Face Recognition using Probabilistic Model for Locally Changed Face

Roshni S. Khedgaonkar, Kavita R. Singh , M.M. Raghuwanshi, Pravin M. Sonsare

Abstract: ***Face recognition is an attention-grabbing area in research field due to various challenges like aging, pose variation, facial expression, and illumination problem. Now-a-days, plastic surgery is a standout amongst the above mentioned exciting issues of face recognition. Local plastic surgery is a type of plastic surgery in which any one feature of the face is changed instead of all features of face. In this paper, the face recognition on local plastic surgical faces using probabilistic approach is presented, where a probabilistic approach like Naive Bayes Classifier, Neural Network Classifier are used to recognize the faces with local plastic surgery from the database. Naive Bayes classifier is fused with Expectation Maximization Algorithm (EMA) for better recognition of the faces from the database. Finally, Results of Naive Bayes Classifier, Naive Bayes Classifier with EMA is evaluated on standard Plastic Surgery Database(PSD). Similarly, Neural network classifier is also been tested on PSD database, which will aid to decide which classifier is efficient for recognizing plastic surgical faces. The motive of this paper is give increase in recognition rate with the help of effective classifier.***

Index Terms: ***Probabilistic approach, Naive Bayes classifier, Expectation Maximization Algorithm (EMA), Neural Network Classifier.***

I. INTRODUCTION

Due to the evolving digital era, face has become one of the common means of communication, transaction, security etc. This evolution in e-transactions and other requirements the demand of fast and correct identification and authentication of a user has been continuously increasing. Thus, the human face plays an important role in verifying people's identification and in social interactions. Use of human face for security purpose, the face recognition technology has presented a sufficiently a good amount of work in last few years. There are a few techniques for biometrics recognition, for example, iris recognition, fingerprints and face recognition [1]. In comparisons with other biometric systems, the face recognition has an advantage because the images of the face can be captured non-intrusively.

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Various face recognition techniques have been introduced and comparison of the techniques is being done on the basis of their recognition rate to make Identification of a face[18,19,20]. However, face recognition tools is yet an uncluttered research issue under vastly varying condition [23, 24]. As discussed above, there exist several challenges in face recognition due to posing, illumination conditions, facial expressions and aging etc. Various researches has been done on face recognition problems that addresses the above mentioned challenges related to face recognition, such as variation in expression [9], posing [22], aging [9], illumination problem [2,3,4], and disguise [10]. In addition to the mentioned challenges, another issue is of plastic surgery[25,26] that influences the performance of face recognition. Now-a-days, demand of plastic surgery has recently made plastic surgery a challenge in recognition of faces because it changes the entire facial features of the face. There are two broad categories of plastic surgery: Local Plastic Surgery and Global Plastic Surgery [5, 6]. Local plastic surgery a kind of surgery which changes a single feature of the persons face and global plastic surgery is surgery which completely modifies the total face structure of a person.

(a) (b)

Fig. 1(a): Sample image of local plastic surgery . (b) Sample image of global plastic surgery

The fig 1(a) depicted the sample image of local plastic surgery and fig 1(b) illustrated the sample image of global plastic surgery. Many approaches have been proposed to build up various classification module for face image which experienced certain component changes via plastic surgery. A near set theory is one of the approach for matching pre-surgical and post-surgical face images [7]. Probabilistic approach considered to be one of the approaches for solving the face recognition challenges. Various algorithms of face recognition uses

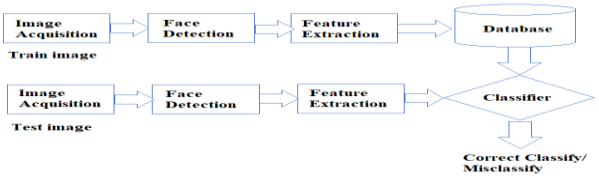

Fig.2: Face Recognition Process [2]

distance-based method but the probabilistic model gives comparably better outcomes for face recognition under varying pose [8]. By and large, the face recognition system comprises of three stages. Specifically, face detection, feature extraction and face recognition as shown in Fig. 2.

Naive Bayes classifier a probabilistic approach that is simple but effective for face recognition problems [1]. This classifier has been used in various applications like image recognition [12], image retrieval [11] and natural language processing. The EM algorithm (Expectation Maximization algorithm) is a structure which determines probabilistic parameter, when the data has missing values. Neural Network Classifier recognize the face through training and learning the correct classification [28]. Naive Bayes classifier and EM algorithm is used as a fused approach for classifying unlabeled data for texture data classification [13].

The rest of the paper structured is as per the following. Section II briefly reviews proposed method, which talk about the flow of face recognition is being discussed and presents the overview of proposed method in which Naive Bayes classifier, Naive Bayes classifier with EM algorithm and Neural Network Classifier are used for classifying the image. Section III presents experimental results followed by section IV is conclusions.

II. PROPOSED WORK

This section of the paper presents the proposed work using probabilistic approach. Probabilistic approach is a method in which distribution describes the range of possible values and shows which value within the range are most likely. It is used for calculating the probability of the local surgical faces with its best match faces in the face database. Probabilistic approach consist of various methods such as Bayesian

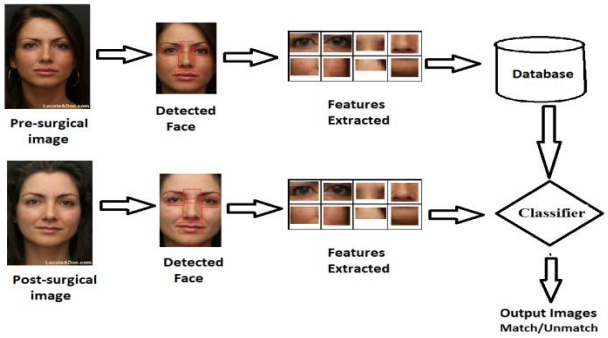

Fig. 3: Overview of Proposed Work

Classifier, Nearest Neighbour Classifier, Naive Bayes classifier and Neural Network classifier which gives results based on probability of likelihood.

Face detection, initial stage of any face recognition method. Face detection process has been carried out with the help of Viola-Jones algorithm [14]. Viola-Jones detector was preferred as a detection algorithm because of its high detection rate, and its capability to run in real time [15]. Viola –Jones Algorithm uses four stages. The first stage is Haar feature selection, second stage is creating an image integration followed by training of Adaboost and last one is Cascading classifier.

Face detection is followed by feature extraction. In our work we have used Grey level co-occurrence integrated algorithm (GLCIA) [16] method for feature extraction. GLCIA shows better results in determination of co-occurrence probability of statistical features. GLCIA algorithm is made by coordinating favored parts of two algorithms. Namely, the grey level co-occurrence hybrid structure (GLCHS) as well as grey level co-occurrence hybrid histogram (GLCHH). The GLCIA algorithm considered as recommended technique for computing a statistical features of co-occurrence probability for huge size digital images. The GLCIA algorithm extracts various statistics such as correlation values, dissimilarity, contrast of the face, maximum probability of match shifted face, entropy value, variance of the image, inverse difference, total edge differences, recursively of the face and in homogeneity.

The extracted features are further used for recognition of the faces using Naive Bayes classifier, Naive Bayes classifier with EM algorithm and Neural Network Classifier. Naive Bayes classifier method learns from data and predict class. Probability is associated with every class [1]. Expectation Maximization Algorithm is utilized to get maximum likelihood parameters of a statistical model in situation where the equations are tough to solved openly. A neural network comprises of neurons which are organized in layers. This layered neurons changes an input value into specific output [27].

A. Probabilistic Approach

Probabilistic approach enables changes and unusual occurrence to be measure by using distributions instead of exact value in evaluation of levels of risk involved in a situation. A distribution states some range of possible values and shows which value are most likely.

B. Naive Bayes classifier

This method is one of the probabilistic method, used for classification of local surgical faces. This classifier is a kind of probabilistic models. It has dependent on applying Bayes theorem with solid (naive) presumption between various features. Naive Bayes classifier expect the occurrence of a specific feature is distinct from the occurrence of other feature. It learns from data as well as predict class with probability associated with these class[1]. Naive Bayes classifier as depicted in equation (1).

$$P(A \mid B) = (P\langle B \mid A\rangle P(A))/P(B) \qquad (1)$$

Where, P (A|B): Probability (conditional probability) of occurrence of event A given the event B is true

P (A) and P (B): Probabilities of the occurrence of event A and B respectively

P (B|A): Probability of the occurrence of event B givens the event A is true

C. Neural Network Classifier

Neural Network is inspired by the processing of brain and works accordingly to develop technique. This

technique is aid to solve and predict complex problems. Neural Network Classifier architecture has input layer, hidden layer and output layer. The hidden layer is used to filter important patterns from input layer and passes it to next layer. . A neural network comprises of neurons which are organized in layers. This layered neurons changes an input value into specific output. Each neural takes an input, applies a function to it and then transfer the output on the next layer [27].

D. Naive Bayes classifier with EM algorithm

Expectation Maximization Algorithm is a repetitive technique to obtained maximum likelihood or posteriori estimates of parameter. Expectation Maximization Algorithm finds the model parameters even if there is have missing data. Expectation Maximization Algorithm has two steps E-step to generate the expected classification for each example and M-step to generate the most likely theory given the classified data.

Collaborating, Naive Bayes classifier with the EM algorithm is a promising minimally supervised approaches because its computational cost is low [21]. The efficient performance of Naive Bayes classifier with the EM algorithm brings an idea to use it for the face recognition.

Algorithm of Proposed Work

Input: Training dataset I of pre-surgical images

I= (I1, I2, I3…In)

Output:

Face is recognized as match or mismatch with database image

Steps:

1. Read the training dataset I;
2. Calculate the statistical values of each image;
3. Repeat

   Calculate the probability of I1;

   until the probability of all images (I1, I2, I3… In) has been calculated
4. Calculate the likelihood for each class;
5. Get the greatest likelihood;
6. Return match;

Otherwise,

   return mismatch;

III. EXPERIMENTAL RESULTS

For experimentation purpose, database of Image Analysis and Biometrics Lab from IIIT Delhi [17], Plastic Surgery Face Database is used. It contains total of 98 images of pre-surgery and post-surgery of local plastic surgery. The 98 images are divided as 28 sample images of Blepharoplasty-Asian-eyes, 15 sample images of Lip Augmentation and 55 sample images of Rhinoplasty (Nose) surgery. Training was performed on all pre-surgical samples of 98 images and testing were conducted on post-surgical 98 images from each category such as Blepharoplasty, Lip Augmentation and Rhinoplasty. Fig 3 depicts the sample input images from Plastic Surgery Face Database [17]. The sample images shown in fig 4 pre-surgical images utilized in training whereas the images after plastic surgery is depicted in fig. 4 have been used for testing. If the two samples (pre and post) surgical of one individual is compared in fig 3, it can be observed that how the appearance have changed drastically due to under knife issues. This makes face recognition under plastic surgery is most exciting problem. Sample images of various surgeries under local plastic surgery are depicted in fig. 5. The next stage, detection of face portion of an individual. In this phase, we have used Viola Jones [15] algorithm for detection of face portion of an image that

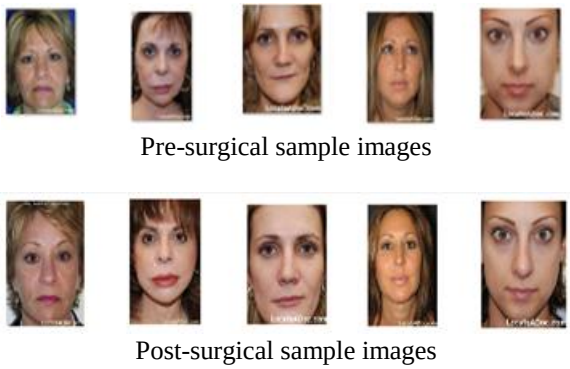

Fig. 4: Sample images from Plastic Surgery Face Database

Fig. 5: Sample input images from Plastic Surgery Face Database

Fig. 6: Face detection

mark as box around left eye, right eye, nose, mouth and last box that covers all the facial parts as shown in fig 6. The resultant detected face parts of few of the samples are shown in the fig 7 and detected faces of few of the sample from Plastic Surgery Face Database(PSD) are shown in fig 8.

Once the face is detected, GLCIA algorithm [16] has been used in representing the human face by extracting some features. The sample output of feature extraction using GLCIA is shown in fig 9.

The extracted features are further used for recognition using Naive Bayes classifier, Neural Network Classifier and Naive Bayes classifier fused with EM algorithm. The test images under each category of surgery such as Blepharoplasty, Lip Augmentation and Rhinoplasty are matched using the aforementioned classifiers against the trained images. Sample resultant match under category is shows in fig. 10, fig. 11 and fig. 12 respectively.

The sample results of recognition of local surgical faces are depicted in table I and the recognition rate of Naive Bayes classifier, Neural Network classifier and Naive Bayes with EM algorithm for different types of facial surgeries are depicted in table II. In table I S1, S2,……S8 represent the sample images from test set. From table I it can be observed that, for example Naive Bayes and Neural Network has shown correct match for sample S1 from train set, whereas fused Naive Bayes and EM classifier have shown mismatch for the same sample S1. Similarly, recognition of other samples by each of the classifier can be analyzed from the table I. The overall recognition rate of each classifier for all surgical categories has been tabulated in table II.

Fig. 7: Detected face parts of few image samples from PSD Database

Fig. 8: Detected faces of few image samples from PSD Database

The graphical representation of recognition rate of three different types of surgeries are shown in figure 13 in which recognition rate of Naive Bayes classifier. Naive Bayes classifier with EM algorithm is shown for Eyelids, Lips and Nose surgery. With same parameter it has also been tested using Neural Network Classifier. It has been analyzed that Naive Bayes classifier computes

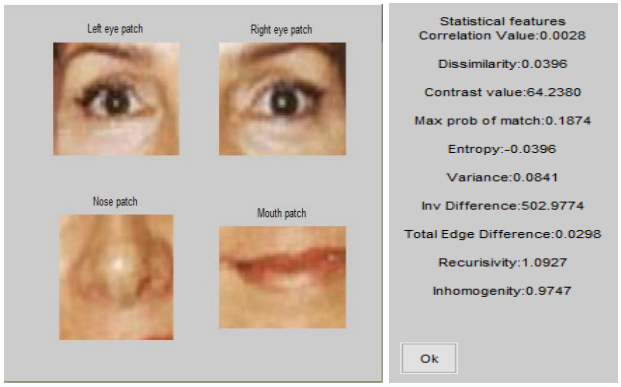

Fig. 9: Feature extraction

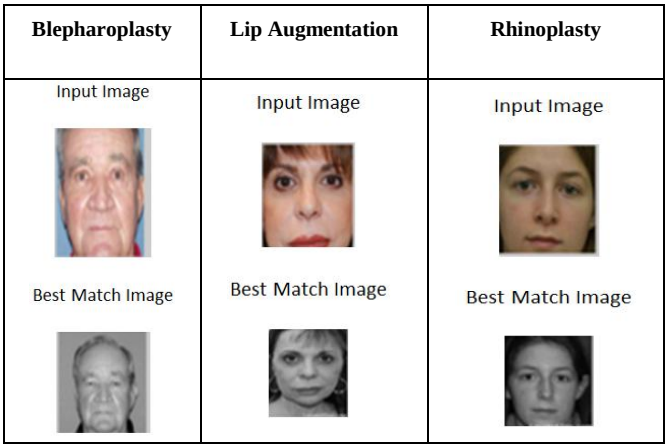

Fig. 10: Naive Bayes Classifier

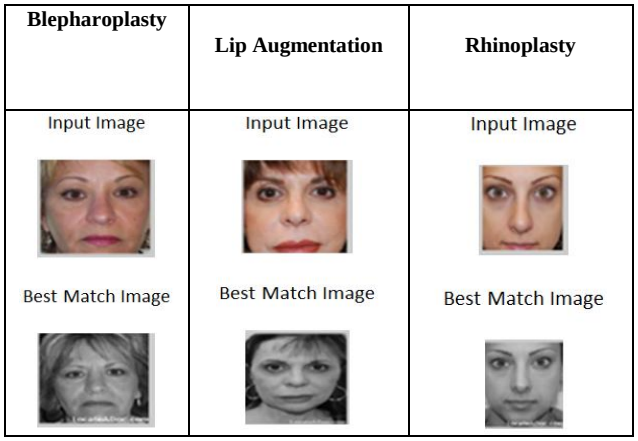

Fig. 11: Naive Bayes classifier fused with EM algorithm

the probability of individual feature and then classifies accordingly and Neural Network Classifier works on learning data and then classifying it. In this paper, we presented Naive Bayes classifier fused with EM algorithm, so that the features matched by Naive Bayes classifier should be maximized by EM algorithm with an expectation of more accurate results. However, as the features of faces are changed after plastic surgery it is difficult to match the maximized number of features. Therefore, EM and Naive Bayes classifier in combination is giving poor performance as compare to Naive Bayes Classifier and Neural Network Classifier in case face recognition of plastic surgery.

Table I: The sample results of recognition of local surgical faces

Surgery Type	Input image	Naive Bayes classifier	Fused Naive Bayes and EM classifier	Neural Network Classifier
Eyelids surgery	S1	**Match**	Unmatch	**Match**
	S2	Unmatch	Unmatch	**Match**
	S3	**Match**	**Match**	**Match**
Lips surgery	S4	Unmatch	Unmatch	Unmatch
	S5	**Match**	**Match**	**Match**
Nose surgery	S6	Unmatch	Unmatch	**Match**
	S7	**Match**	Unmatch	**Match**
	S8	**Match**	**Match**	Unmatch

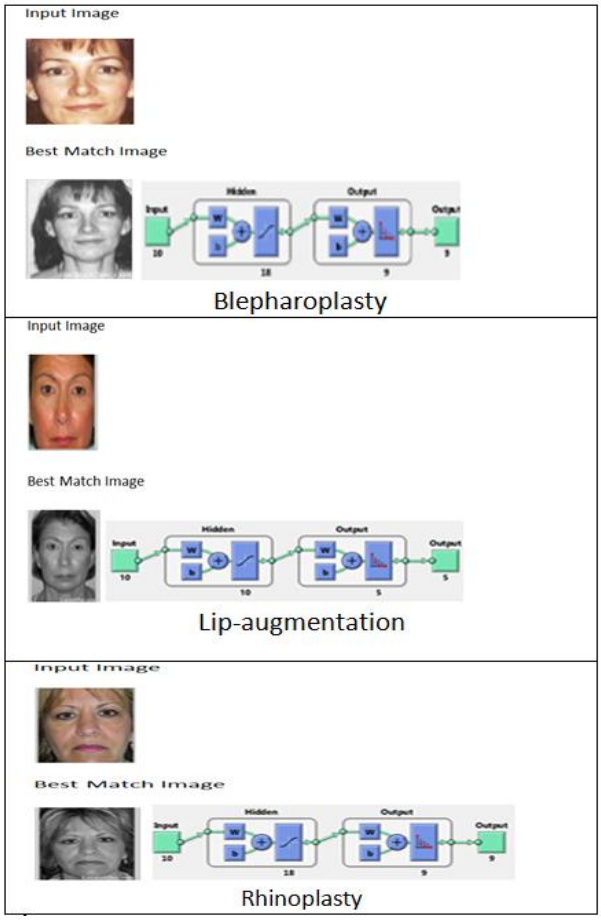

Fig. 12: Neural Network Classifier

Table II: The recognition rate of Naive Bayes, Neural Network and Naive Bayes with EM algorithm for different types of surgery

Surgery Type	Naive Bayes classifier	Fused Naive Bayes classifier with EM algorithm	Neural Network Classifer
Eyelids surgery	47.71%	39%	53.44%
Lips surgery	36%	29%	41%
Nose surgery	52%	41%	61%

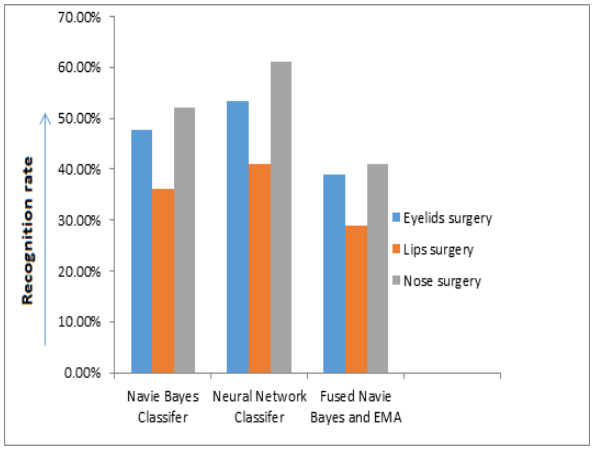

Fig. 13: Graphical representation of recognition rate of three types of surgery

IV. CONCLUSION

This paper has introduced face recognition under local plastic surgical faces using probabilistic approach. Firstly, we have used Naive Bayes classifier for recognition of local plastic surgical faces which has given 45% accuracy in face recognition and after that Naive Bayes classifier fused with EM algorithm to yield effective recognition rate of local plastic surgical faces which has given 36% accuracy. Lastly we have used Neural Network Classifier for recognition of local plastic surgical faces which has given 51% accuracy in face recognition The Naive Bayes classifier individually has given better recognition rate compared to the combination of Naive Bayes classifier with EM algorithm. But Neural Network Classifier has given better recognition than Naive Bayes classifier.

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