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Recognition of Plastic Surgical Faces Using Probabilistic Approach: A Survey

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Abstract: *Face Recognition is one of the key area of research. Face recognition is challenging due to the wide variety of faces with various condition like aging, pose variation, facial expression, and illumination problem. Plastic surgery, on the other hand is considered as a biggest challenge in face recognition. In this paper, the review of face recognition using different probabilistic approach is presented, where a probabilistic approach like Naïve Bayes classifier is used to recognize the faces with plastic surgery and Expectation Maximization Algorithm (EMA) used to approximate the maximum likelihood function. Expectation Maximization Algorithm is combined with Naïve Bayes classifier so that the recognition rate will be improved and face recognition of plastic surgery faces will be effective, other than the above mention algorithm Neural network classifier will also be consider for face recognition*

Keywords: *Probabilistic approach, Naïve Bayes classifier, Expectation Maximization Algorithm (EMA), Neural Network*

I. Introduction

Due to rapid updation in digital world, the digitization plays an important role. When we talk in terms of digitizing the images, the face authentication and authorization is equally important. For verifying people's identification and in social interactions, the human face plays a vital role. Using human face for security purpose, the biometric face recognition technology has presented a sufficiently great observation in last few years. There are several methods of biometrics recognition such as iris recognition, finger prints and face recognition [1]. As compare to the other biometrics system, the face recognition has advantage because the images of the face can be captured from anywhere without the person knowledge. The Face Recognition system consists of three main steps: Face Detection, Face Extraction and Face Recognition as shown in below Fig 1.

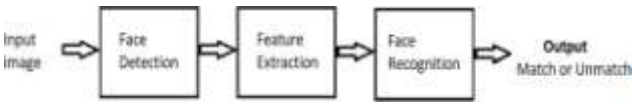

Fig 1. Face Recognition process

Face recognition identify the face by matching the test image with train image. There are many challenges while face recognition which can hamper the face recognition process.

There are various challenges related to face recognition, such as posing, illumination conditions, facial expressions, makeup spoofing and aging. Many researchers has work done regarding this challenges and various techniques has been introduced for recognition but todays major research challenge is plastic surgery based face recognition. There are two broad categories of plastic surgery: local plastic surgery and global plastic surgery [7], [8]. Local plastic surgery is surgery which changes a single feature of the persons face and global plastic surgery is surgery which changes entire structure of the face such as face lift *etc.*

To overcome the challenge of recognizing plastic surgical faces, there is a need of introducing modified approaches. Probabilistic approach is one of the approach for solving face recognition challenges [5]. Naive Bayes classifier is one of the probabilistic approach which is simple but effective classifier which can be used for such face recognition problems. This classifier has been used in various applications like image recognition, natural language processing, and information retrieval [1]. Other than Naïve Bayes as one of the probabilistic approach, two more approaches will be use as fusion of Naïve Bayes with EM (Expectation Maximization) algorithm[20] and Neural Network[13] will also been use as a classifier for recognizing the face of an individual improves classification performance.

This paper is organized as follows. Section II briefly reviews the previous research on various face recognition techniques, face recognition challenges, plastic surgery based face recognition methods and classifier used in face recognition. Section III presents the overview of various challenging issues and

emphasize on plastic surgery based face recognition. Section IV offers conclusions.

II. Related Work

Several Face recognition methods have been introduced in recent few years to make identification of a face easy. Recognition of face in large database is one of the biggest challenge. One of the research in this area has been done by Naeem, Muhammad et.al.[2], the authors introduced all face

recognition techniques[17]. The paper present the survey of techniques, relevant for face recognition. Considering all the advantages and disadvantages of all techniques, comparison is done on basis of recognition rates. According to Ripal Patel [3] the face recognition algorithms fails to identify the peoples under vastly varying condition. As identifying people's faces itself is a complex job, it also contains various challenges. Satonkar S.S Kurhe A. B and Dr.Khanale P.B [4] focuses on the challenges of face recognition system. According to their research due to acquisition conditions and natural aging, the human faces experience many changes. Acquisition conditions include illumination conditions, posing[11], and facial expressions[10]. Some other variations occurs by facial hairs, loss or gain of weight and disguises. Another research of Peng Li and Member [5] proposed that various algorithms of face recognition uses distance based method but the authors explained that probabilistic model gives comparably better outcomes for face recognition under varying pose.

Various research has been done on face recognition problems that addresses the challenges related to face recognition, such as variation in expression [8], posing [3], [8], [15], aging [3], [8], illumination problem [3], [8] and disguise [8], [15]. Now-a-days the 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. Which makes system to do more efforts for finding the similarities between the faces which undergoes surgery. The author R. Singh, M. Vatsa, H. S. Bhatt, S. Bharadwaj, A. Noore and S. S. Nooreyezdan [15] in the paper presented the study to calculate the performance of various face recognition algorithms on surgical face of local and global plastic surgery database.

Giji George, RainuBoben, Radhakrishnan.B and Dr. L. Padma Suresh [6] present a face recognition method on surgically altered faces based on PCA algorithm performance and recognition rate is improved. Work can be enhanced by training the system for noisy input images and for various illumination of input images. There are several approaches for recognizing a face of a person. Ega Bima Putranto, Poldo Andreas Situmorang Abba and Suganda Girsang [1] proposed a new approach by using Eigen face with Naive Bayes Classifier where they claimed that instead of using simple Eigen face approach, use of Eigen face with naive Bayes will give more accuracy. The normalization z- score is added for sharping the accuracy. The method in this paper can be applied on real application such as security.

Amal Saralkhatem Osman Ali, Vijanth Sagayan, Aamir Malik and Azrina Aziz [7] present a novel system for verifying the identity of subjects from face images after plastic surgery. The system was able to achieve maximum verification accuracy of 91%. More fusing mechanisms at different levels and validate the system performance over the same database. Richa Singh, MayankVitsa and Afzel Noore [8] present an experimental study to quantitatively evaluate the performance of face recognition algorithms on plastic surgery database. More research is required in order to design an optimal face recognition algorithm that can also account for the challenges due to plastic surgery. Tsuruoka, Yoshimasa & Tsujii, Jun'ichi [20] proposed fused approach of Naive Bayes Classifier[14] and EM algorithm is used as a fused approach for classifying unlabeled data which improves classification performance. Lastly, the Thai Hoang Le[13] proposed the Artificial Neural Network classifier[16] for matching geometric features of human face. A summary of the discussed methods is presented in Table I.

Table I. Summary of Different Face Recognition Methods

Author and Year	Face Recognition Techniques	Database used	Accuracy
Ripal Patel et al., 2012	GABOR + ICA	FERET	100%
	KAMM	FERET ORL XM2VTS	98%
	KLD-LGBP	Alex-MartinezRobert (AR)	80%
	CFF	FRGC version 2	80.3%
	GIR	FRGC version 2	76%
	DCT	-	99.44%
	KFA-FPPM	FERET	95%
	ESFI	-	80%
	VFVF	MIT face	84.7%

		database	
	3D Aging Model	FG-NET(82,82) MORPFAlbum1 ++(612,612) BROWNS(4,4)	66.4%
	GEI	-	82.2%
	3D MM	Real-time	97%
	DCT+SOM	-	81.36%
Ega Bima Putranto et al., 2016	PEF and Z-score	_	89.5 %
Richa Singh et al., 2014	PCA	Plastic surgery database	19.2%
	FDA		20.4%
	GF		27.8%
	LFA		21.6%
	LBP		30.3%
	GNN		34.1%
Yoshimasa Tsuruoka et al., 20	Naive Bayes classifier with the EM algorithm along with CDC	British National Corpus	89.3%
R. Singh et al., 2014	PCA	Non-Surgery Database Plastic surgery database	45.2%
	FDA		46.5%
	CLBP		56.4%
	LFA		53.23%
	SURF		55.4%
	GNN		70.34%
Peng Li et al., 2012	PLDA Tied PLDA	XM2VTS database	87%
Thai Hoang Le 2011	Artificial Neural Network	MIT + CMU	93.89%

III. Challenging Issues In Face Recognition System

There are various challenges in face recognition systems, such as Illumination condition, pose variation, occlusion,
Aging, Make-up spoofing and plastic surgery. The some of these issues are discussed are as follows.

1. Occlusion: In case of partial occlusion some feature of face completely lost where exact matching cannot be applicable.
2. Illumination: In case of illumination variations in facial feature values due to varying effect of illumination.
3. Expression: Expression is one of the problems faced due to variation in more than one feature values. So to deal with such problem a hybrid approach is used where more than one feature is going to count for recognition.
4. Local Plastic Surgery: As mentioned earlier, local plastic surgery used for improving the facial appearance which may result in change in the appearance of face which creates problem in recognizing faces.

Out of above mentioned challenges we have been focus on one of the emerging issue is local Plastic surgery. The survey has concentrated on three local region of the face as Lip surgery, nose surgery and eyelid surgery. Database of Image Analysis and Biometrics Lab IIIT Delhi, Plastic Surgery Face Database and Frontal Face Database[22]. The database of local plastic pre and post-surgery of Blepharoplasty-Asian-eyes, Lip-Augmentation and Rhinoplasty-Nose-job-nose-surgery is used. Blepharoplasty- Asian-eyes is the surgery of eye lids, Lip-Augmentation is the surgery of lips and Rhinoplasty is the surgery of nose. The sample face images from the Plastic Surgery Database is shown in fig. 2.

Fig 2. Sample face images of Local Plastic surgery from PSD[22]

The Flow of Local Plastic surgery face recognition is depicted in fig 3. accepted surgical image as input image which goes through the three basic steps of face recognition consist of Face Detection, Feature Extraction and Face recognition and in the output the identification of the image from the database is done

A. Face Detection

The first step for recognizing face is face detection. Face detection process is carried out with the help of Viola-Jones algorithm for detecting the face in the image. Viola -Jones detector was chosen as a detection algorithm because of its high detection rate, and its ability to run in real time [18], [19].

B. Feature Extraction

The next step for recognizing face is Feature Extraction. Feature Extraction process is carried out with the help of feature extraction techniques such as PCA [6,12], LDA [6], LBP [8], and GLCIA [20]. Feature Extraction gives the relevant features which are essential for face recognition.

C. Face Recognition

In this step the matching of the features extracted by the feature extraction techniques is done with the help of probabilistic approach like Naive Bayes classifier, fusion of Naïve Bayes classifier with EM algorithm and Neural network classifier. Naive Bayes classifier method learn from data and predict class with each class have probability [1]. Expectation Maximization Algorithm is an iterative method to find maximum likelihood or maximum a posteriori estimates of parameters in statistical models, where the model depends on unobserved latent variables. Combining a naive Bayes classifier with the EM algorithm is one of the promising minimally supervised approaches because its computational cost is low [21]. Neural Network is use to solve problems by simulating neuron's activities[13].

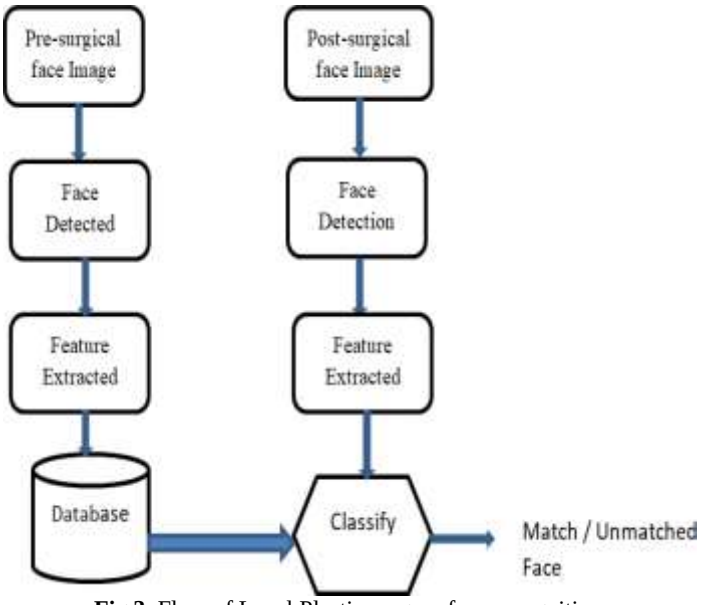

Fig 3. Flow of Local Plastic surgery face recognition

IV. Conclusion

In this paper, we have discussed the face recognition methods, algorithms proposed by many researchers using different probabilistic approaches like Naïve Bayes, fusion of naïve Bayes with EM algorithm and Neural Network which have been used in the field of face recognition and pattern recognition. In addition to this, we have attempted to review a face recognition of plastic surgical faces with the help of probabilistic approach which will give more accuracy in recognizing the plastic surgical faces.

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