Surgically Altered Face Images Recognition Using Multimodal Biometric Features

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Abstract— Face recognition has been one of the most interesting and important research fields in the past two decades. The reasons come from the need of automatic recognitions and surveillance systems, the interest in human visual system on face recognition, and the design of human-computer interface, etc. Altering facial appearance using surgical procedures has raised a challenge for face recognition algorithms. These procedures amend the facial features and skin texture thereby providing a makeover in the appearance of face. This paper focuses on analyzing the effect of plastic surgery in face recognition algorithms and a multimodal bio-metric feature extractor algorithm is proposed therefore to match face images before and after plastic surgery.

Index Terms— Bio-metric feature, face recognition, facial features, plastic surgery.

I. INTRODUCTION

Face provides information such as identity, gender, age and expression. Moreover, face recognition is possible with available resources as it is easier to get a photograph of a person (especially in case of suspected criminals) rather than his fingerprint or iris pattern information. However, even after decades of research, face is still an active topic because of the variability observed in face due to illumination, pose, expression and occlusion. A new challenge to face recognition is facial plastic surgery. These surgeries alters facial features to such an extent that even human beings often struggle to identify a person’s face after surgery. The number of people undergoing these plastic surgeries is increasing every day. These surgeries can be used by evaders to mask their identity and roam without any fear for face recognition systems.

A. Face recognition system

The first semi-automated system for facial recognition to locate the features such as eyes, ears, nose and mouth on photographs was introduced in 1960s. It is a computer application used for automatically identifying or verifying a person from a digital image or a video frame. One of the ways to do this is by comparing selected facial features from the image and a facial database. The system measures nodal points on the face, distance between eyes, shape of the cheekbones and other distinguishable features.

In facial recognition system there are two types of comparison:

1) Verification:
   In face verification, given a face image and a guess of the identification, we want the system to tell true or false about the guess.

2) Identification:
   The system compares the given individual to all the other individuals in the database and gives a ranked list of matches.

B. Plastic Surgery

Plastic surgery is a medical specialty concerned with the "correction" or restoration of form and function. Facial plastic surgery is generally used for correcting facial defects or improving the appearance, removing birth marks, moles, scars etc. Due to increased media fascination it has generated a greater public awareness for cosmetic procedures that propagates an ideal beauty standard that is not attainable by natural. The result is the normalization of certain body images, unrealistic expectations in regard to plastic surgery, as well as unethical practices within cosmetic surgery marketing.

Plastic surgery in general can be classified into two distinct categories.

1) Disease correcting local plastic surgery (Local surgery):
   This is a kind of surgery in which an individual undergoes local plastic surgery for correcting defects, anomalies, or improving skin texture. Local plastic surgery techniques can be applied for possibly three different purposes:
   1) To correct by-birth anomalies,
   2) To cure the defects that are result of some accident, and
   3) To correct the anomalies that have developed over the years.
2) Plastic surgery for reconstructing complete facial structure (Global surgery):
Apart from local surgery, plastic surgery can be performed to completely change the facial structure which is known as full face lift. Global plastic surgery is recommended for cases where functional damage has to be cured such as patients with fatal burns or trauma. Furthermore, global plastic surgery may also be used to entirely change the face appearance, skin texture and other facial geometries. Therefore, it can also be misused by criminals or individuals who want to remain elusive from law enforcement.

II. LITERATURE SURVEY
Transmuting facial geometry and texture increases the intra-class variability between the pre- and post-surgery images of the same individual. Therefore, matching post-surgery images with pre-surgery images becomes an arduous task for automatic face recognition algorithms. Several researches have been carried out regardingly, some of them are discussed below:
Aggarwal et al. [2] proposed sparse representation approach on local facial fragments to match surgically altered face images. But in this approach the main disadvantage is that, it requires multiple samples of data. Also the identification accuracy is less (21.5% - 40%).
Singh et al. [6] analyzed several types of local and global plastic surgery procedures and their effect on different face recognition algorithms. They have experimentally shown that the nonlinear variations introduced by surgical procedures are difficult to address with current face recognition algorithms. The performance of their system is subjected to the neutral expression and proper illumination. If we include other covariates such as pose, expression, and illumination, the performance deteriorates.
Recently, B. Weyrauch, et al [9] proposed a component based face recognition approach using different facial components to provide robustness to pose. The main problems observed using this approach are, it requires large number of training images taken from different viewpoints, under different lightening conditions, and it is unavailable for real-world applications.

Though recent results suggest that the algorithms are improving towards addressing the challenge, there is a significant scope for further improvement.

III. PROPOSED METHODOLOGY
The face plays a major role in our social intercourse in conveying identity and emotions. The human ability to recognize faces is remarkable. We can recognize thousands of faces learned throughout our lifetime and identify familiar faces at a glance even after years of separation. The skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expressions, aging, and distractions such as glasses or changes in hairstyle. But developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional, and subject to change over time.

A. Input Face Image
The face image to be detected after alteration is given as an input face image. This is the Query image. This face image i.e. post-surgery image has to be matched with the pre-surgery image. And the image with which it has to match is the training sequence. This forms the training data base.

B. Pre-processing Face Image
The feature and information of face image should not be altered by local changes due to noise and illumination error. Hence to satisfy the environmental conditions, pre-processing of the raw data is highly important. Image capturing is a random process. The resolution of various image capturing devices may not be the same. This results in different resolution of the captured images. For accurate comparison of the features and to reduce the computational effort needed for processing, all the images should be scaled to a uniform size. So, normalization is done on face images in which images are geometrically normalized and size of each image is uniform.

C. Facial Feature Extraction
Another phase in face recognition is feature extraction. Transforming the input data into a particular set of features is called as feature extraction. This is phase where the system does the localizing of the characteristics of face component (i.e. eyes, mouth, nose, ears etc) in an image. In extra, feature extraction is a step in face recognition where the system locates certain points on the face such as corner and centre of the eyes, tip of the nose, mouth, etc. also called as nodal points. It evaluate spatial geometry of differentiate feature of a
face. The outcome of this analysis is a set of template generated for each face. The template consists of reduced set of data that represent the uniqueness of the face image. This proposed method uses the LBP for extraction of feature from face region.

1) Local Binary Pattern:

Local binary pattern is a nonparametric method and it has aroused demanding interest in image processing, computer vision and related applications. LBP is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. Due to its discriminative power and computational simplicity, LBP texture operator has become a popular approach in various applications. It can be seen as a unifying approach to the traditionally divergent statistical and structural models of texture analysis. Perhaps the most important property of the LBP operator in real-world applications is its robustness to monotonic gray-scale changes caused, for example, by illumination variations. Another important property is its computational simplicity, which makes it possible to analyze images in challenging real-time settings.

Consider a 3*3 pixels with (Xc, Yc) intensity value be Gc and local texture as T = t(G0, G1, G2, G3, G4, G5, G6, G7) where Gi (i = 0, 1, 2, 3, 4, 5, 6, 7) corresponds to the grey values of the 8 surrounding pixels. These surrounding pixels are threshold with the centre value Gc as t(s(G0 - Gc),..., s(G7 - Gc)) and the function s(x) is defined as,

\[
s(z) = \begin{cases} 
1, & z \geq 0 \\
0, & z < 0.
\end{cases}
\]

Then the LBP pattern at the given pixel is defined as an ordered set of the binary comparisons and the resulting value can be obtained using following equation. An example of LBP operator is shown in Fig. 3.

\[
LBP p, R(xc, yc) = \sum_{p=0}^{P-1} s(G_p - Gc)2^p.
\]

![Fig 3](image-url)  
**Fig 3.** The LBP operator thresholds each pixel against its neighboring pixels and interprets the result as a binary number. In the bottom image each gray-level value corresponds to a different local binary pattern.

**IV. Experiment**

The experiments are conducted using surgery and non-surgery face database. The images available in the face database are collected from different source of internet. Using these images, the plastic surgery face database is created. This plastic surgery face database contains one pre and post-surgery face image with frontal pose, different lighting condition, and various expressions. Pre-surgery images are used for training purpose, this forms the training database. And post-surgery images as test database set. The required software for this experiment is Matlab. Different steps to perform recognition are as follows:

1) Select the path of training database which contain the pre-surgery face image.
2) Select the path of test database which contains the post-surgery face image.

![Select test database path](image)

3) Enter name of test image number to be matched.

![Input of LBP-Based Face...](image)

4) Then features are extracted from test image and all train images using LBP and Euclidian distances are calculated between that images. Now the minimum distance between test image feature vector and train image feature vector is calculated. Finally Test image is classified as belonging to train image i when minimum distance from distance vector is obtained.

5) Result of proposed on non-surgery face image.

![Result of proposed on non-surgery face image](image)

6) Result of proposed method on Plastic-surgery face image.

![Result of proposed method on Plastic-surgery face image](image)

7) The matched image from train database with minimum distance and its respective index is shown in following figure.

![The matched image from train database with minimum distance](image)

V. CONCLUSION

Plastic surgery is becoming prevalent due to advances in technology, affordability, and the speed with which these procedures can be performed. The procedures can significantly change the facial regions both locally and globally, altering the appearance, facial features and texture. Existing face recognition algorithms generally rely on this information and any variation can affect the recognition performance.

This paper presents an approach for the recognition of surgically altered human face. This paper proposes a multimodal biometric system which extracts features from face area using local binary pattern operator. This clearly extract the shape and texture features which represents a face image in more meaningful way than any other feature extractor. Based on the results, it is estimated that the problem of face recognition using the widely available plastic surgery database could be further improved if the non-ideal factors (e.g., duplicate entries, low image resolutions, etc.) of the database are accounted for.

![Conclusion figure](image)
REFERENCES


