Recognizing Surgically Altered Face Images Using Granulation Computation Approach and Hybrid Spatial Features

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Abstract— **Use of biometrics and widespread acceptability for person authentication has instigated several techniques. There are many techniques people use to evade their identification. Plastic surgery is one of them. Plastic surgery is surgical procedure to improve the appearance of the face. In this paper, the extraction of robust features based on granular computation approach and hybrid spatial descriptors is done to recognize surgically altered faces for authentication. The results which are obtained from this identification can be used for authentication of person. Here granular computing based on Gaussian operator and spatial features are presented to match face images before and after plastic surgery. In feature extraction stage, Weber's local descriptors and Gabor filter bank is used to characterize the face appearance. These combined features are useful to distinguish the maximum number of samples accurately and it is matched with already stored original face samples for identifiction. The MATLAB software is used for this technique.**

Index Terms— **Plastic Surgery, Face Recognition, Face Detection, Face Granulation, Face Extraction**

I. INTRODUCTION

Face recognition is a challenging problem in the field of pattern recognition and image processing. Now a day security is very important. There are numerous application areas such as, access control, credit card verification, surveillance etc. in which face recognition plays very important role. Face recognition has received great attention because of lots of applications in different fields.

Face recognition system provides information about age, gender, personal identification (physical constitution), temper and emotional state (facial expression) and interest/attention focus (course of gaze). A new challenge to face recognition is facial plastic surgery.

Plastic surgery procedures can significantly alter facial appearance, thereby posing a serious challenge even to the state-of-the-art face matching algorithms. Plastic surgery procedures provide a proficient and enduring way to enhance the facial appearance by correcting feature anomalies and treating facial skin to get a younger look.

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Apart from cosmetic reasons, plastic surgery procedures are beneficial for patients
Suffering from several kinds of disorders caused due to excessive structural growth of facial features or skin tissues. These procedures amend the facial features and skin texture thereby providing a makeover in the appearance of face.

Facial plastic surgeries are typically performed either

• Locally to correct defects, anomalies or to improve general skin texture, e.g., to correct congenital defects such as cleft lip and palate, to improve nose structure, chin, etc., or

• Globally to reconstruct the complete facial structure for example, for patients with severe burns.

Though facial plastic surgeries can be mis used by criminals to avoid law-enforcement, typically the goal of these surgeries in not to create a new identity. In such cases, both local and global surgeries may result in varying amount of change in relative positioning of facial features and texture.

II. LITERATURE REVIEW

Over years several works have been introduced for the face recognition. Neelam Mahale and Dr. M. S. Nagmode use Principal Component Analysis (PCA) method to improve the security in [3]. PCA is successful technique for face recognition system. Face Recognition using PCA is used in [4]. Face biometrics based on PCA and LDA is described in [5]. Face Recognition using Line Edge Map is used in [6]. Face Recognition by Elastic Bunch Graph Matching is described in [7].

There are several researches present on face recognition in the literature. All the methods in literature consist less accuracy and low discriminatory power. This is the main drawback of existing system. Due to that we go for the proposed method for surgically altered face recognition which can help to automatically recognize the human identity. Face detection module is used to obtain face images which have normalized intensity, are uniform in size and shape and depict only the face region. The Gaussian operator generates a sequence of low pass filtered images. By this Granulation, facial features are segregated at different resolutions. In features extraction stage, WLD descriptor represents an image as a histogram of differential excitations and gradient orientations. The Gabor filter bank is then used to extract the features from face regions to discriminate the illumination changes. Further these combined features are

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used to measure similarity using correlation matrices and decision is taken.

III. METHODOLOGY

The proposed system has five modules: 1) Pre-processing 2) Face Detection 3) Face Granulation 4) Feature Extraction 5) Feature Matching.

In the literature survey many algorithms were developed for face recognition. The proposed method consist DOG method based on face granulation. In extraction stage, WLD descriptor and Gabor filter bank is used. Finally, decision is taken using correlation coefficient for feature matching. Figure 1 shows block diagram of proposed system. The proposed method consists of five modules. Each module and its function will be explained below.

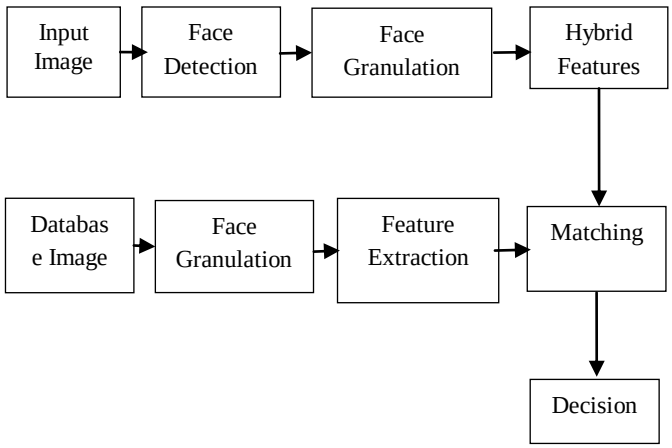

Fig. 1 Detection process for matching surgically altered face images

A. *Pre-processing:*

The pre-processing step converts the image according to the need of the next level. Input image is in RGB format. Conversion of RGB to grey and reshaping also takes place here. The main aim of this paper is to recognize surgically altered face images. Database is a collection of face images in that features are extracted from each image for matching purpose. Similar operation is performing when a face image is taken as input. Further operation is done by face detection and face granulation.

B. *Face Detection:*

Face detection is a computer technology that determines the locations and sizes of human faces in digital images. It detects face and ignores anything else. Face detection is the process to extract face regions from input image which has normalized intensity and uniform in size and shape. The appearance features describes changes of faces such as furrows and wrinkles (skin texture) and are extracted from detected face part. In this system model, an executable (.dll-dynamic link library) file is utilized for extraction of face region. It is used for face detection process. It is based on Haar like features and adaptive boosting method. The key advantage of Haar like features over most other features is its calculation speed.

C. *Face Granulation:*

Granulation is the act or process of forming or crystallizing into grains. Granulation involves construction of granules and granular structure. Calculation of granules levels means divide the input image into number of texture component. Based on that level we get more texture images. Texture information means pattern of face. Face Granulation approach is used to represent the facial information in several parts to extract the features and discriminates presence of variations such as expression, pose and illumination. 2D Gaussian low pass filter is used to generate Difference of Gaussian (DOG) between two successive filtering at each reduced version of image for detection of face granules. At each iteration level, image will be down sampled to desire size to make Difference of Gaussian pyramid. By this granulation, facial features are segregated at different resolution to provide edge details, smoothness, and blurriness.

First stage is formed by convolution of original image with Gaussian functions of varying widths. DOG is calculated as the difference between two filtered images.

$$D(X,Y,\sigma) = L(X,Y,K\sigma) - L(X,Y,\sigma) \quad (1)$$

These images, $L(X,Y,\sigma)$, are produced from the convolution of Gaussian functions,

$$L(X,Y,\sigma) = G(X,Y,\sigma) * I(X,Y) \quad (2)$$

$$G(X,Y,\sigma) = \frac{1}{2\pi\sigma^2} e^{\{-\frac{x^2+y^2}{2\sigma^2}\}} \quad (3)$$

D. *Feature Extraction:*

For feature extraction purpose Weber's Local Descriptor (WLD) is used. WLD descriptor has several properties like illumination changes, robustness to noise, elegant detection of edges and powerful image representation. This descriptor represents an image as a histogram of differential excitations and gradient orientations. WLD descriptor is based on Weber's law. The ratio of increment threshold to the background intensity is a constant. This relationship is known as Weber's law. It can be expressed as,

$$\frac{\Delta I}{I} = K \quad (4)$$

Where ΔI represents the increment threshold, I represents the initial intensity and K signifies that the ratio on the left side of the equation remains constant. The fraction $\frac{\Delta I}{I}$ is known as the Weber fraction.

WLD descriptor involves three steps that is finding differential excitations, gradient orientations and building the histogram.

The Gabor filter bank is then used to extract the features from face regions to discriminate the illumination changes. It is useful to characterize and discriminate the texture of an image through frequency and orientation representation. It uses Gaussian kernel function which is modulated by sinusoidal wave to evaluate the filter coefficients.

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E. Feature Matching

The combination of weber's descriptor and Gabor filter can be used for feature matching. Based on this, person can be identified.

These combined features are useful to distinguish the maximum number of samples accurately and it is matched with already stored original face samples for identification. The simulated results are shown that used granulation and hybrid spatial features descriptors has better discriminatory power and recognition accuracy in the process of recognizing surgically altered face images. Correlation coefficient is used to find the similarity between two different objects with their area features. It is described through,

$$r = \frac{\sum\sum u_1 * u_2}{\sqrt{(\sum\sum(u_1{}^2))(\sum\sum(u_2{}^2))}} \quad (5)$$

IV. RESULTS

In this work, for recognition of surgically altered face images, the proposed process consists of DOG approach which is performed by using face granulation. WL descriptor and Gabor filter bank is used for feature extraction. Above approaches is implemented using MATLAB software.

Plastic surgical treatment procedures can be divided into global and local plastic surgery. Under the local and global categories, there are several varieties of plastic surgery procedures as defined below. Rhytidectomy and skin peeling surgeries are categorized under global plastic surgery. On the other hand local plastic surgery can be classified into two categories that are Blepharoplasty and Browlift surgeries.
Results of surgically altered face images using Rhytidectomy Surgeries are as follows.
Rhytidectomy (full facelift) is the kind of global surgery. It offers a more youthful look and it is used to order the impact of getting older. Outcomes are as follows.

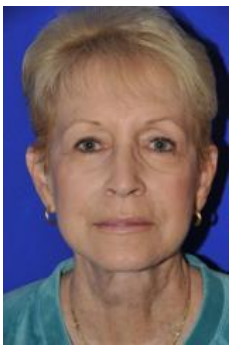

Fig. 2 Input image

Fig. 3 RGB to Grey image

Fig. 4 Face Detection

Input image, conversion of RGB to Gery scale image and face detection shown in figures 1,2,3 respectively.

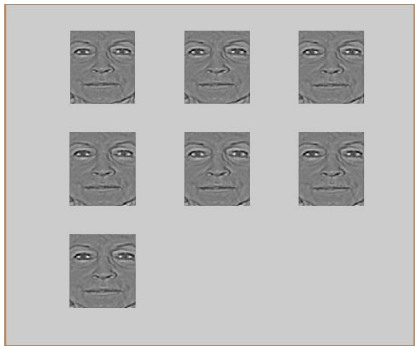

Fig. 5 Face Granules

Fig. 6 Gabor faces

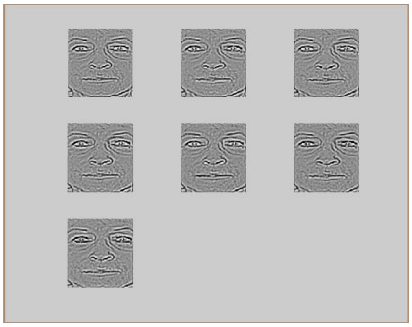

Fig. 7 Weber's faces

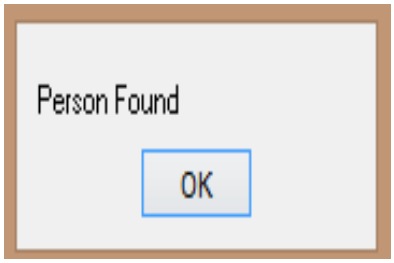

Fig. 8 Output decision window

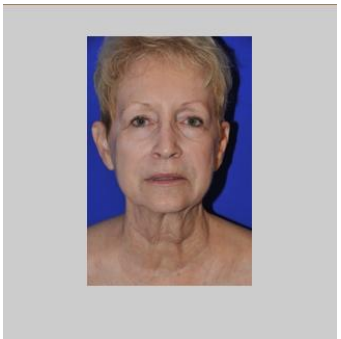

Fig. 9 Matched sample

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Here seven levels of Granulation are computed. Fig.4 Shows output of each level. Results of weber's faces and Gabor faces shown in figures 5 & 6 respectively. If test image is matched with database image then it shows one dialogue box which output decision window is shown in fig 7. Finally matched sample shown in fig.8

Above results of Rhytidectomy surgical procedures are implemented using DOG approach. Similarly we can apply this approach on other surgical local and global procedures such as Browlift, skin peeling and Blepharoplasty (Eyelid).

Table I Identification Accuracy (%) of face recognition for matching surgically altered face images

Type	Surgery	No. of cases	Accuracy (%)	
			PCA	DOG (Proposed)
Local	Browlift	7	57.14	71.42
	Blepharoplasty	8	62.5	75
Global	Rhytidectomy	35	74.28	77.14
	Skin peeling	5	60	60
	Overall	55	72.72	80

Here Table I shows accuracy of existing method and proposed method which is composed type of surgeries. The strategies can extensively alternate the facial areas both domestically and globally, altering the appearance, facial features, and texture, thereby posing a serious challenge to face recognition structures.

Table II Performance measures of face recognition using PCA and DOG algorithm

Algorithm	Total Images	TP	TN	FP	FN	Accuracy (%)
PCA	55	31	9	7	8	72.7273
DOG Method	55	34	10	5	6	80

Here Table II shows performance result of the proposed algorithm is in comparison with PCA for matching surgically altered face images.

The parameter accuracy is calculated [8] making use of equation,

$$\text{Accuracy} = \frac{TP+TN}{TN+TP+FN+FP} \quad (6)$$

In order to evaluate the potential benefits of the proposed approach, the overall performance measures are calculated for datasets and the consequences are given in Table II. So, a new manner of recognizing face images using DOG technique is proposed with a view to obtain high accuracy and with high computational speed. The performance of the proposed algorithm with various global and local plastic surgery procedures is shown in Table I and bar graph in fig. 9. These results show that the proposed algorithm provides improvement of at least 7.27 % compared to existing algorithm across different plastic surgeries. This comparison shows that plastic surgery is a very challenging problem and hence the improvement of algorithms to confound these effects is required.

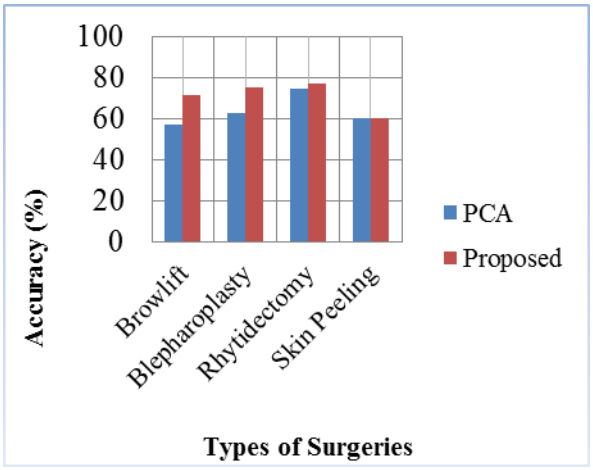

Fig. 10 Percentage graph on different types of local and global plastic surgery procedures

VI. CONCLUSION

The project presents the surgically altered robust human face recognition based on granular computation approach and hybrid spatial features extraction. Here granular computing is done by the DOG method which is used to decompose the image into different scale spaces for effective texture representation. The texture descriptors called Weber's local descriptor and Gabor filter bank is used to characterize the face appearance. WL descriptor and Gabor filter approaches are well used to identify the illumination changes and intensity distributions characteristics. Using correlation metrics, matching is performed between input and original samples. Finally the simulated results shows that used methodologies provides better recognition rate with minimum error rate for all test samples.

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