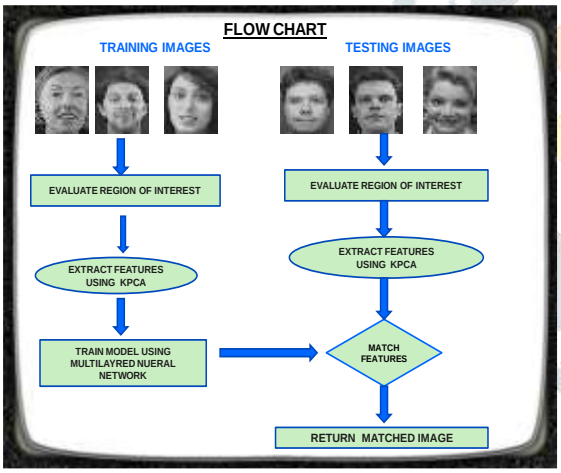

Figure 2.The Flowchart of Proposed Methodology

4. RESULT AND DISCUSSION

The execution of the proposed algorithm assessed utilizing MATLAB 13 version. The MATLAB locates matrix research facility. For experimentation and implementation the proposed technique is evaluated using MATLAB tool. The evaluation of proposed technique is done on the origin of following parameters such as Accuracy, Sensitivity, Specificity, F-measure and G-accuracy based on different images. By comparing of existing results and proposed results of the proposed method i.e. sees Figure.3-7. Also, quantitatively comparison between existing and proposed method with different source images in given in Table 1-5. Using these parameters, the performance evaluation metrics such as Accuracy, Sensitivity, Specificity, F-measure and G-accuracy are defined as follows:

1. ACCURACY

Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations.

$$Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)}$$

Table .1 is indicated the quantized research into the Accuracy. As Accuracy ought to be higher which implies proposed algorithm is indicating the superior results when compared to access methods as the Accuracy is higher in each case.

Table.1: Accuracy evaluation

NO. OF IMAGE	PCA-KNN	KPCA-MNN
1	0.9264	0.9538
2	0.8732	0.9477
3	0.8529	0.9376
4	0.9336	0.9527
5	0.8653	0.9388
6	0.8158	0.9319
7	0.8651	0.9347
8	0.8467	0.9479
9	0.7657	0.9323
10	0.8300	0.9386
11	0.8947	0.9540
12	0.8394	0.9410
13	0.8418	0.9518
14	0.8749	0.9504

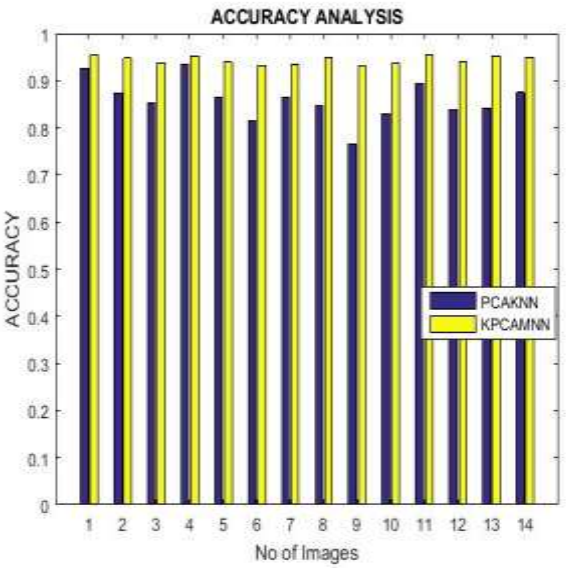

Figure3: Accuracy Analysis

Figure.3: shows the comparison of Accuracy between existing and also the proposed method wherever x-axis shows the no of images and y- axis shows values.

Here, Yellow line indicates the proposed technique and blue line indicate the previous one. In our case the proposed Accuracy are comparatively higher than existing one.

2. RECALL (Sensitivity)

Recall (Sensitivity) (also called the true positive rate) measures the proportion of positives that are correctly identified as positive

$$\boldsymbol{Recall\ (Sensitivity)\ =\ \frac{TP}{(TP\ +FN)}}$$

Table 2 is indicated the quantized research into the Sensitivity. As Sensitivity ought to be higher which implies proposed algorithm is indicating the superior results when compared to access methods as the Sensitivity is higher in each case.

Table.2: Sensitivity evaluation

NO. OF IMAGE	PCA-KNN	KPCA-MNN
1	0.7163	0.9355
2	0.8189	0.9459
3	0.7897	0.9297
4	0.8985	0.9525
5	0.8036	0.9428
6	0.7703	0.9361
7	0.8260	0.9429
8	0.7942	0.9499
9	0.6986	0.9307
10	0.7946	0.9409
11	0.7513	0.9467
12	0.7603	0.9339
13	0.6930	0.9440
14	0.6624	0.9382

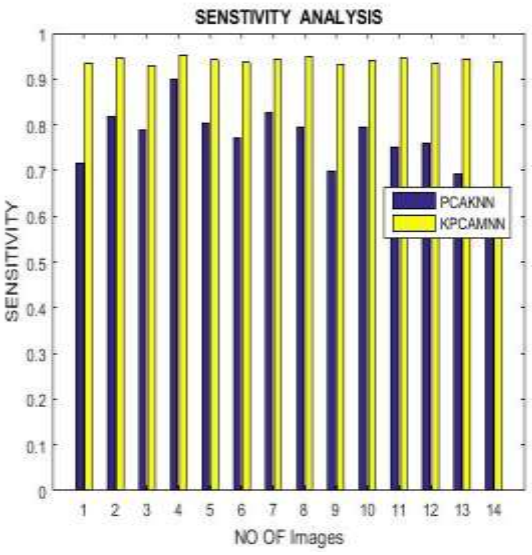

Figure.4: Sensitivity Analysis

Figure.4: shows the comparison of Sensitivity between existing and also the proposed method wherever x-axis shows the no of images and y- axis shows values. Here, Yellow line indicates the proposed technique and blue line indicate the previous one. In our case the proposed Sensitivity are comparatively higher than existing one.

3. SPECIFICITY

Specificity (also called the true negative rate) measures the proportion of negatives that are correctly identified as negative.

$$\boldsymbol{Specificity\ =\ \frac{TN}{(TN\ +FP)}}$$

Table.3 is indicated the quantized research into the Specificity. As Specificity ought to be higher which implies proposed algorithm is indicating the superior results when compared to access methods as the Specificity is higher in each case.

Table.3: Specificity evaluation

NO. OF IMAGE	PCA-KNN	KPCA-MNN
1	0.9349	0.9559
2	0.9098	0.9497
3	0.9245	0.9465
4	0.9219	0.9529
5	0.9032	0.9348
6	0.9032	0.9250
7	0.9012	0.9218
8	0.9241	0.9451
9	0.9023	0.9343
10	0.9022	0.9340
11	0.9232	0.9564
12	0.9268	0.9478
13	0.9245	0.9555
14	0.9212	0.9534

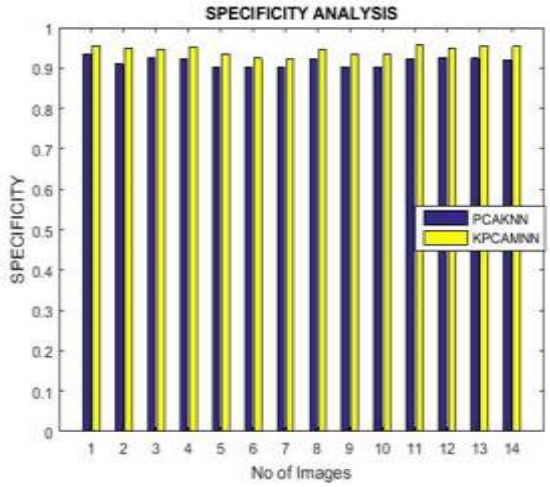

Figure.5: Specificity Analysis

Figure.5: shows the comparison of Specificity between existing and also the proposed method wherever x-axis shows the no of images and y- axis shows values. Here, Yellow line indicates the proposed technique and blue line indicate the previous one. In our case the proposed Specificity are comparatively higher than existing one.

4. F-MEASURE

F-Measure is also called F1 score. F1 Score is the weighted average of Precision and Recall. Therefore, this score takes both false positives and false negatives into account.

$$\boldsymbol{F1\ score\ =\ \frac{(2\ *\ TP)}{(2\ *\ TP\ +FP+\ FN)}}$$

Table.4 is indicated the quantized research into the F-Measure. As F-Measure ought to be higher which implies proposed algorithm is indicating the superior results when compared to access methods as the F-Measure is higher in each case.

Table.4: F-Measure evaluation

NO. OF IMAGE	PCA-KNN	KPCA-MNN
1	86.0867	96.9637
2	92.3709	98.7963
3	90.6530	97.8327
4	96.7876	99.0552
5	91.4775	97.8822
6	89.4805	97.6780
7	92.7783	97.8874
8	90.9212	98.8950
9	84.9255	97.4519
10	90.9437	98.3303
11	88.3104	98.7467
12	88.8687	98.0063
13	84.5501	98.6930
14	82.0494	97.5635

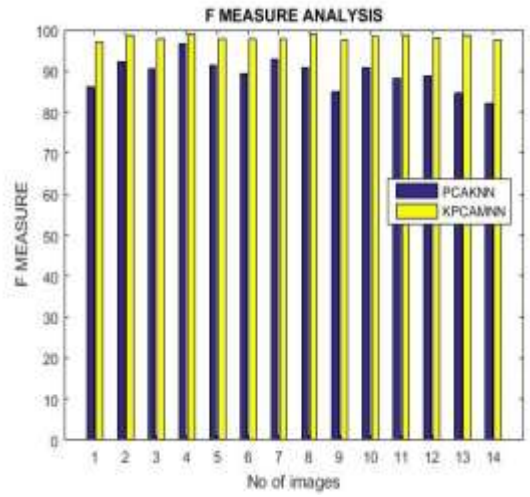

Figure.6: F-measure Analysis

Figure.6 shows the comparison of F-Measure between existing and also the proposed method wherever x-axis shows the no of images and y- axis shows values. Here, Yellow line indicates the proposed technique and blue line indicate the previous one. In our case the proposed F-Measure are comparatively higher than existing one.

5. G-ACCURACY

G-Accuracy is defined as **:**

$$\boldsymbol{GAccuracy} = \frac{(\boldsymbol{Precision} * \boldsymbol{Recall})}{(\boldsymbol{Precision} + \boldsymbol{Recall})}$$

Where,

$$\boldsymbol{Recall}\ (\boldsymbol{Sensitivity}) = \frac{\boldsymbol{TP}}{(\boldsymbol{TP} + \boldsymbol{FN})}$$

$$\boldsymbol{Precision} = \frac{\boldsymbol{TP}}{(\boldsymbol{TP} + \boldsymbol{FP})}$$

Table 5. is indicated the quantized research into the G-accuracy. As G-accuracy ought to be higher which implies proposed algorithm is indicating the superior results when compared to access methods as the G-accuracy is higher in each case.

Table.5: G-accuracy evaluation

NO. OF IMAGE	PCA-KNN	KPCA-MNN
1	0.8297	0.9457
2	0.8868	0.9478
3	0.8709	0.9381
4	0.9288	0.9527
5	0.8785	0.9388
6	0.8602	0.9305
7	0.8906	0.9323
8	0.8734	0.9475
9	0.8194	0.9325
10	0.8736	0.9375
11	0.8496	0.9515
12	0.8546	0.9408
13	0.8161	0.9497
14	0.7981	0.9458

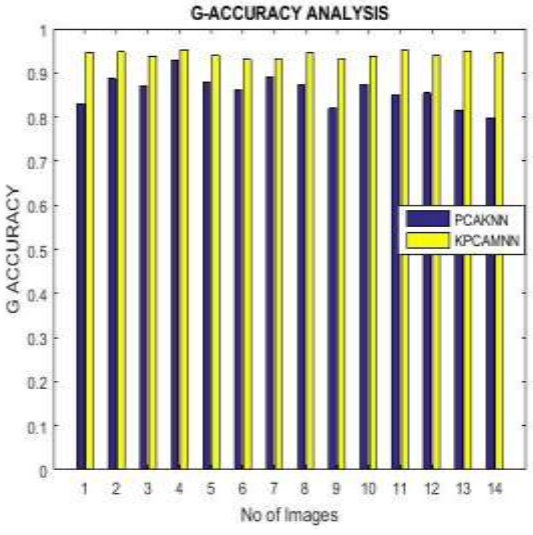

Figure.7: G-accuracy Analysis

Figure.7 shows the comparison of G-accuracy between existing and also the proposed method wherever x-axis shows the no of images and y- axis shows values. Here, Yellow line indicates the proposed technique and blue line indicate the previous one. In our case the proposed G-accuracy are comparatively higher than existing one.

IV. CONCLUSION

The proposed and the existing technique is tested on the MATLAB 2013a tool with the help of image processing toolbox. Extensive experiments have been done by considering benchmark and real-life images. It has been found that the proposed technique outperforms existing techniques in terms of the F measure, Sensitivity, Specificity, Accuracy, and G-accuracy. Therefore, the proposed technique is more efficient for real-time imaging systems. In this thesis work previous method i.e. PCA and KNN are evaluated and compared with a proposed KPCA-MNN method. It is found that KPCA-MNN method gives better results due to increased values. It is evaluated that mean improvement in case of KPCA-MNN in:

- Fmeasure-8.8268
- Sensitivity-0.170857
- Specificity-0.027864
- Accuracy-0.0849
- G-Accuracy- 0.082983

as compared to PCA-KNN respectively.

In near future a novel multi-objective fitness function based meta-heuristic will also be considered to enhance the results further.

REFERENCES

1. S. Susan, A. Jain, A. Sharma, S. Verma and S. Jain, "Fuzzy match index for scale-invariant feature transform (SIFT) features with application to face recognition with weak supervision," IET Image Processing, vol. 9, no. 11, pp. 951-958, 11 2015.
2. C. Tan, H. Wang and P. Deli, "SWF-SIFT approach for infrared face recognition," in Tsinghua Science and Technology, vol. 15, no. 3, pp. 357-362, June 2010.
3. Q. Zhou, u. R. Shafiq, Y. Zhou, X. Wei, L. Wang and B. Zheng, "Face Recognition Using Dense SIFT Feature Alignment," Chinese Journal of Electronics, vol. 25, no. 6, pp. 1034-1039, 2016.
4. A.Azeem, M.Sharif, J.H.Shah and M .Raza, " Hexagonal scale invariant feature transform (HSIFT) for facial feature extraction", Journal of Applied Research and Technology, vol. 13, no. 3, pp. 402-408, 2015.
5. YuanningLiu, FeiHe, Xiaodong Zhu, Zhen Liu, Ying Chen, Ye Han, and Lijiao Yu, " The Improved Characteristics of Bionic Gabor Representations by Combining with SIFT Key-points for Iris Recognition", Journal of Bionic Engineering, vol. 12, no. 3, pp. 504-517, 2015.
6. Xiangzeng Liu, Zheng Tian, Chunyan Chai and Huijing Fu, " Multiscale registration of remote sensing image using robust SIFT features in Steerable-Domain", The Egyptian Journal of Remote Sensing and Space Science, vol. 14, no. 2, pp. 63-72, 2011.
7. Kanika Lakhani, Bhawna Minocha and Neeraj Gugnani, "Analyzing edge detection techniques for feature extraction in dental radiographs", Perspectives in Science, vol. 8, pp. 395-398, 2016.
8. A.R.Lamichhane and C.S.Chen, " The closed-form particular solutions for Laplace and biharmonic operators using a Gaussian function", Applied Mathematics Letters, vol. 46, pp. 50-56, 2015.
9. YuanLuo, Cai-mingWu and YiZhang, " Facial expression recognition based on fusion feature of PCA and LBP with SVM", Optik - International Journal for Light and Electron Optics, vol. 124, no. 17, pp. 2767-2770, 2013.
10. FirasAlOmari and GuohaiLiu, " Novel hybrid soft computing pattern recognition system SVM– GAPSO for classification of eight different hand motions", Optik - International Journal for Light and Electron Optics, vol. 126, no. 23, pp. 4757-4762, 2015.
11. Deepak KumarJain, Surendra Bilouhan Dubey,Rishin Kumar Choubey, AmitSinhal, Siddharth KumarArjaria, AmarJain and HaoxiangWang, " An Approach for Hyperspectral Image Classification by Optimizing SVM using Self Organizing Map", Journal of Computational Science, in press, 2017.
12. H. Boughrara, M. Chtourou, C. Ben Amar and L. Chen, "Face recognition based on perceived facial images and multilayer perceptron neural network using constructive training algorithm," in IET Computer Vision, vol. 8, no. 6, pp. 729-739, 2014.
13. Daniela Sánchez, PatriciaMelin and OscarCastillo, "Optimization of modular granular neural networks using a firefly algorithm for human recognition", Engineering Applications of Artificial Intelligence, vol. 64, pp. 172-186, 2017.
14. JingLu, JianweiZhao and FeilongCao, " Extended feed forward neural networks with random weights for face recognition", Neuro computing, vol. 136, pp. 96-102, 2014.
15. Xingcheng Luo, Ruihan Shen, Jian Hu, Jianhua Deng, Linji Hu and Qing Guan, " A Deep Convolution Neural Network Model for Vehicle Recognition and Face Recognition", Procedia Computer Science, vol. 107, pp. 715-720, 2017.
16. Kankan Dai, Jianwei Zhao and Feilong Cao, "A novel decorrelated neural network ensemble algorithm for face recognition", Knowledge-Based Systems, vol. 89, pp. 541-552, 2015.
17. Amin Jalali, Rammohan Mallipeddi and Minho Lee, " Sensitive deep convolutional neural network for face recognition at large standoffs with small dataset", Expert Systems with Applications, vol. 87, pp. 304-315, 2017.
18. Yan Xu, Xiaofeng Zhang and Huaicun Gai, "Quantum Neural Networks for Face Recognition Classifier", Procedia Engineering, vol. 15, pp. 1319-1323, 2011.
19. Altaf AhmadHuqqani, ErichSchikuta, SicenYe and PengChen, "Multicore and GPU Parallelization of Neural Networks for Face Recognition", Procedia Computer Science, vol. 18, pp. 349-358, 2013.
20. PoonamSharma, K.V.Arya and R.N.Yadav, "Efficient face recognition using wavelet-based generalized neural network", Signal Processing, vol. 93, no.6, pp. 1557-1565, 2013.
21. Reecha Sharma and M.S.Patterh, " A new pose invariant face recognition system using PCA and ANFIS", Optik - International Journal for Light and Electron Optics, vol. 126, no. 23, pp. 3483-3487, 2015.
22. XiaoLuan, BinFang, LinghuiLiu, WeibinYang and JiyeQian, " Extracting sparse error of robust PCA for face recognition in the presence of varying illumination and occlusion", Pattern Recognition, vol. 47, no. 2, pp. 495-508, 2014.

23. Changjun Zhou, Lan Wang, Qiang Zhang and Xiaopeng Wei, " Face recognition based on PCA and logistic regression analysis", Optik - International Journal for Light and Electron Optics, vol. 125, no. 20, pp. 5916-5919, 2014.
24. ChangjunZhou, LanWang, QiangZhang and XiaopengWei, " Face recognition based on PCA image reconstruction and LDA", Optik - International Journal for Light and Electron Optics, vol. 124, no. 22, pp. 5599-5603, 2013.
25. Gui-FuLu, JianZou and YongWang, "Incremental learning of complete linear discriminant analysis for face recognition", Knowledge-Based Systems, vol. 31, pp. 19-27, 2012.