A Novel Face Recognition System for Plastic Surgery Face Database using Single Eigen Value

S.Princy Suganthi Bai, D.Ponmary Pushpa Latha, D.Joseph Pushpa Raj

Abstract*: *The advance development in the field of medicine are quite appreciable in one way and a technical hazard in other way to human society. The plastic surgery face treatments that are availed by the people to beautify themselves, given to the needed patients, or misused by the intruders are the latest huddles for the reliable Face Recognition System (FRS). In this paper, a novel approach of extracting a Single Eigen Value(SEV) from plastic surgery database and classified with the standard classifiers are discussed. The experimental results of the proposed model on Plastic surgery database, shows that the SEV feature with 1-NN rule classifier gives an outstanding performance when compared with the existing FRS models that comprises the plastic surgery challenge.

Index Terms*: *Face Recognition System, Nearest Neighbour rule, Kernel Principal Component Analysis, Plastic Surgery database

I. INTRODUCTION

Surgical and non-surgical face treatments are very popular in the recent years [1] to beautify face or restoration of face abnormality due to the accident injuries on human faces. The Census [2][3], which have been taken every year, states that the percentage of plastic surgery done on the faces are increasing tremendously. Plastic surgeries are possible on any part of the body.USA stands top when thetotal number of plastic surgeries done by the 35000 surgeons are consolidated all over the popular countriesin the year 2018.Plastic surgery face treatments are of different types such as facelift (regain skin elasticity), Blepharoplasty (cosmetic eyelid surgery), Rhinoplasty (nose modification), chin and cheek augmentation [1] which are common in most of the developed countries. In India,plastic surgery treatments on faces are becoming popular among youth and middle age people for the sake of enhancing their prettiness. This is the biggest challenge in the field of FRS (Face Recognition System) that urges the biometric researchers to design a robust FRS in order tosustain its efficiency with the new challenge of plastic surgery face images. The existing feature extraction methodologies and classifiers, which works for plastic surgery face images on FRS are discussed in the section II. The proposed FRS model with the plastic surgery face images are collected from IAB (Image Analysis and Biometrics) lab,which is in IIIT (Indraprastha Institute of Information Technology), Delhi are described in section III. Section IV is added with experimental results and performance analysis of the proposed FRS models. The conclusion of this paper is briefed in the Section V.

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S.Princy Suganthi Bai,Research Scholar, Bharathiar University,Coimbatore, Tamilnadu, India and Assistant Professor, Department of Computer Science, Sarah Tucker College, Tirunelveli, Tamilnadu, India,

Dr.D.Ponmary Pushpa Latha, Associate Professor, Department of Information Technology, Karunya Institute of Technology and Sciences,Coimbatore, India, ponmarymca@gmail.com

D.Joseph Pushpa Raj, Assistant Professor, Department of Information Technology, Francis Xavier Engineering College, Tirunelveli,.Tamilnadu, India.

II. EXISTING FRS MODELS FOR PLASTIC SURGERY DATABASE

R. Singhet al.[4] designed a FRS model that works with six diverse methodologies such as Principal Component Analysis (PCA), Fisher Discriminant Analysis (FDA), Local Feature Analysis (LFA), Circular Local Binary Pattern (CLBP), Speeded Up Robust Features (SURF) and Neural Network Architecture based 2-D Log Polar Gabor Transform (GNN). Performance of their FRS models are evaluated with ten-folds cross validation and the accuracy is calculated with top ten rank identification accuracy. They have tested their models on non-surgery and surgery based face databases. AR, CMU PIE, Georgia Tech, GTAV and FERET are the non-surgery based face databases that are used for evaluationwhich has the face challenges like pose, illumination and occlusion. Pubfig face databaseare utilized for testing FRS models that has nine hundred subjects, which includes before surgery face images and after surgery face images. Rank-1 identification accuracies with their proposed methodologies varies from 29.1% to 54.2% that includes both local and global surgery face databases.

Amal Seralkhatem Osman Ali et al. [5] combines the two feature extractors such asGlobal descriptor and local texture descriptor for their FRS models. These feature extraction descriptors with Hausdroff distance raised the accuracy up to 91% when applied on Plastic Surgery Face Database. Multiple Projective Dictionary Learning method proposed by Naman Kohli et al. [6] produced 97.96% on Plastic Surgery Face Database. In their work, the plastic surgery face images are divided in to local Region Of Interest (ROI) and these regions are compared with each other by means of cosine distance. The two measures, cosine distance score and feature similarity score are classified with SVM classifier to improve the accuracy of surgery-based databases and non-surgery based database.

Himanshu S. Bhatt et al.[7] proposed a multi-objective evolutionary granular algorithm where several levels granules are extracted and the feature selection is done with genetic algorithm. First level of granule are extracted by Gaussian and Laplacian operators, the second level gives the horizontal and vertical information and third level gives local discriminate information. The features are obtained from the three levels of disjoint granules which are produced 89.87% in rank-1 identification accuracy on

Plastic Surgery face databases.

III. PROPOSED FRS MODEL

A. Plastic Surgery Face Database of IAB Lab

The Plastic Surgery face database ofImage Analysis and Biometrics Lab [8] at IIIT Delhiis provided with varies biometric databases. Databases under this lab can be acquired and utilized for educational and research purpose. On written request, we have sanctioned with eighty-one pair of face images that are before surgery and after surgery face images for the research work. The face images of this database are differ in scale, size and inquired with the plastic surgery challenge. Local and Global plastic surgeries are possible on human faces. When the surgery is done on the particular region of the face, then the face is undergone a local surgery. In some cases, the surgery is for the whole face then it is a global surgery. A sample face database of plastic surgery database is shown in the figure1. The proposed FRS model is evaluated with this face database.

Fig.1. Plastic Surgery Face Database

B. Extraction of Single Eigen Value

The initial step of the proposed FRS model is to extract the Eigen vectors from the Plastic Surgery Face Database with traditional PCA approach [9]. The Eigen vectors are then transformed in to the high dimensional space by applying polynomial kernel over it [10] in order to obtain Eigen values of each face images. Then these values are sorted and the dominant Eigen value is allotted for each face images by means of calculating the similarity among Eigen values of the same subject and dissimilarity between the other subjects with 1-NN (First-Nearest Neighbour) rule classifier which is depicted in figure2.

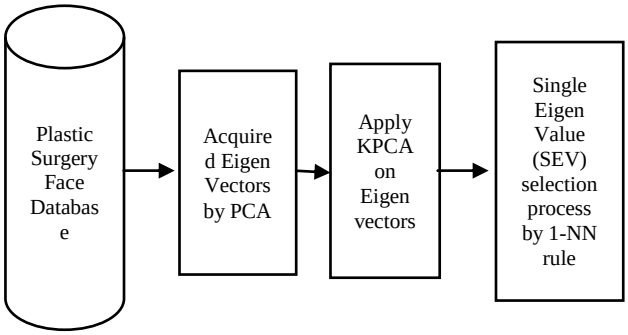

Fig.2. Feature extraction phase of the proposed FRS model

The selection of dominant similar Eigen value of various images of the same subject which are discriminant to other subjects are done on the first ten sorted Eigen values of each face image. Then the chosen Single Eigen Value(SEV) of each face image are fed in to the classifiers which are suggested for the proposed work in order to calculate the accuracy of the FRS models which is shown in the figure3. Neural Networks[13][20][23], Support Vector Machine[11][21] and 1-Nearest Neighbour Rule[12] are the classifiers[22] involved in analyzing the proposed FRS model.

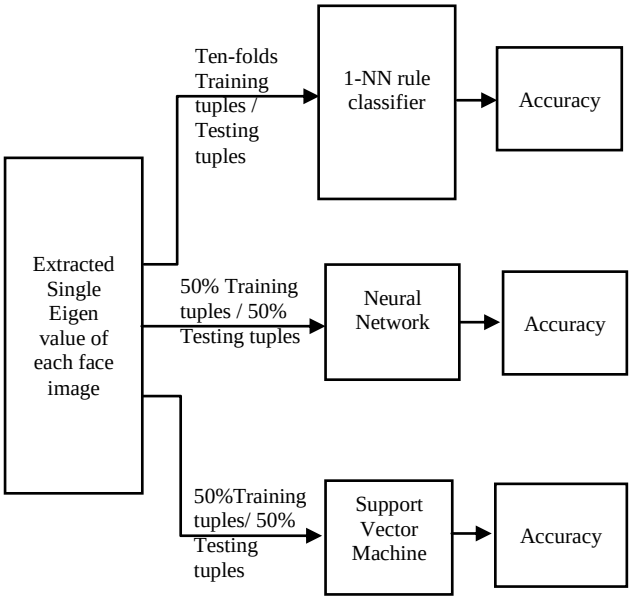

Fig.3. Classification phase of the proposed FRS model

IV. PERFORMANCE EVALUATION AND RESULTS

The Single Eigen Value(SEV) of each pair of images of eighty one subjects are extracted with the KPCA methodology which uses the polynomial kernel in MATLAB 2017. The extracted Eigen values and its subject class label is mapped to form the tuples under a Plastic dataset, which holds a total number of 162 tuples. Then the newly organised Plastic dataset is analysed with three standard classifiers in IBM SPSS Modeller, which are illustrated in this section.

A. Experiment1: SEV of Plastic Surgery Database with Neural Networks

The Plastic dataset is equally divided in to two partitions for the classification process with BPNN (Back Propagation Neural Network)[14]. One part of the partition is for training and another part is for testing process. BPNN has three layers with needed neurons. According to the number of inputs, the number of neurons are fixed in the input layer and the number of outputs decides the number of neurons in the output layer. The proposed FRS model is apportioned with one input neuron, one output neuron and three neurons in the hidden layer. Also, a bias neuron is added in both input and hidden layer which always assigned with value 1. The weights exist between the different layers connects the layers and the weights are adjusted by back propagating the weight adjustment[15] with respect to the error calculated between

the expected and obtained face identities. This approach is a Standard model, that applies the delta-learning rule with learning rate 0.9. Repeating this process with shuffling the dataset by placing training tuples in testing space and vice versa termed as bagging model[18]. The performance of bagging model is observed by the majority outcomes. Again, the weak tuples, which pull downs the accuracy is isolated and enhanced to improve the accuracy of the FRS model, is termed as boosting model[19]. In this classification process of the proposed FRS model,these three models are utilized and the observations are recorded in the table1.

Table I. Accuracy with diverse NN models

Accuracy Estimation Models	Accuracy with BPNN
SM	20.99%
BAG	25.93%
BOOST	32.72%

SEV features of Plastic dataset does not sounds well with NN models, which is clearly depicted in the Figure 4. The accuracy grows up to 32.72% only even after boosting the weak tuples.

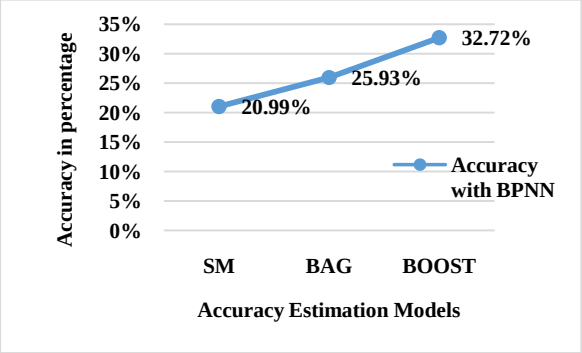

Fig.4. Accuracy Analysis with diverse NN models

B. Experiment2: SEV of Plastic Surgery Database with Support Vector Machine

The Support vectors that are obtained from training tuples forms the hyperplane in the high dimension space in order to classify the non-linear face Plastic dataset. Diverse kernels such as Polynomial Kernel, Radial Basis Function Kernel, Sigmoidal Kernel etc., can be used to transform low dimensional space vectors to high dimension space vectors in SVM. The original Plastic dataset are equally divided into two subsets such as training and testing tuples. Then, it is classified with RBF kernel of diverse gamma values on SVM and the accuracy measured is recorded in the table2.

Gamma Value	Accuracy for Training with KRBF_SVM	Accuracy for Testing with KRBF_SVM
1	60%	44.44%
2	60%	44.44%
3	55%	50%

Table II. Accuracy with SVM models

The functioning of SEV features on SVM with RBF kernel did not produced any appreciable accuracy both in training and testing phases which is shown in the fig5.

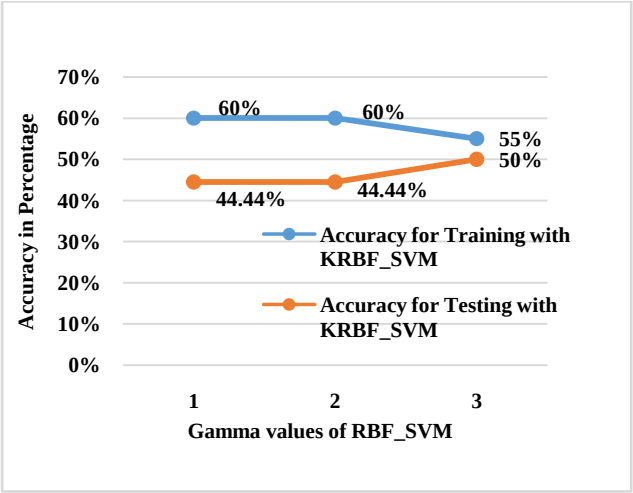

Fig.5. Accuracy Analysis with diverse NN models

The accuracy reached maximum of 50% with gamma values, where the values are three in the testing phase and the higher values of gamma does not improve the accuracy.

C. Experiment3:SEV of Plastic Surgery Database with 1-Nearest Neighbour Rule

KNN(K-Nearest Neighbour) rule is a supervised classifier[16], which works with the concept of distance calculation between the input features vectors with respect to the neighbour template. The distance measurement [17][18] is possible with different distance metrics such as Euclidean distance, Manhattan distance measures, city block measures etc.

KNN classification includes cross validation technique, where the dataset is divided in to certain number of folds. In the proposed FRS model, the Plastic dataset is partitioned into five folds. Among these folds, four folds are placed in the training space, which are used for matching with the rest of the tuples in the single testing fold.

Thus, all the folds get the chance in training phase and testing phase, so more certainty in the correct template matching is possible with this cross validation technique. The best matching is analysed with the first three nearest neighbours of the input test tuple, which is shown in the figure 6 using the quadrant map and distances from the input tuple to the nearest neighbours are displayed in the table3.

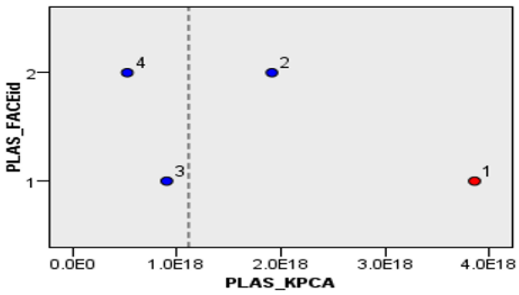

Fig.6. Quadrant map for sample test tuple and its nearest neighbours

Table III. K-Nearest Neighbours and Distances for a sample tuple

Sample Test Tuple	Nearest Neighbours			Nearest Distances		
	1	2	3	1	2	3
1	2	3	4	1.008	1.532	1.728

In the proposed work, distance is classified with Euclidean distance with diverse K values and the accuracy is recorded in the table4.

Table IV. Accuracy with SVM models

K Value	Accuracy with 1-NN rule classifier
1	100.00%
2	69.13%
3	50.00%

Among the three nearest neighbours, generally the closest neighbour scores high accuracy in the FRS that is depicted in the fig7.

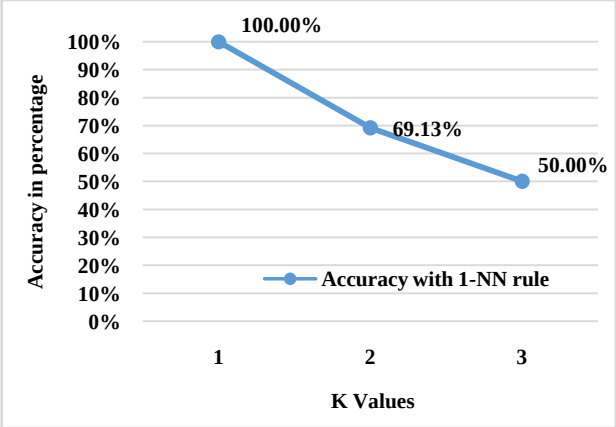

Fig.7. Accuracy Analysis with diverse K values using 1-NN rule

The proposed SEV input feature value with 1-NN ruleclassifier that matches the first nearest neighbour scores themaximum accuracy limit of 100%. When compared withthe existing FRS models for the Plastic Surgery challenge,our proposed FRS model stands top with the best accuracythat is listed in the table5. The performance of existing FRSmodels and proposed FRS model on Plastic Surgerydatabase is illustrated in the figure8.

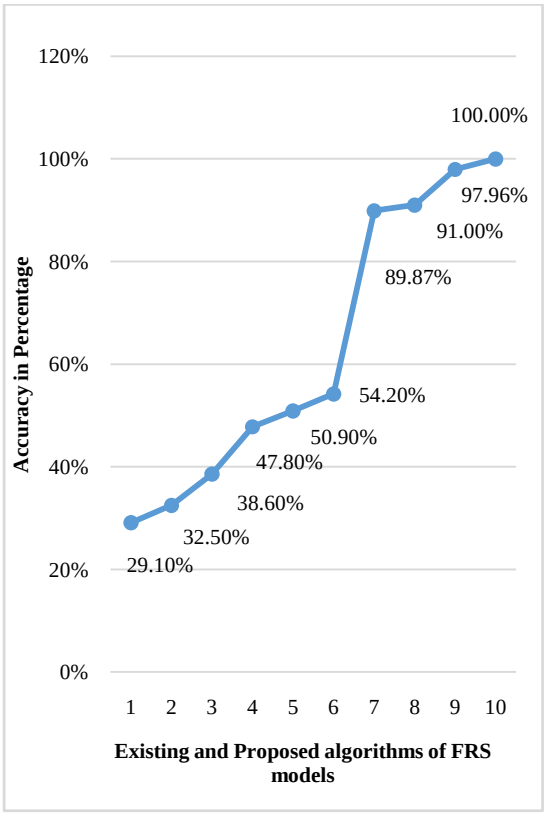

Fig.8. Accuracy Analysis with diverse K values using 1-NN rule

Table V. Accuracy of Existing and proposed FRS models on Plastic Surgery Database

S. No	Author	Algorithm	Database	Accuracy
1	R. Singh et al.[4]	PCA with ten folds Cross Vaidation	Pubfig Face Database	29.10%
2	R. Singh et al.[4]	FDA with ten folds Cross Vaidation	Pubfig Face Database	32.50%
3	R. Singh et al.[4]	LFAwith ten folds Cross Vaidation	Pubfig Face Database	38.60%
4	R. Singh et al.[4]	CLBP with ten folds Cross Vaidation	Pubfig Face Database	47.80%
5	R. Singh et al.[4]	SURF with ten folds Cross Vaidation	Pubfig Face Database	50.90%
6	R. Singh et al.[4]	GNN with ten folds Cross Vaidation	Pubfig Face Database (Plastic)	54.20%
7	Himanshu S. Bhatt et al.[7]	Multi-objective evolutionary granular algorithm and Genetic algorithm with rank-1 identification accuracy	Plastic Surgery Face Database	89.87%
8	Amal Seralkhatem Osman Ali et al.[5]	Global descriptor (GIST) and local texture descriptor(LBP) with Hausdroff distance	Plastic Face Database	91.00%
9	Naman Kohli et al.[6]	Multiple Projective Dictionary Learning algorithm with SVM classifier	Plastic Surgery Face Database	97.96%
10	Proposed work	SEV with 1-NN rule classifier	Plastic Surgery Face Database	100.00%

CONCLUSION

Plastic Surgery faces are the challenging issue in the FRS models, which are designed for face identification and verification. Recently human faces are altered through plastic surgery due to medical reasons or criminal activities. Even though many FRS models are suggested for the Plastic surgery database, the FRS model proposed in this paper stands top by its improved accuracy value. Hence, this proposed model concludes that SEV feature with 1-NN rule classifier gives best results for FRS with plastic surgery face dataset.

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AUTHORS PROFILE

S. Princy Suganthi Bai received the MCA and ME(CSE) degrees from Manonmaniam Sundaranar University. Also, M.Phil degree from Mother Teresa Women's University. Presently she is working as an Assistant Professor in the department of Computer Science, Sarah Tucker College. She is a part-time PhD research scholar at Bharathiar University in the field of Biometrics. She has publishedsix papers in the International Journals, two papers in InternationalConferences and eleven papers in theNational Conferences.

D. Ponmary Pushpa Latha, has completed her M.E. degree in Anna University and Doctorate in Computer Application. Completed her Ph.D. in Data Mining and Bioinformatics. Her area of interest is Data Mining, Big data and Bioinformatics.

D.Joseph Pushpa Raj,has completed his M.E. degree in Computer Science and Engineering and his area of interest is Image Processing.