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Face Biometrics Using Enhanced Version of Genetic Algorithm

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Abstract
Automated face recognition has become a major field of interest. Face recognition is biometric system used to identify or verify a face of a person in security purpose. Some of the previous research work have shown their great enthusiastic in different techniques on face recognition. This research paper propose a novel scheme of entire face recognition method which involves MFCC (Mel Frequency Cepstral Coefficients) for feature extraction, Genetic algorithm(GA) for feature optimization and fuzzy logic for testing. Research work has two sections namely Training and Testing. In training section is processed by two algorithms MFCC and followed by Genetic algorithm for optimization. Finally, recognition done by using Fuzzy logic in testing section. The proposed approach is tested on a number of face images. Experimental results show better accuracy than existing Genetic algorithm.

Keywords: Biometric, MFCC, GA, Fuzzy Logic

Introduction

Face recognition is biometric identification by scanning a person's face and matching it against a library of known faces. Face recognition is defined as the identification of a person from an image of their face. Face biometric system can be constructed using physiological characteristic for identification and verification purposes. These types of systems are developed for security purposes in various fields like crime investigation, e-commerce and military purposes [1]. Multimodal biometric system developed using fingerprint, hand geometry etc., they required the concerned human to make physical contact with a sensing devices [9].

There are two main tasks used in face recognition are Verification and Identification. Verification means one to one (1:1) matching and Identification means one to many (1: N) matching. Face verification is commonly applied in access control applications. Identification system determines identity of input image and compares query face image against all image templates stored in database..

Generally, the structures of face recognition system consist of three major steps, Acquisition of face data, Extracting face feature and Recognition of face. [21]
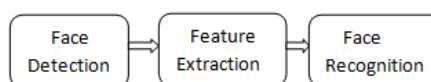
Fig. 1: Face Recognition

Face Acknowledgement System aids the technique to bring computers and human being's much closer than before. The improvement of programmed visual reconnaissance framework is a famous exploration point in PC vision. For observation as well as be utilized to plan frameworks for computerized finance, visual sensors, machine learning and so on.

Though biometric systems have been successfully deployed in a number of real-world apps, biometrics is not so far an entirely resolved problem. In other words, the challenge is to develop a biometric system that is highly exact as well as also secure, appropriate to utilize plus straightforwardly scalable towards a large population.

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Related Work

Pratibha Sukhija et al. (2016) has presented a Genetic Algorithm (GA) based approach used for face recognition. Genetic algorithm is compared with other known face recognition algorithms i.e. Principal Component Analysis (PCA) and Linear Discriminate Analysis (LDA) algorithms. It has been observed that the recognition rate of Genetic algorithm is better [15].

Shikha Gupta et al. (2013), introduced about working with MFCC by using it for Hand gesture recognition. Using MFCC given input image 2D converted into 1D signal. After getting the first 13 MFCCs the extracted feature vectors are classified against SVM. With MFCC for gesture recognition has very good accuracy [16].

Ching-Tang Hsieh et al.(2007) has developed anoid method for Fingerprint recognition. Ridge bifurcations are used as minutiae and ridge bifurcation algorithm with excluding the noise–like points are proposed. Experimental results show the humanoid fingerprint recognition is robust, reliable and rapid [5].

Rajandeep Kaur, Vijay Dhir (2013), evaluated a novel method for face detection with fuzzy based method. This paper proposed the implementation of new face detection methods for still colored images. The edge detection is performed using novel fuzzy edge detection method which is used to detect the edges of an image without determining the threshold value and skin color is detected using YCbCr model. The experimental results show novel method using fuzzy logic for edge detection was better than existing fuzzy method [2].

Duresuoquian Maio et al. (2007) explained algorithm by kegl to obtain principal curves for auto fingerprint identification system. From principal curves, minutiae extraction algorithm is used to extract the minutiae of the fingerprint. The experimental results shows curves obtained from graph algorithm are smoother than the thinning algorithm [8].

Taabish Gulzar et al.(2014), has discussed on Linear Prediction Cepstral Coefficient (LPCC),Mel Frequency Cepstral Coefficient (MFCC),Bark Frequency Cepstral Coefficient (BFCC) feature extraction techniques for recognition of Hindi Isolated, Paired and Hybrid words have been studied and the corresponding rates are compared. The experimental results show that the better recognition was obtained from MFCC as compared to LPCC and BFCC for three types of words [3].

Utku Kosem (2012), has introduced about the Fuzzy Logic and Fuzzy Control approach which are important part of Artificial Intelligence System and defined about an easy-to-use,interactive Fuzzy Logic application that enables users to develop a simple " two input – one output " Fuzzy Control system and also introduced fundamentals of fuzzy logic[14].

Dr C.Sunil Kumar1 et al. (2014), has proposed two methods, first was an edge detection technique. Where it establishes a pheromone matrix that represents the edge information at each pixel based on the routes formed by the Ant Colony Genetic Algorithm (ACOG) dispatched on the image. Second one was face detection based on usage of GA for advance classification of cases and objects of the input image. The work was based on preliminary segmentation of images into regions that contain non face objects and face objects. The efficiency of the Face recognition System by using GA was maximized by clustering the ACO [15].

Proposed Technique

MFCC (Mel Frequency Cepstral Coefficients)

The most popular spectral based parameter used in recognition approach is the Mel Frequency Cepstral Coefficients called MFCC. The MFCC feature extraction technique is more effective and robust. MFCC have been used for feature extraction which is mainly used for speech recognition system [6]. The purpose for using MFCC for image processing is to enhance the effectiveness of MFCC in the field of image processing as well. All extracted MFCC samples are then statistically analyzed for principal components, at least two dimensions minimally required in further recognition performance evaluation [16]. Following are the stages in MFCC:

- Pre emphasis
- Windowing
- Filter Bank processing
- Log Energy computation
- MFCC

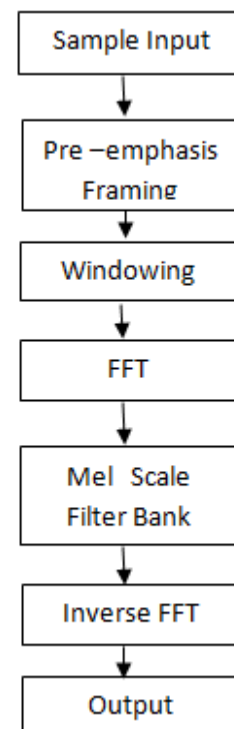Diagrammatically, the process is shown below:

Fig. 2: MFCC process

Genetic Algorithm

The Genetic algorithm is an optimization process based on law of evolution and it has three operations basically i.e. Selection, Genetic Operation, and Replacement [20]. A typical GA cycle is shown in Fig.3.The population consists of chromosomes. Each chromosome is selected from a population using fitness function.

Steps of Genetic Algorithm

Step1: Initialize random population consists of chromosomes.
Step 2: Compute fitness function in the population.
Step3: Develop new population consists of individuals.
Step4: Selection of parent chromosomes to get best fitness function.

Step5: Perform crossover to get copy of parents.
Step6: Perform mutation to mutate new off springs.
Step7: Place new offspring into the population.
Step8: Repeat steps to get a satisfied solution.
Step 9: Stop
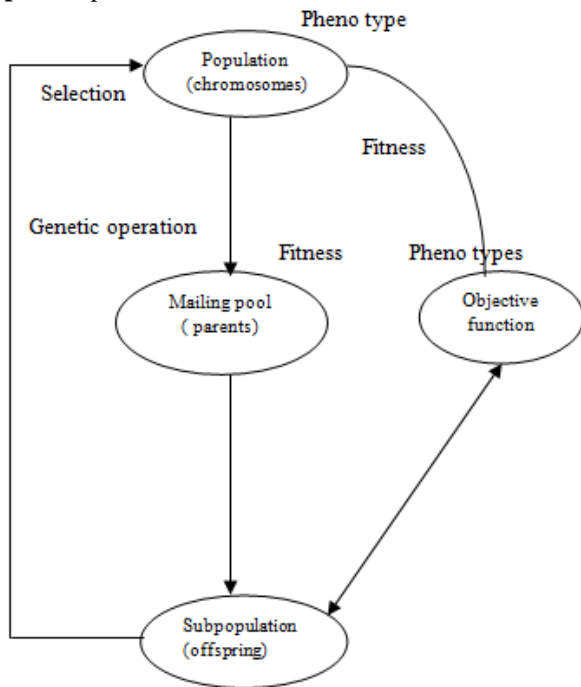
Fig. 3: Basic GA procedure

Fuzzy Logic
Fuzzy logic is the difficult mathematical model for understanding and it gives the uncertainty in reasoning [5].Fuzzy logic is tolerant of imprecise data. Everything is imprecise if you look closely enough, but more than that, most things are imprecise even on careful inspection. Fuzzy reasoning builds this understanding into the process rather than tacking it onto the end. Fuzzy logic is based on natural language. The basis for fuzzy logic is the basis for human communication.[2]
The main features of fuzzy logic are as follows:
- It contains matter of degree.
- Fuzzy logic is flexible
- Any system can be fuzzified.
- Information is decomposed into collection of variables.

There are five attributes associated with fuzzy expert systems:
1) Input variables,
2) Output variables,
3) Subsets of the inputs and the outputs and the membership functions corresponding to the various subsets leading to fuzzy set.
4) Rules connecting the input fuzzy subsets and the output fuzzy subset.
5) Procedure (or methodology) for de-fuzzification of the Output.

Results and Discussion
Simulation Model
A feature extraction method for face based on MFCC is proposed. Feature reduction after MFCC feature extraction done with GA. Fuzzy logic is used for determining the influential or associational relationships among the matching templates by giving them scores considering their effect on defect proneness. In the proposed system, the main goal is to evaluate the performance of the face biometric system based on user dependent fusion approach.
- In the enrolment phase, face data is acquired first and then processed according to the training and classification algorithms.
- In person, feature vector of the face data is derived from spectral and MFCC coefficients. The feature vector is the face template in the knowledgebase.
- In face recognition the feature vector is combination of static and dynamic features which has been extracted by MFCC.
- Feature reduction will be done using GA.
- The feature vector thus obtained is the face template in the knowledgebase. In the identification phase, the matching score of the test template and the training templates are derived using fuzzy logic.

Simulation results
1. The main GUI has training, fusion and testing panel. Firstly we train the samples then have tested many samples for matching.
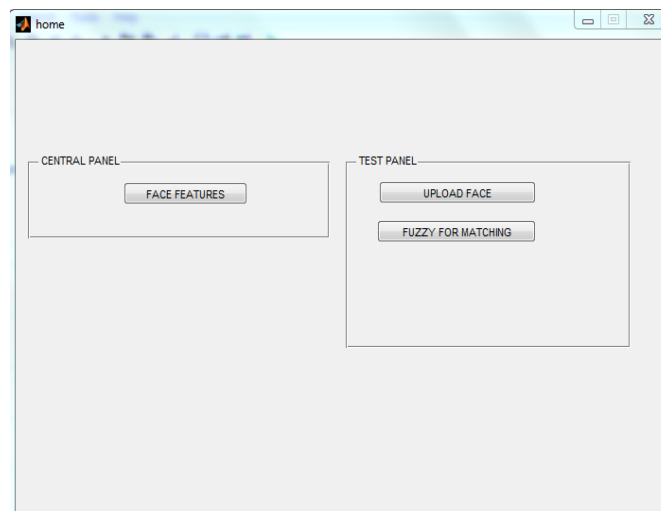
Fig. 4: Main GUI

2. The face training GUI include the sample uploading option after which MFCC algorithm is applied to extract features which are further optimized by GA.
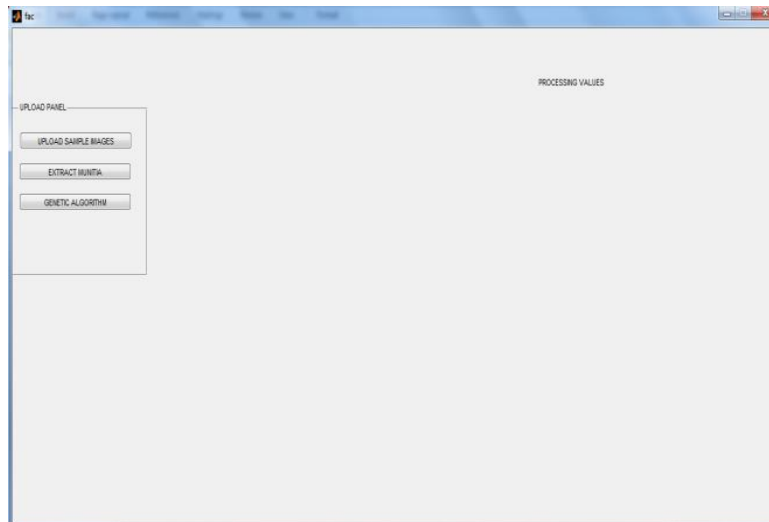

Fig. 5: Face GUI panel

3. The face GUI shows the upload, MFCC feature extraction and GA for feature reduction. In this panel first upload face for further process.
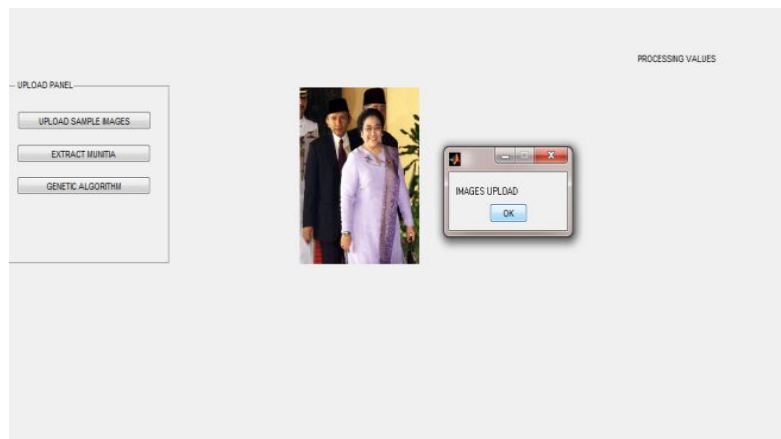

Fig. 6: Face Upload

4. The MFCC feature extraction process which converts the time domain signal to frequency domain using Fast Fourier Transform. By doing feature extraction from the given training data the unnecessary data is stripped way leaving behind the important information for classification
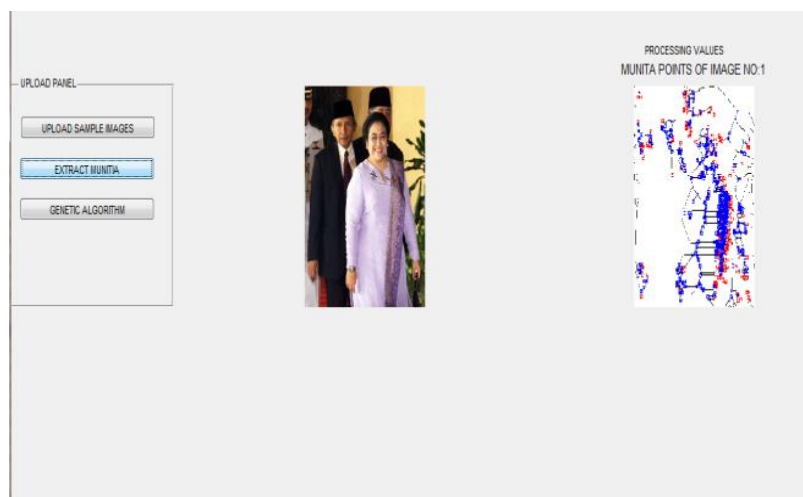

Fig 7: Mel Frequency Cepstrum Coefficient

5. **G**enetic Algorithm is used for the optimization of the extracted features as any feature extraction algorithm cannot figure out all the set features. Hence to reduce the it's relevant features after MFCC and here Genetic Algorithm is utilized.
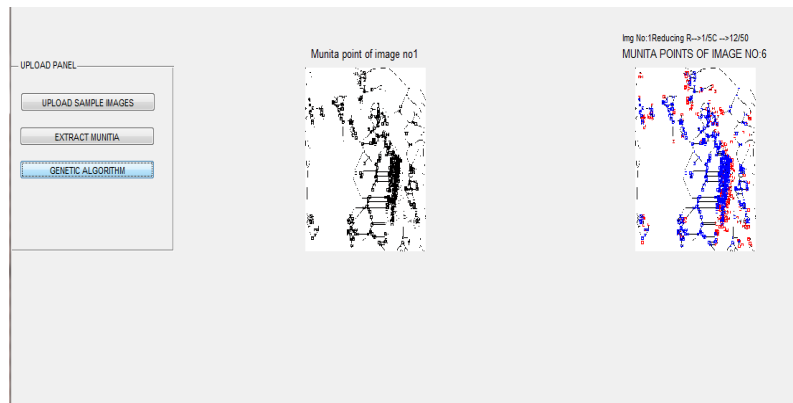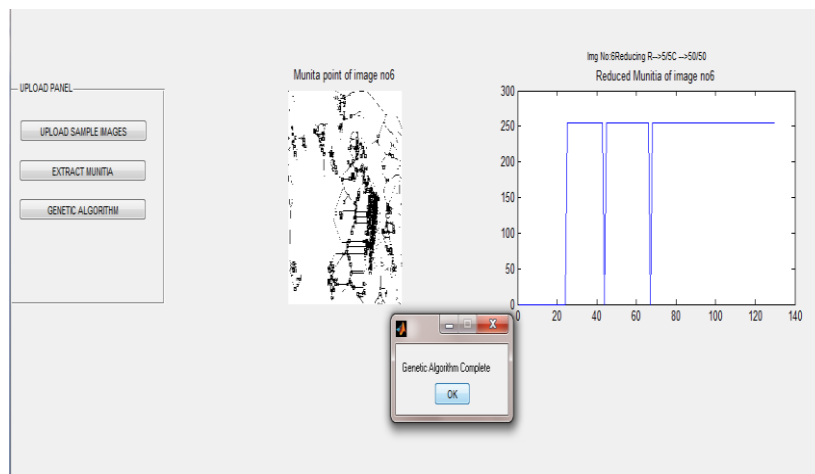

Fig. 8: GA utilization

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Fig. 9: GA complete

In the final step face extracted features is done and results are saved in the database for testing.

6. In test panel upload face which we want to match for recognition, then click on fuzzy for matching and display result.
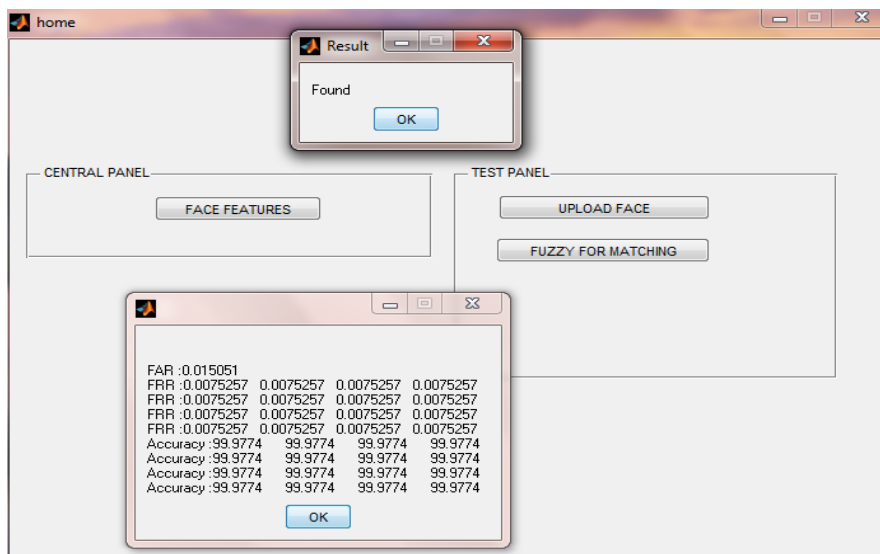

Fig. 10: upload image for recognition

The above figure shows the result of face with accuracy.

Table 1: Comparison of recognition rate with Genetic algorithm and Genetic with fuzzy

Image Name	Accuracy with Genetic algorithm	Accuracy with Genetic with Fuzzy	Improvement Accuracy
Image1	94.58	99.78	5.49%
Image2	94.5	99.23	5.00%
Image3	94.15	98.23	5.39%
Image4	94.46	99.23	4.48%
Image5	94.63	99.34	4.97%
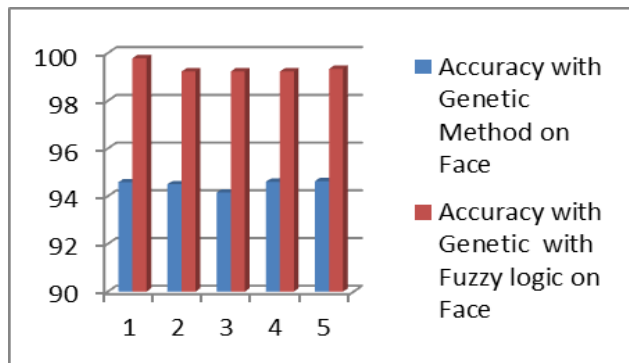
Fig. 11: Comparison Graph

Comparison graph shows that the Genetic with fuzzy has shown the improvement of in all the image samples. There is average improvement of all most 5.06%.

Conclusion

Face recognition is one of the challenging aspect in the field of image analysis and computer vision. The research conducted in this field for the past four decades leads to encouraging results but still we are

Unable to find the face recognition technique which is able to perform efficiently in the various situations commonly encountered in daily life

In this work, a single modal biometric system based on face is developed using MFCC for feature extraction method. GA used to optimize MFCC result and Fuzzy logic gives accuracy on testing samples. The results show that the proposed biometric system leads to better security and improvement in accuracy than the existing face recognition techniques. The proposed work can further be improved using other Combination with Genetic algorithm.

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