

**IMAGE FORGERY DETECTION USING GENETIC ALGORITHM FOR  
SURGICALLY ALTERED FACE IMAGES**

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**Abstract** — *In the Plastic surgery method, changing the shape of face or part of face is done. Such kind of changes can be achieved by using plastic surgery methods and it is come under image forgery if it is done with the intent to hide individual's identity. Now a day, it is difficult to perform matching of surgically altered face by using automatic face detection algorithm. Some of algorithm fails to perform on local and global region of face and there are some plastic surgery methods like Rhinoplasty, which cannot realised by recognition algorithm. So in this paper Granular Computing is done up to Second level for Global and Local regions of face. In this non-disjoint face granules at multiple levels of granularity are generated. The feature extraction on each face granule is done. Afterwards Genetic algorithm is used for matching faces of pre and post surgery images.*

**Keywords-** *Image forgery, Local region, Global region, Rhinoplasty, Granular Computing, Multiobjective Evolutionary algorithm, granule, feature extraction.*

**I. INTRODUCTION TO IDENTIFICATION OF SURGICALLY ALTERED FACE IMAGE**

According to International survey by American Society for Aesthetic [2] plastic surgery for year 2010 about 9% increase in total no. of cosmetic surgery procedures with over 500,000 surgical procedure performed on face. Matching of presurgery and post surgery images is an arduous task for automatic face recognition algorithms. In this, the database related to Rhinoplasty [3] is taken as source. Some causes for making plastic surgery on face.

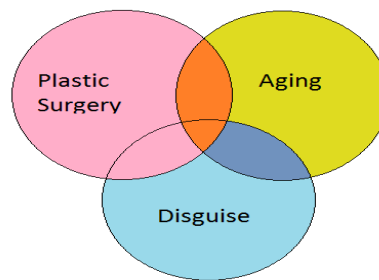


Fig. 1. Causes Related to Plastic surgery

Plastic surgery & disguise can be misused by individuals trying to conceal their identity & evade recognition. Singh et al. analyzes several types of local and global plastic surgery procedures & their effect on different face recognition algorithm. De-Marsico et al [5] developed an approach to integrate information derived from local regions to match pre- & post-surgery images. Aggarwal et al [6] proposed a sparse representation approach on local fragments to match surgically altered face images.

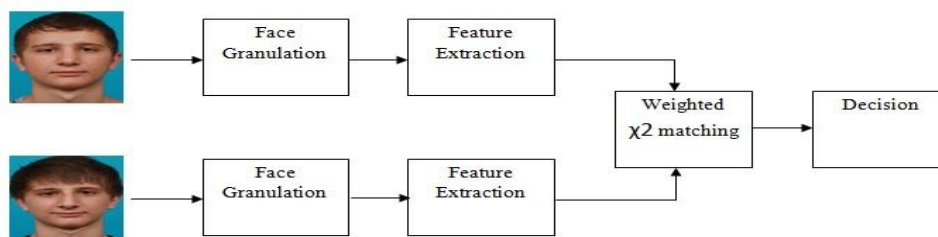


Fig. 2. Block Diagram showing different stages of an algorithm.

The application of previously proposed algorithm starts with generating face granules, where each granule represents different information at different size and resolution. For that two feature extractors & descriptors are used namely

- 1) Extended Uniform Circular Local Binary Pattern (EUCLBP)
- 2) Scale Invariant Feature Transform (SIFT)

Both these are used for extracting discriminating information from face granules. For improve performance above information genetic algorithm is used.

## **II. LITERATURE REVIEW**

In this, image forgery is defined in different way that, if face recognition is not possible or matching between two faces is not found then it will be summarized as Image forgery. So the different approaches on face recognition are discussed below.

G. Aggarwal [6] proposed that, Plastic surgery procedures can significantly alter facial appearance, thereby posing a serious challenge even to the state-of-the-art face matching algorithms. A novel approach to address the challenges involved in automatic matching of faces across plastic surgery variations. In the proposed formulation, part wise facial characterization is combined with the recently popular sparse representation [6] approach to address these challenges. The sparse representation approach requires several images per subject in the gallery to function effectively which is often not available in several use cases. The proposed formulation utilizes images from sequestered non-gallery subjects with similar local facial characteristics to fulfill this requirement.

H.S. Bhatt [7] designed an efficient algorithm for matching sketches with digital face images. The algorithm extracts discriminating information present in local facial regions at different levels of granularity. Both sketches and digital images are decomposed into multi-resolution pyramid to conserve high frequency information which forms the discriminating facial patterns [7]. Extended uniform circular local binary pattern based descriptors use these patterns to form a unique signature of the face image. Further, for matching, a genetic optimization based approach is proposed to find the optimum weights corresponding to each facial region. The information obtained from different levels of Laplacian pyramid is combined to improve the identification accuracy.

According to B. Heisele's work [8], Component-based method and two global methods for face recognition and evaluate them with respect to robustness against pose changes. In the component system first locate facial components, extract them, and combine them into a single feature vector which is classified by a support vector machine (SVM) [8]. The two global systems recognize faces by classifying a single feature vector consisting of the gray values of the whole face image. In the first global system, author trained a single SVM classifier for each person in the database. The second system consists of sets of view-specific SVM classifiers and involves clustering during training. He performed extensive tests on a database which included faces rotated up to about 40° in depth. The component system clearly outperformed both global systems.

G.B. Gorkberk [9] uses FERET database. In this, the local feature-based technique is used. It proposes a novel, local feature-based face representation method based on two-stage subset selection where the first stage finds the informative regions and the second stage finds the discriminative features in those locations. In order to reach an accurate and simple facial feature set, the authors used the training data from the FERET dataset [9]. It has showed that from the experiments conducted on the FERET dataset, there is a high recognition power at face outline, forehead, eyebrows, eye corners and nose area. It is also shown that location and parameter selection are not highly sensitive to correct alignment and the benefits of using feature selection is true even when small errors are present.

Weyrauch et al. [10] uses a gray level pixel value from several facial components & classification performed using SVM. Li et al. [12] propose an approach to retrieve information from local patches of face image by using different level. Singh et al. [4] also observed that surgical procedure may lead to alterations in more than one facial region. Sinha et al [10] worked on 19 results based on face recognition capabilities of human mind. As he suggest that human can efficiently recognize faces even with low resolution and noise.

In our work, matching is done by using two methods as given above as Granular way [2] and Genetic algorithm [1] way.

## **III. GRANULAR COMPUTING AND FEATURE EXTRACTION APPROACH FOR FACE RECOGNITION**

For information related to facial algorithm is either in holistic way or extract feature & process them in parts. The local variations related to pose, expression, illumination and disguise. Holistic approach together with discrete levels of information granularity is used. Campbell et al. [11] proposes that inner & outer facial information is very helpful in recognizing face. So in granular computing approach, non-disjoint features are extracted at different granular levels.

In this the face image size is  $n \times m$ . Up to second level of granularity is done for local and global region of face. Multiple resolutions are taken in the first level of granularity. Inner and outer facial information is taken out from image at second level of granularity. The second level of granularity is developed by Campbell et al.

1) *First Level of Granularity:*

In this Laplacian and Gaussian operators are used to generate granules of images Gaussian operator acts as a low pass filter [2]. After that facial features are segregated. Different granules are generated by Gaussian operator in Fig.3. First level of Granularity reduces the effect of wrinkle from face image. By using the calculation related to noise and noise power is used to generate the following granular image. Blurring as a noise is added to the facial image and power is divided by real no. to generate multiple granules. Variations in skin texture due to dermabrasion or skin-resurfacing are more prominently observed in first level of granularity.



Fig.3. First level of Granularity generated by Gaussian operator.

2) *Second Level of Granularity:*

For the observations Regarding Campbell et al. [11] are detailed in this granularity. The horizontal and vertical granules are generated by dividing face image into different as shown in Figs. 4 & 5. In this granules from hz11 to hz33 shows the horizontal sections and remaining granules from vz11 to vz33 shows vertical sections. In this, first nine granules are generated by performing operations on face related to row element of face image. By considering the different pixel co-ordinates the image is divided in different according to region of interest and vice –versa for vertical granules by doing column operations. This granularity provides information about inner and outer region of face image. It uses vertical and horizontal relation to address variation in chin, nose and forehead.

Second level of Granularity helps to analyze different combinations of local features that provide resilience to concurrent variations introduced in multiple regions by different plastic surgery procedures

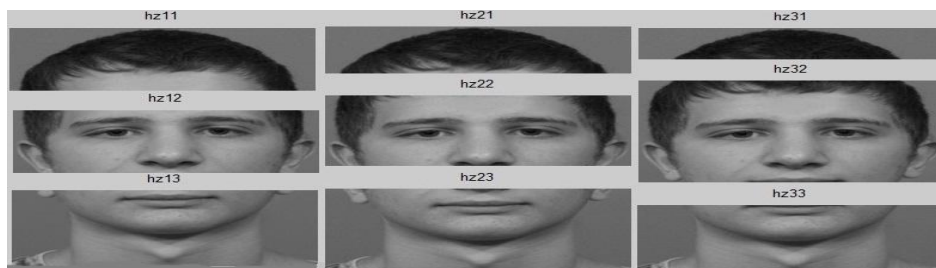


Fig.4. Output of Second level of granularity as horizontal face granules (hz11 to hz33)



Fig.5. Output of Second level of granularity as vertical face granules (vz11 to vz33)

A. FACIAL FEATURE EXTRACTION

According to theory, some face region provide distinct comparison for feature extraction such as eyes, nose and mouth and some granule contain skin region such as forehead, cheeks and outer facial region. Different feature extractors are needed to encode diverse information from granule. For that, two different extractors are used such as *Extended Uniform Circular Local Binary Patterns (EUCLBP)* and *Scale Invariant Feature Transform (SIFT)*. Both of these are Fast,

discriminating, rotation invariant & robust to changes to gray level intensities due to illumination. They extract information at different value of intensities & other assimilates information from image gradients.

1) *Extended Uniform Circular Local Binary Patterns:*

It is texture based descriptor that encodes exact gray level difference along with difference sign between neighbour pixel. During this, the image is first decorated with mosaics into overlapping uniform local patches of size  $32 \times 32$ . As shown in Fig.6 after the descriptor is computed, based on 8-neighbouring pixel, it is uniformly sampled on a circle centered on centre pixel. EUCLBP [7] descriptor are matched using  $\chi^2$  distance.

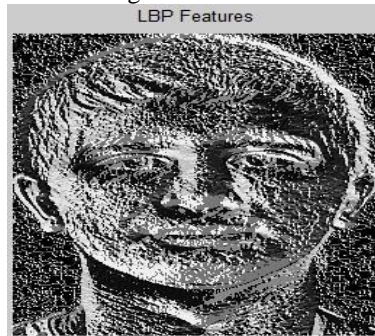


Fig.6 EUCLBP feature

2) *Scale Invariant Feature Transform:*

It is scale & rotation invariant descriptor which generates a compact representation of image based on image magnitude orientation & spatial vicinity of image gradient [2]. As shown in Fig.7. In this sparse descriptor that is computed around detected interest points. *SIFT* [7] can also be used in a dense manner where descriptor is computed around predetermined interest points. Similar to EUCLBP descriptor, weighted matched  $\chi^2$  distance is used to compare two SIFT descriptor.



Fig.7 SIFT feature

#### IV. GENETIC ALGORITHM FOR SELECTION OF FEATURE EXTRACTOR

Every granule has useful & diverse information which can be used to combine and produce discriminating information for face recognition. Selective combination of feature is used to combine diverse information for improved performance. EUCLBP & SIFT [7] approaches. Genetic search is used to find most informative feature.

##### GENETIC ALGORITHM APPROACH

Genetic algorithms are more acceptable algorithms for finding the global optimum solution for an optimization Problem. Here the genetic algorithm is used as optimization tool [14].

In this, the fitness function plays an important role. All the parameters related to genetic algorithm (GA) [1] [2] are used in this approach also. Initial population, Fitness function, Crossover, Mutation are used for finding minimum function using genetic algorithm. Here, the fitness function and min-max values are shown on the graph analysis. Best fitness function is also calculated from Genetic algorithm optimization. By giving threshold to value parameter matching Between face is observed in genetic algorithm.

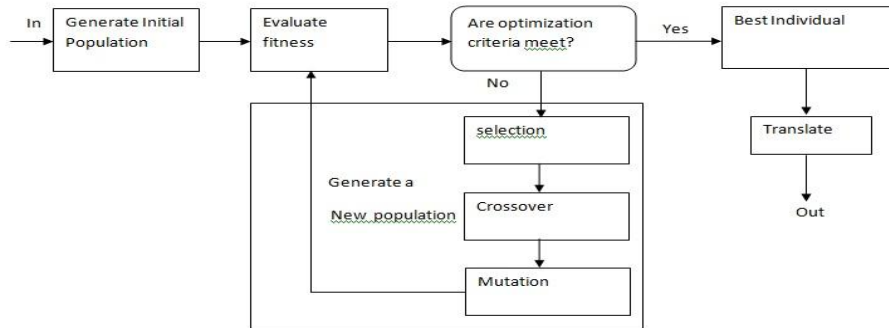


Fig.8. Generalized B.D. of Genetic Algorithm (GA)

Here the genetic algorithm is used as optimization tool. Following steps are involved for fulfilling the realization of GA

*Generate initial population:*

In this, population is related the feature values of feature extractor. And from that population fitness function is calculated.

*Fitness Function:*

Fitness function is best performing features from extractor point of view which generates best results for further improvement of Genetic algorithm.

It is checked for optimization. If it is not then it is passed to the chain of genetic processing functional block like Selection, Cross-over & Mutation. And their output is feed-back to fitness generations as its input.

*Selection:*

Rejected features are extracted and selected for further processing of generating fitness function. And send it to crossover Operation.

*Cross-over:*

Cross-over is performed on selected features of extractor and next population is generated.

*Mutation:*

Mutation is basically the changing or altering the pattern of selected feature. In this, mutation is performed by inverting feature in the generation. And it is feedback to evaluation of fitness function. As optimization is proceeding further, it generates best individuals as it is output of genetic algorithm.

The matching of faces is distinguished by using taking one of the variables [2] from genetic algorithm. And that variable is threshold with a real value (based on face characteristics) and further detection is possible.

**V. EXPERIMENTAL RESULTS**

Some database from Rhinoplasty is taken for image testing and training. Experimental result shows different minimum function for calculating of fitness function. Here average is calculated over fitness function. The related graphs are given below.

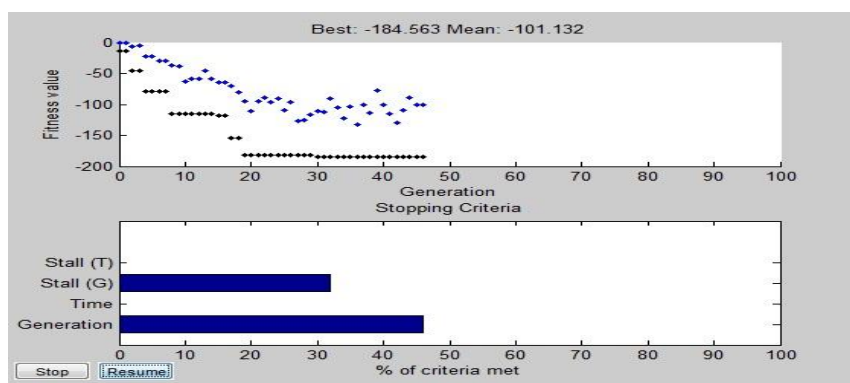


Fig.9. Graph showing relation between fitness values and generation

Following table [7] helps to find out the number of population related to genetic computation and fitness value which relates with generation.

Description	In Numbers
Number of Generations	51
Number of Evaluations	1040
Best function found	-184.846

Table.1 starting criteria of genetic encoding

After training, the database is tested according to fitness function. It work for different population and generation according fitness function and generates best fitness function. The tested database and its corresponding graph are shown below. The ‘stall’ function G & T are for generation and termination of fitness functions and generations.

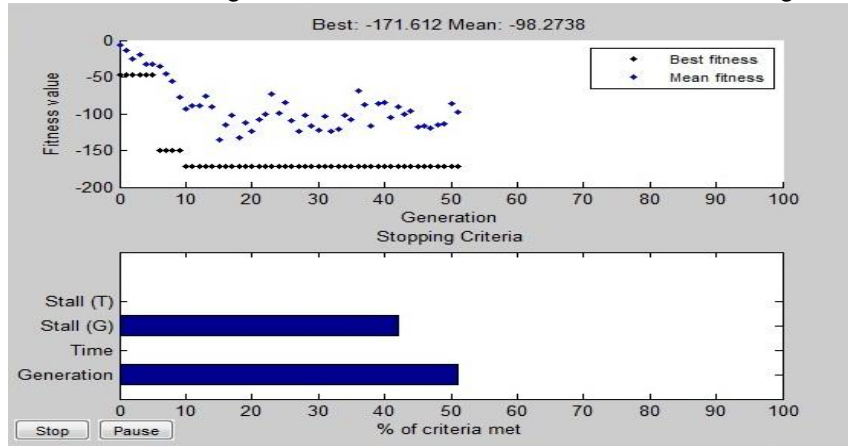


Fig.10. Graph shows relation between best fitness and mean fitness

The table is also used elaborate information on the mean between and best function. Table will help to describe the analytical performance.

Description	In Numbers
Number of Generations	51
Number of Evaluations	520
Best function found	-171.612

Table.2 stopping criteria of genetic encoding

And it is found that training and testing database for fitness function. During testing it gives best fitness function. Matching and Un-matching will help to detect image forgery in pre and post surgery image.

## VI. CONCLUSION

Hence the image forgery detection helps to resolve the problem of face recognition. The feature extractors plays an important role while recognition of individual. Multiple levels of face segmentation is also useful for identifying a person by using different result analysis from computer research scholar. And the matching of face image is done by using GA for minimum function.

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