

Face Recognition System Invariant to Plastic Surgery

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Abstract: The importance of biometric authentication is increasing rapidly because it verifies the claimed user identity. There are different types of biometrics available such as finger print, facial scan, retinal scan, voice print. From these, face is one of the most commonly used biometric. Hence the development of face recognition system seems to be useful. There are many techniques people use to evade their identification. Plastic surgery is one of them. Plastic surgery is a surgical procedure to correct the facial anomalies or to improve the appearance of the face. Matching of images before and after the plastic surgery process is the difficult task for automatic face recognition systems because of the wide variations created due to plastic surgery. Facial plastic surgery changes facial features to large extent and thus creating a major problem to face recognition system. This paper proposes a method to match before and after surgery images so one can prove the identity. For this image is divided in to different granules and features are extracted using SIFT and Efficient LBP to get different information's from the face granules. The features are selected using SWARM Optimization feature selection algorithm.

Keywords: Plastic surgery, SIFT, Efficient LBP, Local binary pattern, SWARM Optimization Algorithm.

I. INTRODUCTION

Face is special as it provides information such as identity, gender, age, expression and ethnicity. Also, 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 finger print 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 face after surgery [1], [2]. The number of people undergoing these plastic surgeries is increasing every day. The reason behind this transition is due to the intension among people to look young, improved technology with very less incur period and the cost involved. These surgeries can be used by evaders to mask their identity and roam without any fear for face recognition systems. Figure 1 shows the typical changes in facial features after plastic surgery [1]. Due to privacy issues, the surgical details of a particular individual are not available. Also, plastic surgery face database [2], [4] contains one pre-surgery image for training and a post-surgery image for testing. This further complicates feature extraction task in face recognition methods.

The proposed algorithm initially generates different face granules for both before and after plastic surgery images. The face granulation is the first module of the proposed system. After the face granulation the features are extracted for each granule by using two complementary feature extractors. This is because of each face granules give different information such as some gives the texture information where as some gives fiducial features such as eyes, nose etc[2]. Two feature extractors are efficient local

binary pattern (LBP) and Scale Invariant Feature Transform (SIFT). For each face granule the features are extracted and calculate the weights for corresponding descriptors of SIFT feature and LBP feature. The features are selected using SWARM Optimization algorithm. After the selection of features the matching is done according to the selected features.



Fig 1: Before (Pre) and After (Post) Plastic surgery images.

II. PROPOSED SYSTEM

Proposed system generates different face granules using a face granulation approach with three levels of granularity. After plastic surgery the facial features of an individual may changes either globally or locally [9]. Here the feature extractors namely Efficient Local Binary Pattern and Scale Invariant Feature Transform are used for extracting distinct information from different face granules. Thus gives high identification accuracy compared to the existing system. SWARM Optimization algorithm offers less computation time for selecting the features and yield reasonably accurate identification results.

A. Face Image Granulation

In this module different features are generated by three levels of granularity. The granules contain information such as nose, ears, forehead, cheeks and the combination of two or more features [10]. The loaded

image is applied to a facedetector to get the frontal face. The detected frontal face is divided into several granules through three levels of granularity. In the first level of granularity [2] the image is applied to Gaussian and Laplacian operators to get different smoothed images which help to find out different plastic surgery procedures. In the second level of granularity the image is divided into horizontal and vertical parts whereas the third level of granularity the image is divided into 16 parts to match each granule with others in the after plastic surgery image.

1. First level of granularity:

In the first level of granularity the face granules are generated by applying the Gaussian Fig.3 and Laplacian Fig.4 pyramidal operators. The Gaussian pyramidal operator generates a sequence of low pass filtered images in which iteratively convolving each of the component images. The convolution operator is used with the half of the size of the image to get the pyramidal structure. By applying this operator can get the blurred image from level 0 to level 3. The Laplacian pyramidal operator generates a series of band-pass filtered images which provide edge information. The difference of Gaussian operator gives the band-pass images. The first level of granularity provides different information at multiple resolutions so that, can identify whether which plastic surgery procedure is used like skin lifting. From the first level of granularity can get 6 granules.

2. Second Level of Granularity:

In the second level of granularity the image is divided into horizontal Fig.5 and vertical granules Fig.5. It provides resilience to variations in inner and outer facial regions. It uses the relation between horizontal and vertical granules to address the variations in forehead, chin, ears, and cheeks caused due to plastic surgery procedures. From this level can get different combinational patterns of eyes, nose, cheek and chin. From the second level of granularity can get 18 granules.

3. Third Level of Granularity:

In the third level of granularity is done by dividing the image into 16 granules based on the golden ratio template algorithm Fig.6. The human face golden ratio means the most beautiful face ratio. It has three parts that mean from hairline to eyebrow, from eyebrow to nose and from nose to chin. In this level the faces are divided according to these three parts. Here the human face golden ratio is used to define the facial feature size.



Fig.3: first level of granularity by applying Gaussian operator.



Fig.4: first level of granularity by applying Laplacian operator.



Fig.5: second level of granularity (Vertical face granules)

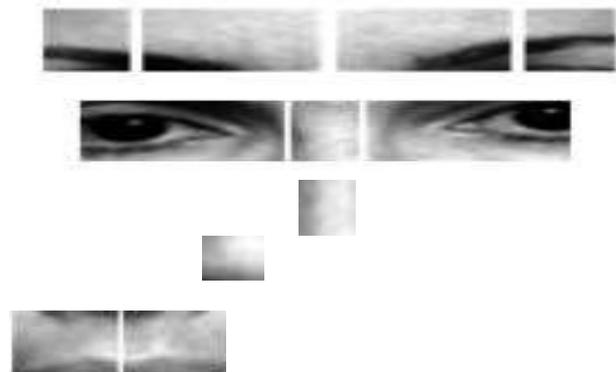


Fig.6: third level of granularity

B. Feature Extraction

Feature extraction is used in pattern recognition and also in image processing to reduce dimensionality. Feature extraction can be used to detect and isolate various desired portions or shapes (features) of an image. Texture and fiducial features can be extracted using different feature extractors. There are two popular feature extractors used to extract distinct features from different face granules. Here the feature extractors are Efficient Local Binary Patterns [3] and Scale Invariant Feature Transform [4].

- 1) **Efficient LBP:** Local Binary Pattern (LBP) is a simple yet very efficient texture operator. Each pixel of an image is compared with 8 neighbouring pixels to get a binary pattern. This is done by setting the centre pixel as the threshold and comparing it with the neighbouring pixels. If the neighbouring pixel has a value greater than or equal to the threshold value then assign 1 to the corresponding pixel, otherwise 0. It takes the binary pattern by left-to-right reading pattern. From this binary pattern, calculate the decimal value for the corresponding centre pixel. It is used for texture analysis.
- 2) **SIFT:** SIFT is a scale and rotation invariant descriptor that generates an image based on

image gradients. It can be used for feature extraction. SIFT algorithm is used for object identification. In proposed method the 40 granules are undergone for feature extraction. It uses a sparse descriptor is computed around the detected interest points. Here the SIFT descriptor is computed in a dense manner.

C. Feature Selection

Features are selected using SWARM Optimization approach [8]. It is a computational method that optimizes a given problem by iteratively attempting to enhance each candidate solutions with regard to a given measure of quality. SWARM Optimization approach [5] optimizes a problem by having a population of candidate solutions. Each particle has a weight and they solve the problem by comparing it with the corresponding neighbours.

III. RESULTS

The proposed algorithm is evaluated by considering two datasets. One dataset consists of images that are taken before plastic surgery and the second one contains images after plastic surgery fig8.

The weights for the corresponding features are calculated for each face granules. And from each calculated weight pair is compared with each granules. The selections of features are done by SWARM Optimization approach. High identification accuracy features are selected for each face granules. Matching is done by comparing each face granules with after plastic surgery images. Maximum compared face granules give the resultant output. If the compared result is greater than the threshold value, then print as MATCHED otherwise NOT MATCHED.

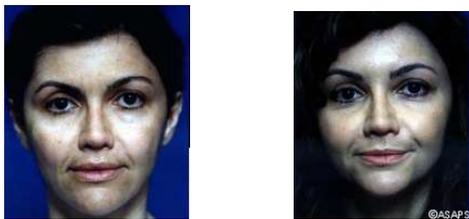


Fig.8: Input images(Before and after plastic surgery)

CONCLUSIONS

This research presents an efficient face matching algorithm in plastic surgery using an evolutionary granular algorithm. Input for the system is the images from before and after plastic surgery and then perform the face matching algorithm for both images. In Genetic algorithm the original image itself is taken as input and found the match with surgical images. The disadvantage of this approach is some results gave incorrect match. In proposed system the granular approach is used, so that several face granules are used as input for the feature extraction. SWARM optimization algorithm selects the first level of granularity processes the image with Gaussian and Laplacian operators and second level of granularity the image is divided into horizontal and vertical granules of different size to get different

information content. Proposed swarm optimization algorithm [5][6][7] finds the best particles based on two level mentioned above and move particle i to j if the best recognition result are found than the existing recognition results. Detailed analysis on the contribution of granular levels and individual face granules corroborates the hypothesis that the proposed algorithm unifies diverse information from all the granules to address the non-linear variations in the pre and post-surgery images and have high degree of identification accuracy.

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