# Pattern Recognition of Surgically Altered Face Images Using Multi-Objective Evolutionary Algorithm

Leena Patil
Computer Department
SSBT's COET Bambhori
Jalgaon, India
*Leena3911@gmail.com*

Sana Deshmukh
Computer Department
SSBT's COET Bambhori
Jalgaon, India
*deshmukhsana25@gmail.com*

Rakhi Mahajan
Computer Department
SSBT's COET Bambhori
Jalgaon, India
*rakhimahajan7@gmail.com*

Utkarsha Narkhede
Computer Department
SSBT's COET Bambhori
Jalgaon, India
*utkarsha.narkhede20@gmail.com*

***Abstract***—Plastic surgery has been recently coming up with a new and important aspect of face recognition alongside pose, expression, illumination, aging and disguise. Plastic surgery procedures changes the texture, appearance and the shape of different facial regions. Therefore, it is difficult for conventional face recognition algorithms to match a post-surgery face image with a pre-surgery face image. The non-linear variations produced by plastic surgery procedures are hard to be addressed using current face recognition algorithms. The multi-objective evolutionary algorithm is a novel approach for pattern recognition of surgically altered face images. The algorithms starts with generating non-disjoint face granules and two feature extractors EUCLBP (Extended Uniform Circular Local Binary Pattern) and SIFT (Scale Invariant Feature Transform), are used to extract discriminating facial information from face granules.

***Keywords***—*Plastic Surgery, Face Recognition System, Granulations ,Feature selection, Feature Extraction.*

*****

## I. INTRODUCTION

Recognition of surgically altered faces with changed appearances is a challenging task. A big challenge to face recognition is facial plastic surgery. These surgeries change the facial features of a person.

Due to advances in technology, plastic surgery procedures can be performed because of its affordability and the speed, several people undergo plastic surgery for medical reasons and some choose cosmetic surgery to look younger[1][6] .

The procedures can significantly change the facial regions both locally and globally, altering the appearance, facial features and texture[1][3][6], after this there is difficult to find that person's identity. The non-linear variations are induced by plastic surgery procedures. These variations in images are hard to recognize by using current face recognition algorithms. This plastic surgery process can also be misused by individuals who are trying to hide their identity for the reason of fraud or evade the law enforcement. Also this surgery is abused by the theft or terrorist and it allows them to freely move around without any fear of being identified by any face recognition system.

The multi-objective Evolutionary algorithm extracts discriminating information from non- disjoint face granules obtained at different levels of granularity. An evolutionary approach is come up with a genetic algorithm to parallel optimize selection of feature extractor for each face granule along with finding optimal weights corresponding to each face granule for matching[2][3].

## II. RELATED WORK

Ramya Priya R et. al., in [4], have proposed system in which PSO (Particle Swarm Optimization) was used to produce better accuracy in altered faces by using l best and g best methods. The optimization and LDA, MFA algorithms are found to produce better recognition results, while comparing to traditional methods. The work was extended to identify misclassifications present in face by means of assuming cost for each classification.

B. Heisele et. al., in [5], have described a semi-automatic alignment step in combination with support vector machine (SVM) classification was examined. Due to self-occlusion, automatic alignment procedures will eventually fail to compute the correct correspondences for large pose deviations between input and reference faces. Combining view-specific classifiers has also been applied to face detection. A probabilistic approach using part-based matching has been used for expression invariant and occlusion tolerant recognition of frontal faces. There are two global approaches and a component-based approach to face recognition and evaluate their robustness against pose changes. The l best global method consists of a straight forward face detector which extracts the face from an input image and propagates it to a set of SVM classifiers that perform the face recognition. By using a face detector achieves translation and scale invariant.

Minal Mun et. al., in [6], have proposed a new multimodal bio metric using face and periodical bio-metric for the recognition of face invariant to plastic surgery. This method made the use of different features from face and periodical region to match face images before and after plastic surgery. Feature is extracted from both face and particular region with the help of local binary pattern and then dimension reduction is done by using PCA. Then for classification, Euclidian distance is used. If face is not match, then periodical biometric is performed for face recognition under plastic surgery.

Gaurav Aggarwal, et. al., in [7], has proposed a novel approach to address the challenges involved in automatic matching of faces across plastic surgery variations. They proposed a part- wise sparse representation Approach combined with the popular sparse representation to address the challenge of plastic surgery variations and utilizes images from sequestered non-gallery subjects with similar local facial characteristics to fulfill this requirement. They stated that this sparse representation approach also used for several other biometrics and computer vision problems. One limitation of scarcity-based biometric recognition is, it requires several images per subject in the gallery. Algorithm consists the several steps for recognition. The proposed algorithm starts with generating non-disjoint face granules where each granule represents different information at different size and resolution. The two feature extractors, namely Extended Uniform Circular Local Binary Pattern (EUCLBP) and Scale Invariant Feature Transform (SIFT), are used to extract discriminating information from face granules. Finally, different responses are combined in an evolutionary manner using a multi-objective genetic approach for improved performance.

## III. FACE RECOGNITION SYSTEM

The algorithm is an evolutionary granular computing approach for face recognition.

Algorithm consists of the several steps for recognition. The face recognition algorithm starts with generating non-disjoint face granules where each granule represents different information at different size and resolution. Extended Uniform Circular Local Binary Pattern (EUCLBP)[2] and Scale Invariant Feature Transform (SIFT), these two feature extractors are used to discriminate the feature information from face granules. Then different responses are merged by using a multi-objective genetic approach for improved performance.

Figure.1 shows the architecture of face recognition system.

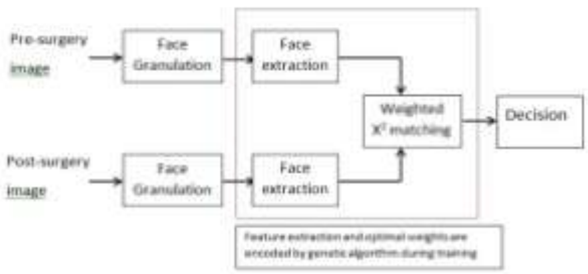


Figure.1 Face Recognition System Architecture[2]

Face Image Granulation: The detected frontal face image of size n x m. Face granules are generated through the three levels of granularity[8]. The first level brings global information at multiple resolutions. In second level Inner and outer facial information are extracted. At the third level, features are extracted from the local facial regions.

Face Extraction: Feature extraction and optimal weights are encoded by genetic algorithm and feature selection is done here.

Decision: In this phase after selection of feature extraction, face granules is combined with multi-objective evolutionary and then a decision is taken.

### *A. Extended Uniform Circular Local Binary Pattern (EUCLBP)*

Extended Uniform Circular Local Binary Pattern (EUCLBP) is a texture-based descriptor that encodes exact gray-level differences along with the difference of sign between neighboring pixels[2]. The image is first trimmed into non-overlapping uniform local patches of size 32 × 32 for computing EUCLBP descriptor[2]. For each local patch, the EUCLBP descriptor is computed based on the neighboring pixels[2]. The concatenation of all descriptors from each local patch creates the image signature. Using the weighted $\chi^2$ distance two EUCLBP descriptors are matched[2][8], because it is found to perform better than histogram intersection or log-likelihood distance.

The concept of using EUCLBP features is that the face images can be seen as composed of micro patterns which are invariant with respect to gray scale transformations. Global information of the face image is obtained by combining these micro patterns. Having features that are invariant or robust to rotations of the input image is useful in different texture analysis applications. The statistical robustness is the main reason for considering uniform patterns. Using these uniform patterns instead of all the possible patterns has produced better recognition results in many applications.

**Phases of EUCLBP Algorithm:**

1. The preprocessing technique is used to enhance the quality of both the digital face images and sketch images.
2. Both the sketches and digital face images are trimmed into non-overlapping local facial regions (6x7).
3. EUCLBP descriptors are computed for each local facial region.
4. The weighted distance measure is used where the weights are optimized using the Memetic algorithm to match two EUCLBP descriptor.
5. This procedure is applied for each gallery probe image pair and top matches are obtained.

*B. Scale Invariant Feature Transform (SIFT)*

SIFT is a scale and rotation invariant descriptor that generates a compact representation of an image based on orientation, the magnitude and spatial vicinity of image gradients[2]. SIFT uses a sparse descriptor which is computed from the detected interest points[8]. However, SIFT can be used in a dense manner where the descriptor is computed around predefined interest points. In this approach, SIFT descriptor is calculated in a dense manner over a set of uniformly distributed non-overlapping local regions of size 32×32. SIFT descriptors calculated at the sampled regions are then concatenated to form the image signature. Weighted $\chi^2$ distance is too used to compare two SIFT descriptors because of its performance[2][8]. Interesting points on the object are extracted to provide a further description of the object for any object in an image. Then these descriptions extracted from a training image can be used to identify the object when attempting to locate the object in a test image containing many other objects.

**Phases of SIFT Algorithm:**

1. The first phase, Extreme Detection, examines the image under various scales and octaves to isolate points of the picture that are different from their surroundings. These points are potential candidates for image features are called extreme.
2. The next phase is Key point Detection that starts with the extreme and selects some of these points to be key points, which are a whittled down a set of feature candidates. This refinement discards extreme, that are obtained by the edges of the picture and by low contrast points[9].
3. The third phase is the Orientation Assignment which converts each key point and its neighborhood into a set of vectors by computing a magnitude and a direction for them. It identifies other key points that may have been missed in the first two phases; this is done on the basis of a point having a significant magnitude without being an extremum. Now the algorithm has identified a final set of key points[9].
4. The last phase is Key point Descriptor Generation that takes a collection of vectors in the neighborhood of each key point and consolidates this information into a set of eight vectors called the descriptor. By computing a normalized sum of these vectors, each descriptor is converted into a feature.

## IV. RESULT

The after and before surgically altered images are matched using multi-evolutionary algorithm. Face recognition algorithm use facial information or extract features and process them in parts. In the granular approach, non-disjoint features are extracted at different granular levels. Face granulation are generated pertaining to three levels of granularity. The first level provides global information at multiple resolutions of face image as shown in Figure.2.


Figure.2 Face granules in the First Level of Granulation

The granules Gr1, Gr2 and Gr3 are generated by using the Gaussian operator and Gr4, Gr5, Gr6 are generated by Laplacian operator. The Gaussian operator reduced the resolution and sample density of the image between successive iteration[2]. Similarly, Laplacian operator generates a series of images.

In the second level of granulation horizontal and vertical granules are generated by dividing the face image into different regions as shown in Figure.3 and Figure.4. Here, Gr7 to Gr15 are the horizontal granules and Gr16 to Gr24 are the vertical granules.

In second level of granulation, it provides elasticity to variations in inner and outer facial regions. It makes use of the relation between horizontal and vertical granules to address variations in eyes, chin, foreheads and cheeks caused due to plastic surgery process.

Figure.3 Horizontal granules generated in second level of granulation


Figure.4 Vertical granules generated in second level of granulation.

At the third level local facial fragments are extracted and utilized as granules. Each of these regions is the local information that provides unique features for addressing variations due to surgery. Various features of face obtained from granulation. Based on that feature only the face is recognized. Further, feature extractors are used to encode diverse information from the generated granules. At the last in this module, the features are matched with both before surgery and after surgery data sets. Then, by using Multi-objective evolutionary algorithm decision is obtained.

## V. CONCLUSION

Generally, face recognition systems and algorithms are designed to recognize faces of cooperative individuals in a controlled environment. In this development, an evolutionary granular approach is used for matching surgically altered face images. The algorithm utilizes the observation that human mind recognizes face image by analyzing the relation between non-disjoint spatial features extracted from each granule image. The phase of face image granulation is completed, which is used for further functionality. The granulation technique is used to generate non-disjoint face granules from a face image. At the end of the face image granulation process, the granules are generated in the first level of granulation by using Gaussian and Laplacian operator. The second level of granularity is generated the granules in the form of horizontal and vertical granules. In the third level of granulation, local facial fragments are extracted and utilized.

## ACKNOWLEDGMENT

This material is based on work supported by Miss Utkarsha Narkhede, HOD of computer department Dr.Prof.G.K.Patnaik from SSBT COET, Jalgaon.

## REFERENCES

[1] Minal Mun et al," Implementation of Plastic Surgery Face Recognition Using Multimodal Biometric Features", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 2014, 3711-3715

[2] Himanshu S. Bhatt et al.,"Recognizing Surgically Altered Face Images Using Multi-objective Evolutionary Algorithm", IEEE TRANSACTIONSON INFORMTION FORENSICS AND SECURITY, VOL.8, NO.1, JANUARY 2013.

[3] H.S. Bhatt, S. Bhardwaj, R. Singh, M. Vasta, "Evolutionary granular approach for recognizing faces altered due to plastic surgery", Automatic Face and Guesture Recognition workshop(FG2011), IEEE International Conference, March 2011, 720-725.

[4] Ramya Priya R et. al., "Face Recognition in Surgically Altered Faces Using Optimization and Dimensionality Reduction Methods", IJRIT International Journal of Research in Information Technology, Volume 2, Issue 4, April 2014, Pg: 267- 273.

[5] B. Heisele, P. Ho, J. Wu and T. Poggio, "Face recognition: component based versus global approaches", Computer Vision and Image Understanding, vol. 91, pp. 621, 2003.

[6] Minal Mun et. al.,"Recognizing Pre And Post Surgery Faces Using Multimodal Biometric Approach", International Journal Of Pure And Applied Research In Engineering And Technology (IJPARET), Volume 2 (9): 37-46, 2014.

[7] Gaurav Aggarwalet. al., "A Sparse Representation Approach to Face Matching across Plastic Surgery", IEEE Workshop on Applications Of Computer Vision (WACV), 2011.

[8] P. Karuppusamy, Dr. P. Ponmuthuramalingam, "Recognizing Pre and Post Surgery Faces Using Multi Objective Particle Swam Optimization", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 10, October 2013.

[9] Shivakanth, Archana Mane," Object Recognition using SIFT", IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 4, June 2014.