Human Expression Recognition using Facial Features

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ABSTRACT
Facial expression recognition can be used in many applications such as surveillances, security, gaming, customer care center and human computer interactions during non verbal communication. The user's emotion state makes the system to recognize the emotions and to interact with the human effectively. Facial expressions can notify the changes in the user's emotional state and these can be detected and interpreted by a computer. This feature extraction program captures each facial frame and extracts all those feature points, which are sent to the classifier. When emotional changes detected, the output of the emotion classifier constitutes an emotion code. These emotional face expressions and voice tones are combined with the verbal behavior. Support vector machine (SVM) is used to classify the expressions. Then the output can be displayed as a person's various emotional expressions such as fear, happy, sad, disgust, anger, fear and shame in a self assessment test. In the proposed work the expression recognition is done effectively for several expressions. The expression can be recognized from video by converting the video file to the frame format. The recognition can be done by the cost effective manner by using web camera to capture the human emotions.

Keywords
Recognition, SVM, Score values, Emotional State, PCA

1. INTRODUCTION
The human has an ability to adapt their expressions and spoken style during their conversation with others. To enhance the human system interactions, the study of entrainment on various aspects like pronunciation, tone, speaking rate and various facial expressions in different situations such as happy, anger, disgust, neutral, sad, fear, surprise, and shame becomes essential. Many researchers like Jui et al. (2007), Soroosh(2013) studied the human response on the aspects like facial expressions, voice tone etc. several algorithms have been developed by researches like Yu( ) for recognizing the human faces.

Human facial expression recognition has been receiving lot of attention due to its increase in applications. Hence this study reviews the various work on the recognition of human emotional state in the video.

REVIEW ANALYSIS

A device takes an input signal as an images and process based on the emotions. Proper training is done over various expressions and the collection of information is stored in the main database. During testing the information of the captured image and the relevant image stored in database is compared and retrieved successfully. The feature extraction from face can be done in an automatic approach [1]. The audio is used to extract the emotional state of the human during human to system interaction [2] [3].

In facial expression recognition the features are placed in the sets and it creates the decision boundaries in the two dimensional image and the expressions can be classified and identified successfully. The emotion state can also deals with the video. For each expression the neutral state expression is consider as the baseline. From the neutral state the other expressions can be classified and resulted. In this paper the various expressions are trained and stored in the database. During testing process the image under test is compared with the related images in the main database and the result is produced. The training and testing process uses the principal component analysis (PCA) algorithm. The dimensionality in the images can be greatly reduced by using this algorithm. Support vector machine (SVM) [4] is used for classifying the faces. The feature extraction can be done by the haar wavelet in the image.

The remaining part of this paper is organized as follows: section II describes the preprocessing steps in the facial emotion recognition. Section III deals with the working steps of the algorithm. Section IV explains about the feature extraction from the image. Section V gives the experimental results. Section VI describes the conclusion part of the proposed system.

2. PROPOSED SYSTEM
The proposed system architecture is given in figure 1. Pre processing is performed to improve the accuracy and the efficiency.

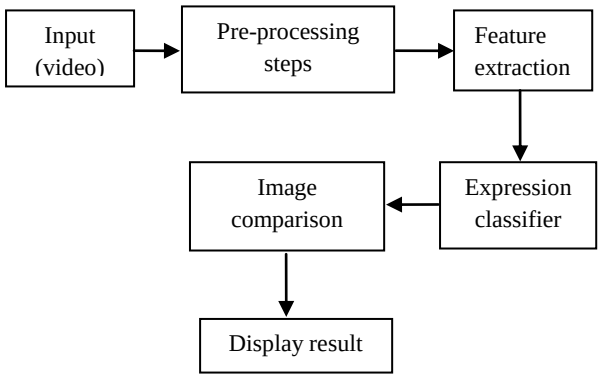


Fig 1: System Architecture

2.1 Pre-processing Steps

The working step in pre-processing method is discussed in figure 2.The video captured by the web camera is converted into frames and the frame conversion is done for the fixed interval. The converted frames are stored in the certain selected location. Each and every frame is converted into one common size.

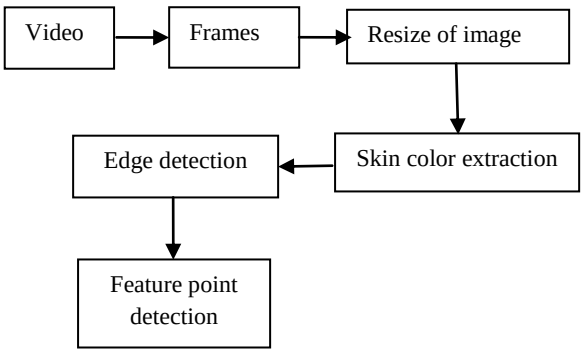


Fig 2: Working steps in pre-processing stage

The skin color is extracted from the resized image. The color image is converted into equivalent image in the YCbCr color space, where Y is luminance, Cb and Cr is chrominance. The image is created by M X N matrix of zeros to extract the skin color. The edges of the object in images can be determined by one of the methods like Sobel method, Prewit method, Roberts method or canny method [6]. After determining the corner features, the model is used to detect the complete facial features. Then the morphological structuring of each element is created and the image regions and the holes are filled. Finally the difference between the filled image regions and the extracted skin color is calculated.

3. ALGORITHM STEPS

Principal component analysis (PCA) is a useful technique to reduce the dimensionality. This method can be used in the large data sets. By using PCA the signals can be found effectively from the noisy data. The procedure adopted in PCA algorithm is as follows. The image of rectangular matrix is converted into column vector which contains the mean value of the each row. Normalization vector is calculated by determining the difference between column vector of an image and the mean vector calculated from all column vectors.

$$\mu = \left(\frac{1}{m}\right)\sum_{n=1}^{m} x_n$$

$$c = \left(\frac{1}{m}\right)\sum_{n=1}^{m}(x_n - \mu)(x_n - \mu)^T \qquad (1)$$

The mean and covariance matrix is calculated by using equation (1). This normalization vector is given as an input to the principal component analysis which returns score in the image. The rows of scores correspond to the observations and columns to the components.

Principal component returns latent i.e., a vector containing the Eigen values of the covariance matrix of the image. Rows in the matrix X, represents the observations and the columns correspond to the variables. The economy of principal component returns only the elements of latent that are not necessarily zero.

Haar wavelet is discontinuous, and resembles a step function. It performs translation and dilation process [5]. The working principle of Haar wavelet is as follows,

- The average value for each pair of sample is calculated.
- Difference between the average and the sample is estimated.
- First half is filled with the averages.
- Second half is filled with the differences.
- The process is repeated on the first half.

The feature points are extracted from the image using this Haar wavelet algorithm.

4. FEATURE DETECTION

The expressions classified by the score values are computed by Euclidean distance. Support vector machine is used for image classification and the regression purpose. It is used to classify the data into two classes like the data belongs to dataset and the data not belongs to the dataset.

To extract the feature points from face, the distance has to be calculated. The distance between expression under test and the mean neutral expression is being calculated to extract the features. The distance can be determined by calculating Euclidean distance. The distance in two dimensions is given as

$$d(p,q) = \sqrt{((p1-q1)^2) + (p2-q2)^2)} \qquad (2)$$

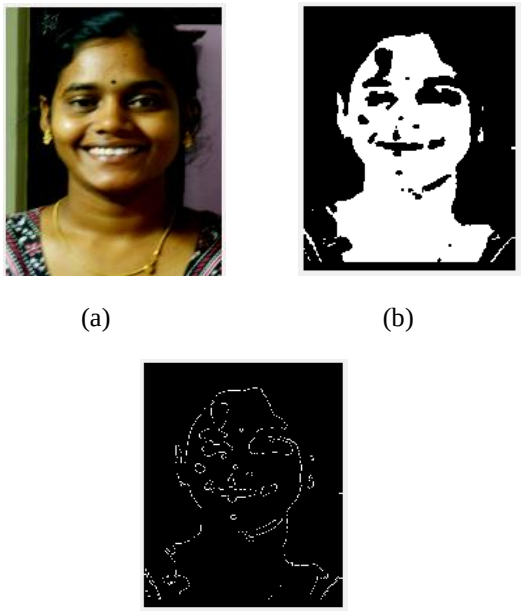
Where P represents the test image and q represents the mean neutral. The neutral position is calculated by pos parameter in an image. The minimum distance between the test image and the corresponding image in dataset is considered as a perfect match.

To compare the test image with the images in the main database the feature point is calculated for every image. The feature calculation for each image is done by taking square root for the difference between the images in test database and the sore values calculated for the Eigen range of the image in

the test database. This is performed to extract the feature point in an image. The best match of image in test database to the train database is calculated by converting cell array to numeric array. The result will be produce for all the images in test database. The emotional state of the human can be recognized and the result will be produced in a text format.

5. EXPERIMENTAL RESULTS

The human expression is recognized from facial expressions and from voice tone. The training dataset is created by saving various expressions made by five persons, 24 images for happy, 12 for sad, 13 for disgust, 11 for neutral and 13 for anger. During recognition process the following steps are followed. The web camera is used to record the human expressions. The various emotions are stored in the desired location as a frame format. The stored frames are compared with the images in the database to produce the results. Experimental result in pre-processing step is given in fig.3. By using the skin regularization algorithm the contrast level of the image is adjusted in figure 3.(a). Then the skin color is extracted from the image using luminance value in figure 3.(b). The edge detection is performed over the extracted skin color image in figure 3. (c).

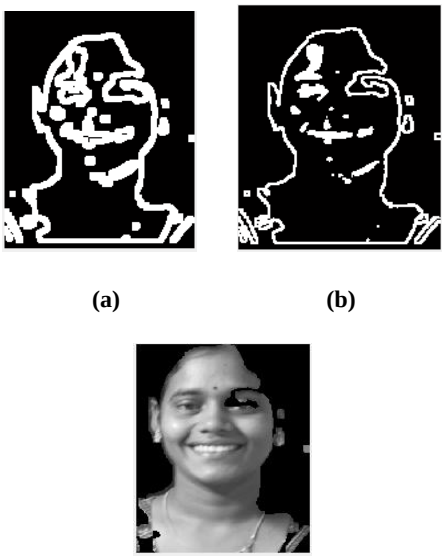


(a) (b)

(c)

Fig 3: Pre-processing steps. (a) Lightning compensation (b) skin extraction (c) edge detection.

Figure 4 gives the feature detection and extraction. The feature points are detected from the edge detected image by creating morphological structure elements and dilation process in figure 4. (a). The resulted regions and holes are filled in figure 4.(b). Finally the face is identified by calculating Euclidean distance in figure 4. (c).



(a) **(b)**

(c)

Fig 4: Feature detection and extraction. (a) feature points (b) Extracted positions (c) identified face.

Fig.5 represents the output. Neutral expression is consider as the base expression. The output is produced by calculating the Euclidean distance between image in the test database and the mean calculated from the neutral expression. Output expression is displayed in dialog box and the result will be produced in the text format.

Fig 5: Output

6. CONCLUSION

The visual features of human emotional states are recognized to improve the performance of human system recognition during non-verbal communication. It is useful in human machine interaction. To get the efficient result the entrainment over various expressions are performed. The image which is under test is compared with the images in main database. The result will be produced by comparing and retrieving the related expressions from the main database. Time consumption for testing phase is more. The delay will be large. In the future work the delay can be reduced by using various techniques, where the dimensionality to save and retrieve the image will be greatly reduced.

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