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Local Ternary Pattern for the Recognition of Surgically Altered Face Images

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***Abstract*— Plastic surgery provides an efficient method for enhancing facial appearance by correcting feature anomalies to get a younger look. When a person undergoes surgery, the facial features are reconstructed either globally or locally. These variations are difficult to be modelled by existing face recognition systems. This can be misused by individuals who are trying to conceal their identity. So here a method Local Ternary Pattern is used along with Multi-Objective Evolutionary Algorithm for identifying surgically altered face images. On the plastic surgery face database and non-surgery face database, the proposed methods yields high identification accuracy as compared to existing face recognition system.**

***Keywords*— Face recognition system, Local Ternary Pattern, Multi-Objective Evolutionary Algorithm, Plastic surgery.**

I. INTRODUCTION

The term Biometrics is derived from the Greek word bio (life) and metric (to measure). Here biometrics refers to technologies for measuring and analyzing a person's physiological or behavioural characteristics. These characteristics are unique to individuals and hence can be used to verify or identify a person.

Face recognition is an important and secure biometric for person authentication as face is a unique part. It requires no physical interaction on behalf of the user [1]. In facial recognition there are two types of comparisons namely:

- Verification: The system compares the given individual with who they say they are and gives a yes or no decision
- Identification: The system compares the given individual to all other individuals in the database

All identification and authentication process passes through the following technologies:

- Image capture: A physical or behavioural sample is captured
- Extraction: Unique data is extracted from the sample and a template is created
- Comparison: The template is then compared with a new sample
- Match or non-match: The system decides whether the feature extracted from the new sample is a match or non-match

Plastic surgery procedures provide a skilled and permanent way to enhance the facial appearance by correcting feature abnormality and treating facial skin to get a younger look. Apart from beauty reasons, plastic surgery procedures are favourable for patients suffering from several kinds of disorders caused due to excessive structural growth of facial features or skin tissues. Plastic surgery procedures modify the facial features and skin texture thereby providing a makeover in the appearance of face. Plastic surgery is used to [1]

- Adjust defects that are present from birth
- Restore skin and tissue damage resulting from disease or illness
- Restore skin and tissue damage resulting from injury

II. PROPOSED WORK

Plastic surgery has emerged as a new covariate of face recognition and its allure has made it indispensable for face recognition algorithms to be robust in matching surgically altered face images. Traditionally, face recognition research has focused primarily on developing novel characterizations and algorithms to deal with challenges posed by variations in acquisition conditions like head pose etc [2]. Tremendous success in dealing with these problems is probably one of the primary factors that have generated interest in new avenues in face matching that include matching faces across plastic surgery variations. Matching across plastic surgery variations are introduced in several algorithms in a new dimension to face recognition discussing various ethical, social and engineering challenges [3].

The input image that we obtained may not be of the required format. It may not have the proper illumination conditions. This illumination variation will adversely affect the feature extraction stage [4]. The commonly used feature extractor, Extended Uniform Circular Local Binary Pattern is not able to respond to illumination changes. This may affect our recognition process. So here a slight variation in this feature extractor is proposed to address the changes due to poor illumination conditions. We call this local binary pattern as Local Ternary Pattern as it considers three values instead of two.

III. METHODOLGY AND DESIGN

The proposed algorithm is:

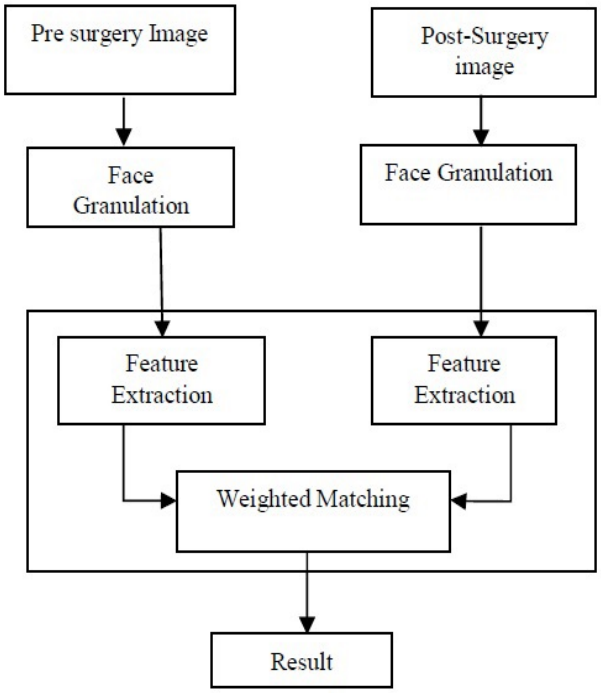

Fig.1 Proposed Algorithm

A. Image Capture and Pre-processing

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 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.

B. Face Image Granulation

Face granules are generated pertaining to three levels of granularity. The first level provides global information at multiple resolutions. This is analogous to a human mind processing holistic information for face recognition at varying resolutions. Inner and outer facial information are extracted at the second level. Local facial features play an important role in face recognition by human mind. Therefore, at the third level, features are extracted from the local facial regions.

C. Feature Extraction

The goal of feature extraction is to find a specific representation of the data that can highlight relevant information. Usually, a face image is represented by a high dimensional vector containing pixel values (holistic representation) or a set of vectors where each vector summarizes the underlying content of a local region by using a high level transformation. They efficiently use information assimilated from local regions and form a global image signature by concatenating the descriptors obtained from every local facial region.

1) Local Ternary pattern

In real time applications, intensity values of face images are severely affected due to various factors such as surrounding environment and imaging equipment. Illumination variation affects the low frequency component or global appearance of the image. Compared to other real time challenges, lighting variation causes larger differences in the facial images. Lighting variation can sternly alter the appearance of a face in the image and to the extent that facial images with extreme illumination changes appear more different to their individual un-illuminated facial images. Hence pre-processing techniques are preferred to improve the illumination and lighting conditions in images. Texture features can characterize regularity, randomness, directionality and coarseness properties of patterns. A face can be viewed as a texture pattern exhibiting symmetry and regularity. Hence texture plays an important role in computer vision and pattern recognition. Texture descriptors have gained increasing attention in facial image analysis due to their robustness to challenges such as pose and illumination changes.

The calculation of Local Ternary Pattern is shown schematically as:

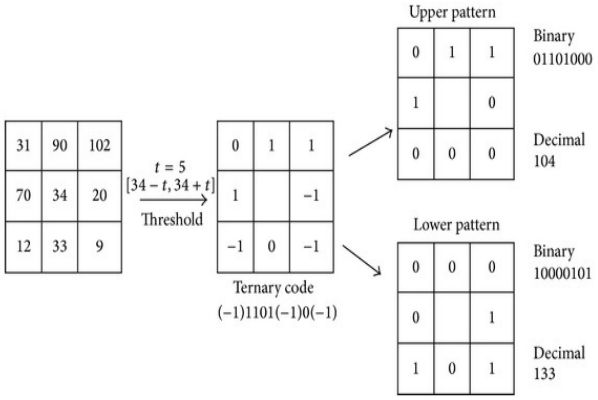

Fig.2 Local Ternary Pattern

D. Multi-Objective Evolutionary Algorithm

The algorithm for multi-objective evolutionary algorithm is given as:

- The evolution usually starts from a population of randomly generated individuals and happens in generations.
- In each generation, the fitness of every individual in the population is evaluated, multiple individuals are selected from the current population (based on their fitness), and modified (recombined and possibly mutated) to form a new population.
- The new population is then used in the next iteration of the algorithm.
- Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.
- If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached.

IV. RESULTS AND DISCUSSIONS

The input image is shown below:

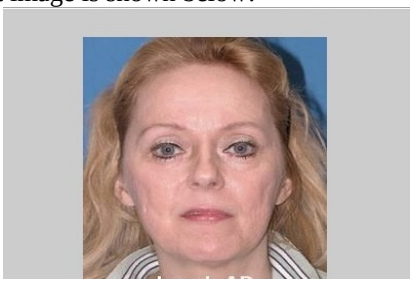

Fig.3 Input Image

The first level face image granulation is shown below as:

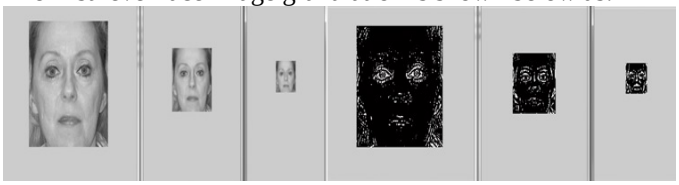

Fig.4 First Level Face Image Granulation

The second level face image granulation is shown below:

Fig.5 Second Level Face Image Granulation

The third level face image granulation is shown below:

Fig.6. Third level face image granulation

There are 40 granules from the granulation process. After granulation, the next step is the feature extraction. From each of the granules, even the minute features have to be extracted. From the granules it is clear that some contains fiducial information and others may not. So in order to extract even the minute details, we have to choose the appropriate feature extractor. So here Local Ternary Pattern is used for feature extraction. The features are extracted for the forty granules of each image. And then feature selection and weight optimization is done as part of the genetic algorithm. The weight is obtained as a result of the steps discussed above. For each image, a corresponding weight will be obtained. This weight is used to match between ore and post surgery images.

When compared with the normal feature extractors, Local Ternary Pattern seems to respond to illumination changes and it gives high accuracy.

A comparison with the commonly used feature extractor Extended Uniform Circular Local Binary Pattern (EUCLBP) theoretically and Local Ternary Pattern (LTP) gives the following accuracy.

Table.1 Comparison of the accuracies of EUCLBP and LTP

Feature Extractor	Accuracy(percentage)
EUCLBP[1]	80
LTP	86.6

V. CONCLUSIONS

Face recognition is an important biometric for person authentication sine face is the unique part for each individual. Plastic surgery has emerged as a new covariate of face recognition and its allure has made it indispensable for face recognition algorithms to be robust in matching surgically altered face images. The variation caused by plastic surgery is permanent and existing methods are not able to solve this problem. This will help those whose are trying to conceal their identity. The present face recognition methods are not able to identify the surgically altered face images or suggest applications.

This proposed work tries to find a solution to this problem. So here the image after surgery is granulated to three levels of granulation. First level of granularity provides resilience to plastic surgery procedures that alter the face texture such as face-lift, skin resurfacing, and dermabrasion. The second level of granularity provides resilience to variations in inner and outer facial regions. The third level of granularity independently analyzes each local feature to address the variations in individual facial regions. Then the features are extracted using Local Ternary Pattern which is able to respond to illumination changes. Finally weight optimization is done using genetic encoding.

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