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Performance Analysis and Design of Automatic Real Time Face Organs Identification and Classifications

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Abstract

Now a day's security and identification of a person are crucial in real time applications and solving the problems in biometric identification. **Objectives:** To address the issues in real time, the face and its organ's identification are the main parts of the human body. The proposed work involves extraction of the face of the real time captured image, after extraction of the face, the organs like eyes, mouth and nose is extracted for identification of exact person. **Methods/ Analysis:** The present work captures the real time image from cameras or moving video devices for facial recognition using Principal Component Analysis (PCA), the facial features are extracted from both Hidden Markov Model (HMM), Gaussian mixture model (GMM) methods and classified into different organs using Artificial Neural Network (ANN). The features of organs are extracted in different stages, in first stage Eigen values with the help of PCA, second and third stage feature extraction with help GMM and HMM since these three techniques are the most powerful tools for statistical natural image processing. After extraction of organs of the face, the ANN is applied for classifications of eyes, mouth and nose separately. **Findings:** In the proposed work the facialorgans are separated into threeslight scale images and these are recombined to acquire the appreciationfacial image results like mouth, eyes and nose. The final obtained results shows that the proposed method has been achieved 95.8% recognition accuracy, Fault Rejection Ratio (FRR) is about 93.1% and Fault Acceptance Ratio (FAR) is 1.7 % which are implemented in Matlab2013A.

Keywords: Facial Database, GMM, HMM, MLP-BP ANN, PCA, Wavelet Franformation

1. Introduction

Nowadays, an identification and verification of person are important for security and reduction of thefts, the main sources for person identification are video and digital image. There are different scenarios to identify the human activity and its recognitions like surveillance, entertainment environments and video analysis. For so many decades, the research scholars were developing many methods for human action recognition as their own part of active research. The face recognition is also one of the main research areas in image processing, in which preprocessing is the first stage for improving the quality of the image, features extraction in terms Eigen values using PCA and GMM, segmentation of required area in the facial image and classifications using artificial neural network. The face recognition application is categorized into low level, mod level and high level categories, in low level identifies the core concepts like required objects, different features and identification of face organs, in mid-level category detecting or recognizing human commotion in several scenarios such as single person, multiple persons, collaborations and uncharacteristic behaviour's and high level category delivers various activities of human recognition such as surveillance, entertainment environments, and health care based on the complexity, a classification of human activities such as interfaces, gesticulations, group activities and actions is done.The face organ identification is a part and similar to biometrics like iris recognition and fingerprint application. The facial organs recognition algorithm in the existing works is for extraction of features from the human face and then identifies its organs. The extracted features are stored in the database for further identification and classifications. The important and efficient feature extraction techniques are PCA, GMM and HMM, the PCA uses to extract features in terms of Eigenvalues and applied to HMM and GMM.

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2. Related Work

S. Palanivel. et. al propose an efficient person identification with multimedia system for extraction of motion information and facial organ identification like face, eyes and nose. In this system, for the database of 50 images, the maximum obtained an error rate is close to 0.45% [5]. Eshwarappa. M. N. et. al. Proposesthat for many biometric applications the fusion technique have been suggested and the obtained results show 90% identification, performance of the same design. The proposed work has been produced both fault acceptance ratio and fault rejection ratio are nearly to 0%[4]. Prabhu Teja. et. alproposed the subspace and pre-processing algorithm for recognition and requires less memory utilization, lowest error estimation ratio[6].

Faten Bellakhdhar. et. al proposed a novel technique thatcombines bothangle and enormousness of Gabor's illustration of the face using PCA and SVM techniques for identification of pattern[1]. The obtained outcomes unimproved recognition rate of 99.9%[1]. Mahesh.P. K. et. al proposed a biometric automated system for palmprint uniquenessconfirmationand speech signal with an accuracy of 98.63% with FRR in 0.84%and FAR of 1.07%[7].

Conrad Sandersonet. alproposes a method which can processes the eminence of speech signal independent individualityauthentication system. The values of Eigen for faces approach and also designatesaround many speech feature extraction techniques[8]. Sangeeta Karkarwal.et.al projectedthe wavelet subbandsconstructedinvestigation method for facial identification based on wavelet Transform. The results show the recital of correlation and threshholding[2]. The same authors were resolved gait recognition, gait image presentation, feature dimensionality reduction and gait classification. Changhan Park and Joonki Paik proposed PCA and HMM for both speech and face recognition and FRR was reduced to 0.0001%[3]. FarhoodMousavizadeh. et. al proposed Face recognition and livenessrecognitionuses the both algorithms and simulates simultaneously to reduce time consuming and also accurate detection of a face, this algorithm is also contemporary feature extraction, after extraction rotation, scale and translation has been to regularize the objects and maximum accuracy obtained is 94%[16]. The two major groups of model based features and model free features for identification the gait and to recognition[17]. S. Venkatesan. et. alproposed ant colony optimization algorithm and genetic algorithm fora prototype device to face identification[3]. This system uses clustering, genetic and ant Colony Optimization algorithm and shows the maximum efficiency of 96%. The ACOGA capability can be greater than before by using a better face scanner, the best method of mounting and well organized technique of edge detection and feature extraction of the face image[18]. The different angles and illumination variations are used to detect faces in video and live stream[19]. Movina R. Ayoob, et.al, suggested forface recognition based on Symmetric Local Graph Structure (SLGS) higher recognition accuracy as compared with the existing technique like LBP, DCT and Gabor[19]. Jana Selvaganesan. et. al proposed invariant feature set of posture and obstruction is generated the invariant local features, features of appearance and the principle of outlier detection and it is based holoentropy concept. This entropy uses the combination of indecision information and holoentropy for measuring of invariant local features. By using the reverse sigmoid function suitable weights are assigned to the holoentropy to increase the usefulness in the selection of key frames to recognize the faces from the test videos[20, 21]. The Center Symmetric Local Binary Pattern (CSLBP) proposed to extract the features and evaluation of database of faces and demonstration the best performance and measured the result in terms of illumination and computation because of less parameter[22]. The pose range of the input image was prophesied to indicate the proper colonnade set. This colonnade set will help to decrease time corresponding between the input image and database images, and error proliferation when poses forecast returns false results. The concert of these methods was evaluated with the public database FERET[23]. SarathChanduGaddam. et. alproposed the face recognition based attendance system and classification todeliver theaccurate attendance information of the students and the same is uploading the attendance into the server using Ethernet cable. The attendance gives the high secure for any type of systems instead of using fingerprint or RFID and this system is easy to use and gives better safety and develops outputs with 88% of accuracy[24].

3. Problem Statement

Biometric technology is the most recurrent for the recognition of human faces of individual persons and for improving the security level is also one of the challenging tasks in communication field. In previous work, several methods are projected for facialidentificationsystem,

includingface detection, monograms, eyes and speech. In this proposed work, modified PCA it includes HMM to recognize faces, but also differentfragments of the face like the eyes, nose, and mouth for the stored images in the database. This shows an accuracy of 96.8%, which is used for the identification of both grayscale and color images.

4. Methodology

The overall block diagram of the proposed work is shown in Fig.1 for facial organs identifications, image pre-processing, Principal Component Analysis (PCA) it includes Hidden Markov Model (HMM), Gaussian Mixture Model (GMM) and Artificial Neural Network (ANN).

4.1 Database of Face and Its Organs Images

Real time captured face images are collected from different sources of various persons and all images are stored as database and some of face images are collected from standard databases. The Figure1 shows the proposed system for real time face recognition.

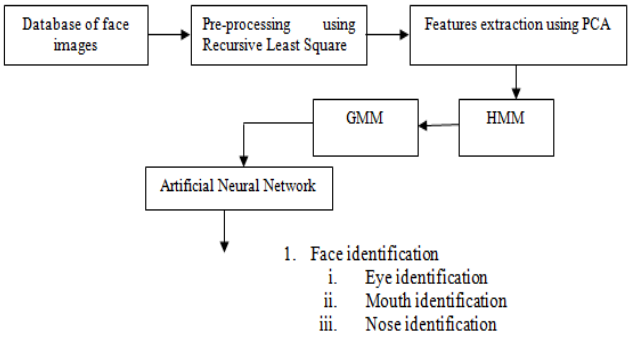

Figure 1. Block Diagram of Proposed Face Organ's Recognition.

4.2 Image Pre-Processinguses Recursive Least Square (RLS)

The initial phase for face recognition is the image Pre-processingusingadaptive wiener filtering technique which is based on Recursive Least Square (RLS) with the comparative performance parameters such as SNR, PSNR and RMSE with some of existing filters. The image which has to match with the image stored in the database must first undergo pre-processing testing. Each filter imaging schemeundergoes with a communal problem of "Noise". Objectionable data may reduce the contrast, declining the shape or size of objects in the image and distorting of edges or weakening of fine details in the image may be termed as noise. Salt and pepper noise is a multiplicative noise which obscures fine details in face image processing. The occurrence of Salt and pepper noise results in blurring of the image which affects the visualization of the problem through the facial organs images.

Most noise filters are established for enhancing visualization of images which can develop by spatial domain filter or frequency domain filter. The spatial domain refers to discrete image domain operates directly on the pixels. In the frequency domain image is transformed to the frequency domain (DFT) and passed via filter and finally filtered output is mapped into the spatial domain using an inverse to transform by using smoothing algorithms. The salt and pepper noise filters mainly having two applications those are noise images in SAR (Synthetic Aperture Radar). Achieving higher performance metrics like signal to noise ratio, peak signal to noise ratio, with low root mean square error is desired in image processing while doing dancing or filtering, which results in good quality image in medical image processing, this project reports on efficient filtering methods using adaptive wiener filtering techniques results in good quality images by achieving the highest peak signal noise ratio and low value of root mean square error and signal to noise ratio. The outcome of the preprocessing is that the adaptive wiener filtering algorithms like LMS (Least Mean Square) and RLS (Recursive Lest Square) are designed efficiently using MAT lab with Graphical User Interface, and it is achieved that RLS is the best method for diagnosing any type noises from real time captured images by achieving a higher peak to signal noise ratio (PSNR) and lower root mean square error (RMSE).

The input image is read from the stored image database, available in standard image format which is considered as a test image for the denoising. The filter bank consists of designing filters which include both spatial and frequency domain filters which are helpful in removal of noise from test image. The noise reduction techniques consisting of designing filters like contra harmonic mean filter, geometric mean filter, correlation filter, wiener, adaptive Wiener, LMS and RLS algorithms as shown in the Figure 2.

In the preprocessing method, the intensity of each image pixel is normalized to adjust the size of all database images and using an RLS filter technique the image quality and reduce the fluctuations are improved. For

the development of many applications related to face recognition, persistence of energetic range and normal to the senses are brought to an image which is known as normalization. If the intensity range of the image is 50 to 180 and the desired range is 0 to 255 the process entails subtracting 50 from each of pixel intensity, making the range 0 to 130. Then the each pixel intensity is multiplied by 255/130, making the range 0 to 255

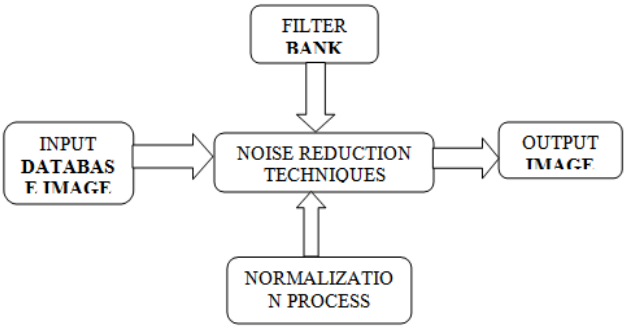

Figure 2. Block Diagram of Pre-Processing for Facial Image.

5. Principal Component Analysis

In proposed work, the PCA is essential for extraction of features of different organs in the captured face image because it uses by using an orthogonal transformation due itsarithmetical procedure which converts a set of interpretations of perhaps correlated variables into a linear interrelated set of values[13]. The extracted features are in terms of Eigenvectors of the face and these Eigen values extractvariousstructures of the face and its organs when the Eigen value is high[20]. For the approximation of pose using PCA covariance matrix C, the Eigenvalues are trained by comparing reference Eigen values. Let us consider the trainingEigen valuesNofface vectors v_1, v_2, v_3.....v_N. By definition C can be estimated as [3].

$$C = E\,[VV^T] = 1/N\sum_{k=1}^{N} V_K V_K^T \quad (1)$$

The training data set is packed into following matrix.

$$V = [V_1, V_{2.....} V_N] \quad (2)$$

To approximation the Eigenvectors of $VV^T$are founded and from the fundamental linear algebra, theEigenvectors of VV^T can be found from Eigenvectors of V^TV. Suppose rank of V is being, $r \leq N$. then

$$V = \sum_{k=1}^{r} \sqrt{\lambda}_k u_k v_k^T \quad (3)$$

Where $\sqrt{\lambda}$, $u_{k\,and}$ v_k represents the singular values, left, and right singular vectors of V, $u_{k\,and}$ v_k have the following relationship.

$$u_{k=} 1/\sqrt{\lambda}. Vv_k$$

Therefore find Eigen face $u_k$can be find easily after finding $v_{k.}$ Recognized face classified using

$$d=R_i\text{-}t_i)^2$$

Where $R_i$andto characterize the input pattern and pattern of train respectively.If there is any large dissimilarity in the detected image it will be retained and then applied to the next stage.

6. Hidden Markov Model

HMM is adapted forarithmeticalregular image processing as aninfluential tool. In many biological sequences and face recognition the HMM is extensively used tool. It can be applied to investigate several problems like several categorization configurations, classification, penetrating of resemblances and many others. The Figure 3 shows the architecture of HMM[14].

The probability of HMM for state transitions depends on the HMM parameter to get information about the output that which state it is depended. The transitions provide the token and this token gives the information related to the sequence of the states. HMM is a combinationalsysteminclude the variables to be hidden and are well-ordered by the combinationtools which are designated for each and every observation that are related in Markov process and independent of each other. The general architecture of HMM and the oval shapeis the random variable to any number of values. The following are the variable and hidden states of the HMM

$e(t)$ =Hidden state at t.
$e(t) \in \{e_1, e_2, e_3\}$.
$e_n(t)$ = observation time t.
$e_n(t) \in \{e_{n\,1}, e_{n\,2}, e_{n\,3}, e_{n\,4}\}$
Arrows denote that dependencies are conditional.

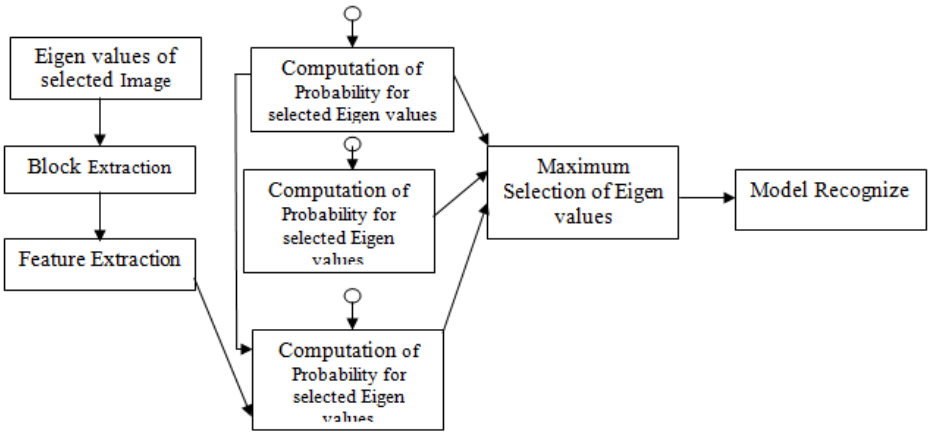

Figure 3. Black diagram of HMM.

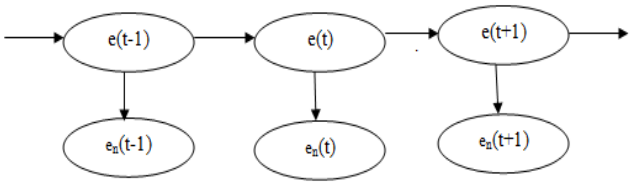

Figure 4. General Architecture of an Instantiated HMM.

For given e(t) is the variable time of hidden, (t-1) is the property of Markov which is depends on e. The transition probability and emission probability are basic properties of Hidden Markov.

7. Gaussian Mixture Model (GMM)

The GMM is the densities sum of Gaussian coefficients for identification of faces and it can be changed based on the situation and several of moving face objects. The detection of moving objects and understanding are difficult. To address the issues The GMM has been applied to find out invariant face recognition. This method is used to illustrate face's features and find out variations in the faces with different mixed components. It consists of Gaussian mixture distribution which have one or more multivariate Gaussian distribution components.

GMM consists of following components which are processed by a step by step process.

- The interpretations consist of N random variables which are distributed conferring to K components and belong to the same family of distribution.
- The identity of the mixture component latest variables which are corresponding to the N random variables and is distributed according to K dimensional distribution.
- A set of K mixtures weight is having the probability whose sum is equal to 1.
- Each component in the distribution has a mean and variance. According to V-dimensional distributions the observations are distributed.

8. Artificial Neural Network

The collection of different neurons from the GMM model and multiplying with weights are known as processing element. Each element is analogous to organic neurons in the brain as shown in the Figure 5. The gestures are delivered from one neuron to another using weighted links. The outputs of each neuron are connected to transmitter to get output signals. Each connection divided into a number of hidden layers which will transmit same signals to another neuron. These networks involve themselves to solve problemsand reduce the mean square error. The foremostobjective of ANN is to acquire from the trained data set. Whenever there is ambiguity in the data functions for final decision of output to get different images of facial organs. The classification perceptron is the set with target t for a given input set. The perceptron weight changes by a factor Δw if the output o is not equal to target t.

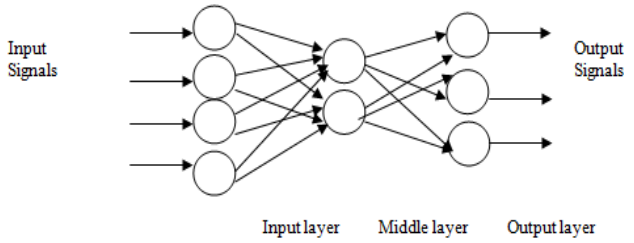

Figure 5. Construction of Artificial Neural Network.

9. Implementation and Results

The proposed is designed and validated using Matlab 2014a and the designed face recognition tool is user friendly to operate each module operation. The Graphical User Interface (GUI) has been created with different switches, each switch is for one operation as shown in the Figure6 (a). From the database, any one of the images is subject to the proposed GUI system for further operations. The subjected image is smoothened and sharpened using wiener filter later output image is applied to histogram equalizer for improving the contrast level. The experimental results show that the proposed method has been achieved 95.8% recognition accuracy.

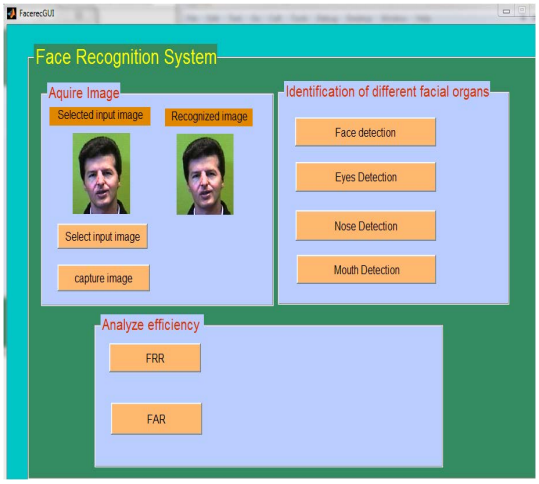

Figure 6 (a). GUI for Proposed Face Organs Recognition.

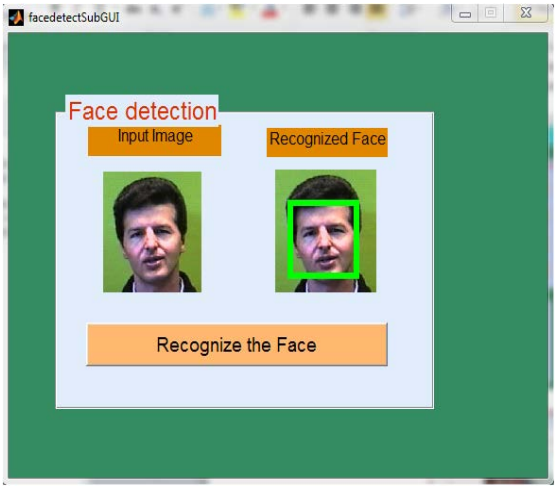

Figure 6 (b). GUI for Face Recognition.

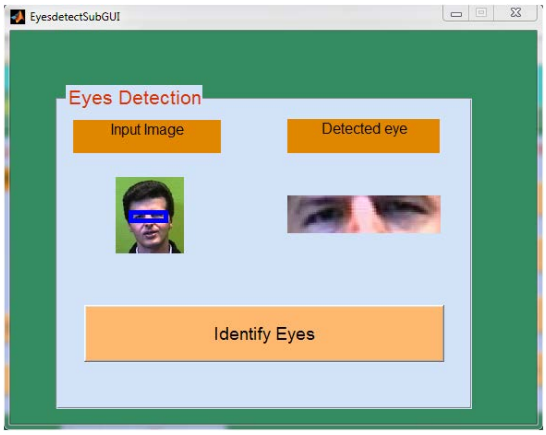

Figure 6 (c). GUI for Eye Recognition.

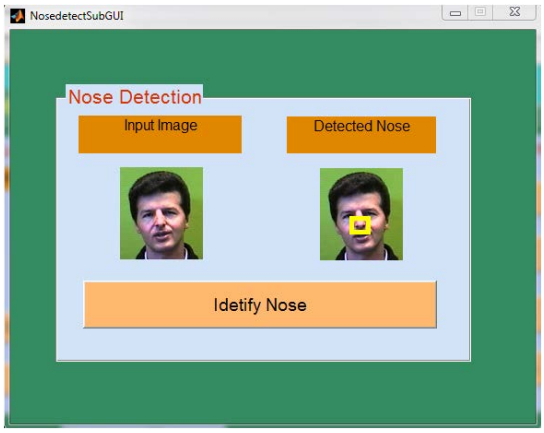

Figure 6 (d). GUI for Nose Recognition.

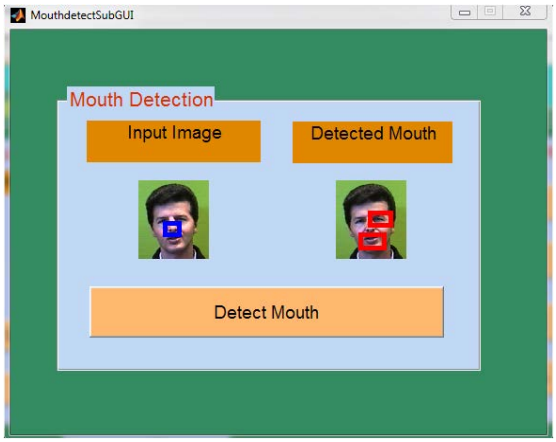

Figure 6 (e). GUI for Mouth Recognition.

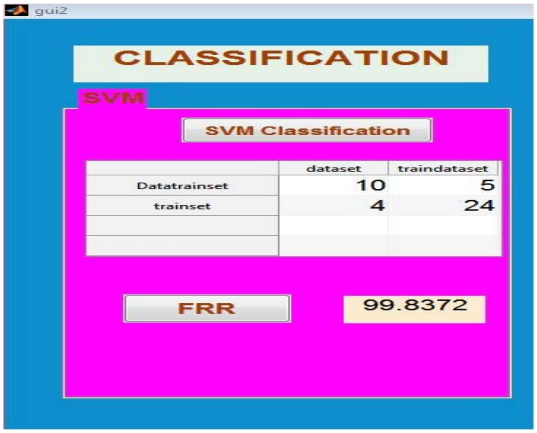

Figure 6 (f). GUI for FRR Parameter. calculation.

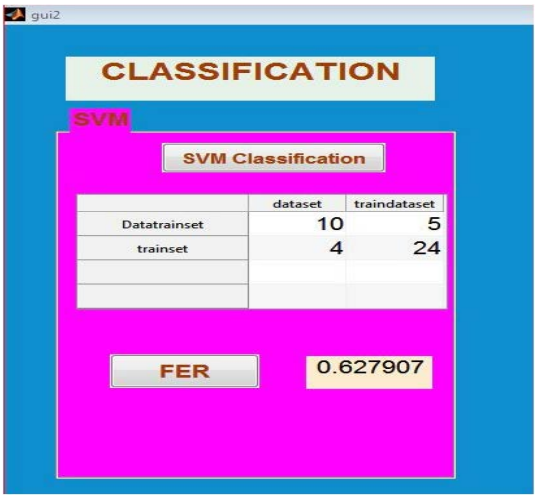

Figure 6 (g). GUI for FER Parameter Calculation.

Figure 7. GUI for Organs Recognition.

In the Figure 6 (a to g) and Figure 7 one of the stored image is subjected through the GUI to complete face recognition process. The loaded image is cropped and resizing into standard size using pre-processed technique and is shown in GUI to increase the intensity and sharpens the image. The enhanced image is then applied to the principal component analysis (PCA) for extraction of features. The cropped image is then pragmatic to HMM which resolves the problem of classification and penetratingresemblances. GMM is used to find out invariant faces. Finally the image is applied to ANN which corrects errors and classifies the image based on the similarities of the image stored in the database.

Figure 7. GUI for Multiple Face Recognition.

10. Conclusion and Future Work

The proposed work model is a multimodal face recognition system by employing the methods like Principal Component Analysis which retains the tested image if there is a large variation and gives it to the hidden Markow model and also reduces the noise in an image. HMM is used for error correction. Compared to the previous methods in this paper is used to extract the smaller parts of face like nose, mouth, and eyes with easier implementation, and provides an accuracy of 95.8%. In the future this can be implemented in VLSI by using Field Programmable Gate Array which can be used for many real time applications.

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