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AN INNOVATIVE APPROACH FOR PLASTIC SURGERY FACE RECOGNITION-A REVIEW

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ABSTRACT

The face recognition has great significance in surveillance system as it doesn't need the object's cooperation. The actual advantages of face based identification over other biometrics are uniqueness and acceptance. Advancement and affordability is leading to popularity of plastic surgery procedures. Facial plastic surgery can be reconstructive to correct facial feature anomalies or cosmetic to improve the appearance. Both corrective as well as cosmetic surgeries alter the original facial information to a great extent thereby posing a great challenge for face recognition algorithms. It has been observed that many face recognition algorithms fail to recognize faces after plastic surgery, which thus poses a new challenge to automatic face recognition. There are several effective methods invented in recent past. So here we are suggesting an innovative approach to find out a mean method that will provide the most accurate result even after the subject has undergone a plastic surgery with higher accuracy and better response rate. This method consist of finding a mean image, which is obtained by applying several popular methods like PCA, LBP along with periocular biometrics to the test image. For comparing pre and post surgery face images Euclidean distance is used.

KEYWORDS: Plastic Surgery, Periocular Region, Feature Extraction.

INTRODUCTION

In recent years, plastic surgery has become popular worldwide. People take facial plastic surgery to correct feature defects or improve attractiveness and confidence. According to the American society's 2013 report there have been 15.1 million cosmetic procedures and 5.7 million reconstructive procedures performed in the year 2013.Among the cosmetic surgical procedures the top five are Breast augmentation , Nose reshaping, Eyelid surgery, Liposuction and Facelift. It shows that the percentage of persons going for plastic surgery is highest in the age ranging from 40 to 54 years old. It also shows that 91% of all the cosmetic surgeries are performed by females [1]. Facial plastic surgery is generally used for correcting feature defects or improving the appearance, for example, removing birth marks, moles, scars and correcting disfiguring defects.The allure for plastic surgery is experienced world-wide and is driven by factors such as the availability of advanced technology, affordable cost and the speed with which these procedures are performed. These surgical procedures prove beneficial for patients suffering from structural or functional impairment of facial features, but these procedures can also be misused by individuals who are trying to conceal their identity with the intent to commit fraud or evade law enforcement.

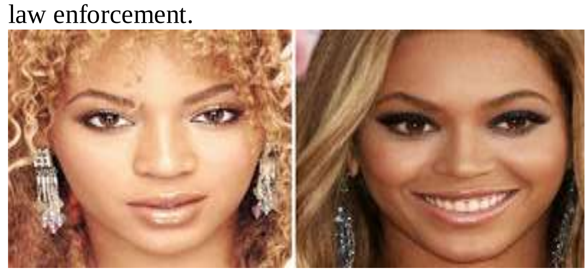

Fig. 1. Illustrating the variations in facial appearance, texture, and structural geometry caused due to plastic surgery (images taken from internet)

These surgical procedures may allow anti-social elements to freely move around without any fear of being identified by any face recognition system. Plastic surgery, results being long-lasting or even permanent, provide an easy and robust way to evade law and security mechanism [3][6]. Sometimes, facial plastic surgery may unintentionally cause rejection of genuine users. While face recognition is a

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well-studied problem in which several approaches have been proposed to address the challenges of illumination, pose, expression, aging and disguise, the growing popularity of plastic surgery introduces new challenges in designing future face recognition systems [8]. Since these procedures modify both the shape and texture of facial features to varying degrees, it is difficult to find the correlation between pre and post-surgery facial geometry [6].

Types of Facial Plastic Surgery

When an individual undergoes plastic surgery, the facial features are reconstructed either globally or locally. Therefore, in general, plastic surgery can be classified into two distinct categories.

• 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.

• 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.[6]

RELATED WORK

Most popular face recognition algorithms after plastic surgery are described as below.

1. A Sparse Representation Approach[3]

Gaurav Aggarwal and his colleagues proposed a sparse representation approach.Both local and global surgeries may result in varying amount of change in relative positioning of facial features and texture. Though the overall face appearance changes, the resulting face typically resembles the original face in a part-wise manner. Unfortunately, these appearance variations are enough to cause most face matching approaches to show significant degradation in performance. Based on these observations, they proposed to use a part-wise approach to deal with the challenges posed by these subtle variations in facial appearance.The part-wise framework is combined with the sparse representation approach [11] to improve face matching performance across plastic surgery variations. Here they proposed a partwise approach that is based on the intuition that appearance of one or more facial features may not change much across plastic surgery procedures. In such a part-wise framework, the proposed approach exploits recent successes of sparse representations for face matching [11].With just one image per subject in the gallery,they overcame this challenge by using sequestered training face images. For each facial part of each gallery subject, they identified most similar facial parts from the training images and used them in the absence of multiple images per subject in the gallery. Even though entire faces from training data did not resemble those in the gallery at all, faces typically showed higher part-wise resemblance. Conceptually, this approach shares similarities with simile classifiers [10] recently proposed for the task of face verification. The simile classifiers are binary classifiers trained to recognize the similarity of faces, or regions of faces to a few reference people.Closely resembling training images with facial parts most similar to each subject in the gallery are identified and used in the absence of multiple gallery images. They showed that the proposed algorithm significantly bridges the performance gap earlier observed when matching faces across plastic surgeries, compared to matching normal face images. As supported by the experimental evaluations, the good performance of the proposed approach is attributed to both part-wise analysis and sparse recognition technique.[3]

2.Multiobjective Evolutionary Algorithm[12]

Himanshu S. Bhatt and his colleagues proposed a multiobjective evolutionary granular algorithm to match face images before and after plastic surgery. The proposed algorithm starts with generating non-disjoint face granules where each granule represents different information at different size and resolution. Further, two feature extractors, namely Extended Uniform Circular Local Binary Pattern (EUCLBP) and Scale Invariant Feature Transform (SIFT) , are used for extracting discriminating information from face granules. Finally, different responses are unified in an evolutionary manner using a multiobjective genetic approach for improved performance. In this algorithm first of all 40 face granules are extracted from each image for a given gallery-probe pair. Then EUCLBP or SIFT features are computed for each face granule according to the evolutionary model learned using the training data. The descriptors extracted from the gallery and probe images are matched using weighted $\chi 2$ distance measure. Lastly in identification mode (1:N) , this procedure is repeated for all the gallery-probe pairs and top matches are obtained based on the match scores.The proposed algorithm utilizes the observation that human mind recognizes faces by analyzing the relation among non-disjoint spatial features extracted at different granularity levels.

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3. Near Sets Approach[4]

K. R. Singh suggested a near sets approach for local plastic surgery face detection which geometrically obtain feature values and their approximation using near sets. Once the features will be extracted a feature database will be formed. Using this feature values near set theory provides a method to establish resemblance between objects contained in a disjoint set, that is it provides a formal basis for observational comparison and classification of the objects.In near set theory, each object is described by a list of feature values.The word feature corresponds to an observable property of physical objects in this context. For a feature such as nose on a human face, nose length or nose width will be the feature values. Comparing this list of feature values, similarity between the objects can be determined and can be grouped together in a set, called as near set. Thus near set theory provides a formal basis for the observation, comparison and recognition or classification of objects. The nearness of objects can be approximated using near sets. Approximation can be considered in the context of information granules (neighborhoods).

4. Multimodal Biometric FeaturesApproach[5]

N. S. Lakshmiprabha and his colleagues suggested a multimodal approach in which facial and periocular region features are extracted and used for comparison. Feature extraction is done for both face and periocular images using feature extraction methods such as Gabor wavelets and Local Binary Pattern (LBP) which is followed by feature dimension reduction using PCA. Classification is performed using Euclidean distance. Features from the face images are matched first and when there is a negative result periocular image features are matched. The paper concluded that the discriminative nature of periocular region increases the performance of the recognition system than the face biometric and this is valid only when the number of images is reasonably large for training. In case of plastic surgery, this proposed method performs better than other methods. However it can be improved by considering more number of features.

PROPOSED METHODALOGY

This paper proposes a new simple and innovative approach for the face recognition after plastic surgery. This method makes the use of different features from face and periocular region to match face images before and after plastic surgery. The block diagram of proposed method is shown in Fig.2 To extract the features from both face and periocular biometrics local binary pattern feature extractor is used alongwith principal component analysis to reduce the dimensions. Then Euclidian distance is used for classification of processed images. The distance metric from each method is calculated and the image with minimum distance metric is selected as the recognized face image. The block diagram has the following steps: Preprocessing, Feature Extraction and Classification.

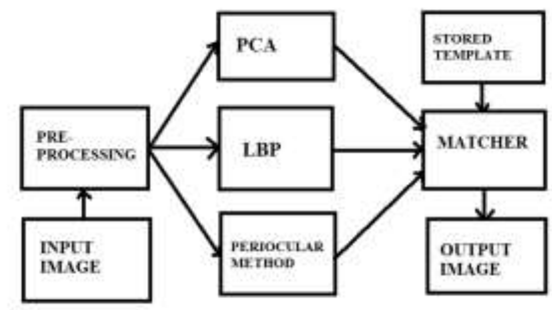

Fig.2. Proposed Block Diagram

1. Preprocessing

The pre-processing of the raw images is very important step in face recognition system. For proper analysis ,comparison or manipulation of various objects in the image we need to do the preprocessing in order to level the various field such as cardiac cross sections and spines needed to occupy the same area in the coordinate plane. Data pre-processing describes any type of processing performed on raw data to prepare it for another processing procedure . Data pre-processing changes the data into a format that will be more easily and effectively processed for the purpose of the user.The feature and information of face image should not be altered by local changes due to noise and illumination error [1]. Hence to satisfy the environmental conditions, preprocessing of the raw data is highly important [4]. The change in resolution of various image capturing devices results in different resolution of the captured images. Hence to increase the accuracy and to decrease the computational efforts all the images should be made uniform in size. Allignment of face image is also necessary to have a better result.

2.Feature Extraction

Feature extraction is done after the preprocessing phase. Features should contain information required to distinguish between classes, be insensitive to irrelevant variability in the input, and also be limited in number, to permit, efficient computation of discriminant functions and to limit the amount of training data required. Feature extraction is an important step in the construction of any pattern

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classification and aims at the extraction of the relevant information that characterizes each class. In this process relevant features are extracted from objects to form feature vectors. These feature vectors are then used by classifiers to recognize the input unit with target output unit. It becomes easier for the classifier to classify between different classes by looking at these features as it allows fairly easy to distinguish. Feature extraction is the process to retrieve the most important data from the raw data. Feature extraction is finding the set of parameter that define the shape of a character precisely and uniquely. The major goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements and to generate similar feature set for variety of instance of the same symbol. In this proposed method we will use the LBP and PCA for feature extraction.

Local Binary Pattern

The LBP operator [13] is one of the best performing texture descriptors and it has been widely used in various applications. It has proven to be highly discriminative and its key advantages, namely, its invariance to monotonic gray-level changes and computational efficiency, make it suitable for demanding image analysis tasks [13]. As a non-parametric method, LBP summarizes local structures of images efficiently by comparing each pixel with its neighboring pixels. The most important properties of LBP are its tolerance regarding monotonic illumination changes and its computational simplicity[9]. The original LBP operator labels the pixels of an image with decimal numbers, called Local Binary Patterns or LBP codes, which encode the local structure around each pixel. It proceeds thus, as illustrated in Fig.3 Each pixel is compared with its eight neighbors in a 3x3 neighborhood by subtracting the center pixel value. The resulting strictly negative values are encoded with 0 and the others with 1. A binary number is obtained by concatenating all these binary codes in a clockwise direction starting from the top-left one and its corresponding decimal value is used for labeling. The derived binary numbers are referred to as Local Binary Patterns or LBP codes.

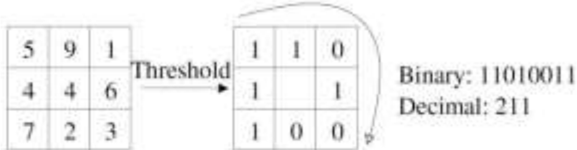

Fig. 3. An example of the basic LBP operator

One limitation of the basic LBP operator is that its small 3x3 neighborhood cannot capture dominant features with large scale structures. To deal with the texture at different scales, the operator was later generalized to use neighborhoods of different sizes [9]. A local neighborhood is defined as a set of sampling points evenly spaced on a circle which is centered at the pixel to be labeled, and the sampling points that do not fall within the pixels are interpolated using bilinear interpolation, thus allowing for any radius and any number of sampling points in the neighborhood. Fig. 4 shows some examples of the extended LBP operator, where the notation (P, R) denotes a neighborhood of P sampling points on a circle of radius R.

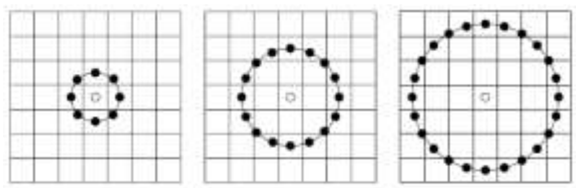

Fig. 4. Examples of the extended LBP operator [20]: the circular (8, 1), (16, 2),and(24, 3) neighborhoods.

Formally, given a pixel at (*xc*, *yc*), the resulting LBP can be expressed in decimal form as:

$$LBP_{P,R}(x_c, y_c) = \sum_{P=0}^{P-1} s(i_P - i_c)2^P$$

Where i_c and i_p are respectively gray-level values of the central pixel and P surrounding pixels in the circle neighborhood witha radius R, and function S(x) is defined as:

$$s(x) = \begin{cases} 1 & if \quad x \geq 0 \\ 0 & if \quad x < 0 \end{cases}$$

By the definition above, the basic LBP operator is invariant to monotonic gray-scale transformations preserving pixel intensity order in the local neighborhoods. The histogram of LBP labels calculated over a region can be exploited as a texture descriptor. The facial image is divided into local regions and texture descriptors are extracted from each region independently. The descriptors are then concatenated to form a global description of the face. See Fig.5 for an example of a facial image divided into rectangular regions.

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Fig. 5. A facial image divided into 7x7,5x5 And 3x3 Rectangular Region

The basic histogram can be extended into a spatially enhanced histogram which encodes both the appearance and the spatial relations of facial regions. As the m facial regions R0,R1….Rm-1 have been determined, a histogram is computed independently within each of the m regions. The resulting m histograms are combined yielding the spatially enhanced histogram. The spatially enhanced histogram has size mxn where n is the length of a single LBP histogram.

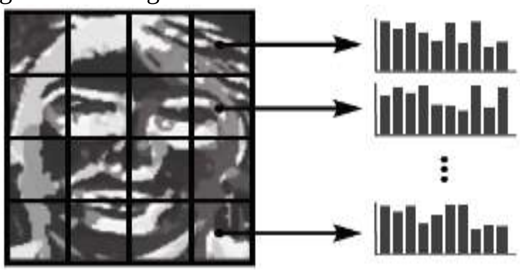

Figure 6. LBP descriptors are built by partitioning the LBP face image into a grid and computing LBP histograms over each grid cell. These histograms may then be concatenated into a vector or treated as individual descriptors.

Principal Component Analysis(PCA)

Principal Component Analysis is a mathematical algorithm that reduces the dimensionality of the data while retaining most of the variation in the data set. It accomplishes this reduction by identifying directions, called principal components, along which the variation in the data is maximal. By using a few components, each sample can be represented by relatively few numbers instead of by values for thousands of variables. Samples can then be plotted, making it possible to visually assess similarities and differences between samples and determine whether samples can be grouped. PCA for face recognition is based on the information theory approach. It extracts the relevant information in a face image and encodes as efficiently as possible. It identifies the subspace of the image space spanned by the training face image data and decorrelates the pixel values. The classical representation of a face image is obtained by projecting it to the coordinate system defined by the principal components. The projection of face images into the principal component subspace achieves information compression, decorrelation and dimensionality reduction to facilitate decision making. In mathematical terms, the principal components of the distribution of faces or the eigenvectors of the covariance matrix of the set of face images, is sought by treating an image as a vector in a very high dimensional face space[14].We apply PCA on this database and get the unique feature vectors using the following method .Suppose there are P patterns and each pattern has t training images of m x n configuration.

• The database is rearranged in the form of a matrix where each column represents an image.
• With the help of Eigen values and Eigen vectors covariance matrix is computed.
• Feature vector for each image is then computed. This feature vector represents the signature of the image. Signature matrix for whole database is then computed.
• Euclidian distance of the image is computed with all the signatures in the database.
• Image is identified as the one which gives least distance with the signature of the image to recognize.

Periocular Biometrics

Periocular area (i.e. a region surrounding the eye) is considered to be one of the most discriminative regions of a face [5] and is used for identifying an individual. The use of periocular region may be beneficial in situations where the face is partially occluded, or the subjects have facial hair, etc. Also, it has been proposed in some recent approaches that part-based face representation as opposed to the traditional holistic face representation, may lead to improved face recognition performance[7]. The low-level features extracted from the periocular region can be effectively used for identification[2]. There is no database available with periocular region images. Only way to fetch this is using a face image. There are three different ways to perform Periocular biometric such as overlapping, Non-overlapping and Strip[5].

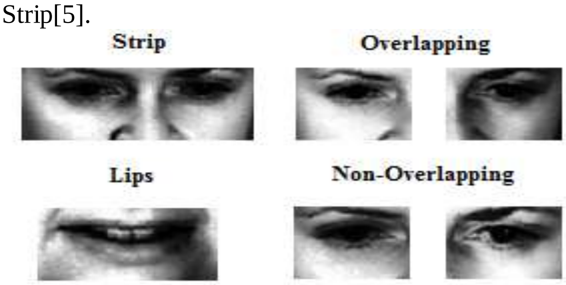

Fig.7 Different types of periocular regions

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LBP and PCA are used on this periocular data to extract features and to form reduced dimension templates which will be then used for classification.

3. Classification

Euclidean distance can be used for the classification to identify the image in the training set to which the test image belong. Classification will be performed by comparing the feature vectors (weight matrix) of the images in the training set with the feature vectors calculated by three used methods on the test image, using Euclidian distance, ε_i.

$\varepsilon_i^2 = ||\Omega_T - \Omega i||^2$ [5]

where Ωi is a vector describing the ith face image in the training set. Thus minimum ε_i is calculated for each method used viz. LBP,PCA and Periocular and finally among the three face imges with minimum ε_i image having minimum ε_i among them will be selected as the recognized image.

CONCLUSION

The trend of facial plastic surgery has been increased drastically and many are using it for hiding their identity. Currently there are very few approaches available to detect faces after plastic surgery with high identification rate. To extract the features we will use holistic as well as part wise approach to increase the performance. Here in this paper we have given a new approach based on PCA, LBP and Periocular biometrics which will not only be more simpler than others but also more efficient when applied.

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