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Design And Implementation of Facial Expression Recognition Using Adaptive Neuro Fuzzy Classifier

Swati Mishra [1], Avinash Dhole [2]

[1] M.Tech.(CSE) Scholar, RITEE College, Raipur,
CSVTU University, Bhilai, Chhattisgarh, India
swati.mishra823@gmail.com

[2]Assistant Professor, Department of (CSE), RITEE College, Raipur,
CSVTU University, Bhilai, Chhattisgarh, India
avi_dhole33@rediffmail.com

Abstract: ***Human facial Expression recognition through computer by means of high recognition rate and less time consumption is still a demanding and motivating task. Various emotional information is conveyed by facial expression alone. Facial expression recognition system have a vital role in numerous areas such as human-computer intelligent interaction system. This paper aimed to present an Automatic Facial Expressions Recognition System that would recognize five foremost expressions, named as Happy, Sad, Neutral, Angry and Disgusted. In this system recognition of five different expressions is done by using some extracted features. A well known Viola Jones face detection method is used for the detection of the frontal face. After face detection ROI (region of interest) that is eyes and mouth is taken for feature extraction in which local binary pattern (LBP) is used as a feature. Then obtained LBP features are clustered by using an efficient method named adaptive Neuro Fuzzy Classifier (ANFIS) to efficiently recognize various expressions. The whole system is implemented on the dataset of 110 images of frontal facial expressions of Happy, Sad, Neutral, Angry and Disgusted from live Indian facial expression images as well as 54 untrained images have been used for testing the developed system to determine the recognition efficiency of new or untrained images by using MATLAB R2012(b). The database is created from live Indian images. After the successful testing with the proposed system the expression recognition efficiency found is 85.45% for five specified expressions for trained images and 38.89% for untrained images.***

Keywords: Facial Expression Recognition, Facial Expressions, Feature Extraction, ROI, LBP, ANFIS.

1. Introduction

It is well known that the simplest way to express emotions and feelings through human facial expressions. There are various attributes of persons behavior which can convey information of one's status of mind directly or indirectly such as facial expression, body gesture or conveying information orally but among these simplest and powerful way of conveying information is facial expression. Facial expressions have been categorized in early 1970s by Ekman's studies. He has stated that humans have six senses where each sense represents a specific emotion such as anger, happy, sad, fear, surprise and disgust [2]. Face detection and expression recognition related problems can easily resolved by an automatic Facial expression recognition system and thus it becomes an active research area in the field of real life application. It is also used in health sector, robotics, mobile sector, security purpose and human system communication etc. Generally facial expression recognition system comprises of three important parts which performs in sequence such as detection of face, extraction of facial features and recognition or classification of facial expression.

In this paper introducing a unique, and an efficient method to recognizes and examine five major expressions such as Happy, Sad, Neutral, Angry and Disgusted for facial expressions recognition system. This recognition system performs following steps comprises pre-processing, face detection, facial feature extraction and expression recognition to efficiently recognize the facial expressions. In this system recognition of five different expressions is done by using some extracted features. A well known Viola Jones face detection method is used for the detection of the frontal face. After face detection ROI (region of interest) that is eyes and mouth is taken for feature extraction in which local binary pattern (LBP) is used as a feature. Then obtained LBP features are clustered by using an efficient method named adaptive Neuro Fuzzy Classifier (ANFIS) to efficiently recognize various expressions. The database is created from live Indian images.

2. Methodology

In this paper introducing a unique, and an efficient method to recognizes and examine five major expressions such as Happy, Sad, Neutral, Angry and Disgusted for facial expressions recognition system. This recognition system performs following steps comprises pre-processing, face detection, facial feature extraction and expression recognition to efficiently recognize the facial expressions. In this system recognition of five different expressions is done by using some extracted features. A well known Viola Jones face detection method is used for the detection of the frontal face. After face detection ROI (region of interest) that is eyes and mouth is taken for feature extraction in which local binary pattern (LBP) is used as a feature. Then obtained LBP features are clustered by using an efficient method named adaptive Neuro Fuzzy Classifier (ANFIS) to efficiently recognize various expressions.
The whole development of the planned system is shown in figure 1, with the help of following flow chart.

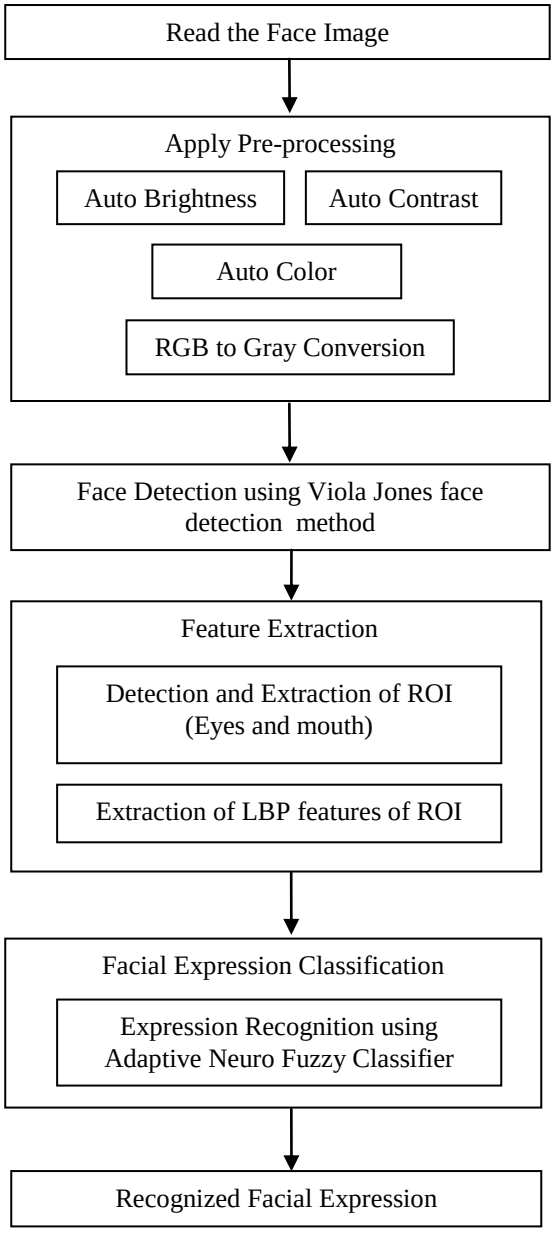

Figure 1: Flow process of proposed Facial Expression Recognition System

2.1 Preprocessing

Pre-processing is the essential and basic step of the image processing and in this proposed system pre-processing of an image is the first step to obtain uniform and noise free image for further processing. In this step auto brightness, auto contrast, auto color function and RGB to Gray conversion is performed. To adjust brightness of an image auto brightness function is used, to automatically calculates the favorable contrast for the image auto contrast function is used and to adjust the color of the image auto color function is used. The last step of pre-processing is RGB to Gray conversion and it is an important step because to extract features of an image only single channel image (gray image) is required.

Figure 2: Input image for preprocessing

Figure 3: Image after preprocessing

2.2 Face detection using Viola- Jones technique

In this project work Viola-Jones face detector is used for detection of an input face image. According to the principle of the Viola-Jones algorithm detection of face is done by scanning a sub-window across a given input image. In Viola-Jones method many times the detector is rescaled and each time runs the detector through the image with a different size. Viola-Jones have devised a scale invariant detector which is constructed by using an integral image. This method is successful and most accepted technique because of high detection accuracy and very low false positive rate.

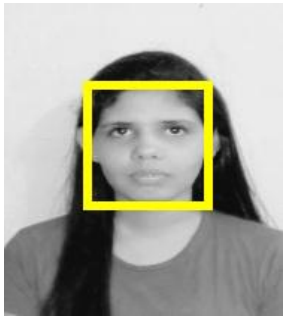

Figure 4: Face identified using viola jones technique

2.3 Feature extraction using Local Binary Pattern (LBP)

LBP is a form of feature which is used for classification in computer vision, image processing, texture classification etc.

The LBP feature vector is created in the following way:

- Examined window is divided into cells (e.g. 4x4 pixels for each cell).
- In a cell each pixel is compared with each of its two neighbors i.e. its left-top, left-middle, left-bottom, right-top, etc. Follow the pixels using a circular neighborhood of any radius, i.e. clockwise or counter-clockwise.
- Now the center pixel's value is compared with neighboring pixel's value if the center pixel's value is less than the neighboring pixel's value then write "0". Otherwise, write "1". By this method an 8-digit binary number is obtained and usually for convenience the binary values are converted to the corresponding decimal values.
- Now the histogram is computed, over the cell for each combination of pixels which are smaller and which are greater than the center.
- It is optional to normalize the histogram.
- Resulting (normalized) histograms of all cells are concatenated into single enhanced histogram. In this way the feature vector for the window is created.

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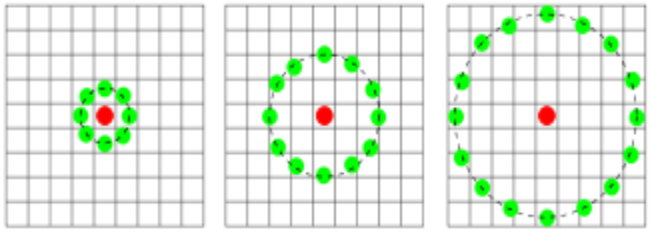

Figure 5: Circularly symmetric neighbour sets.

In Figure 5 three neighborhood examples used to define a texture and calculate a local binary pattern (LBP).

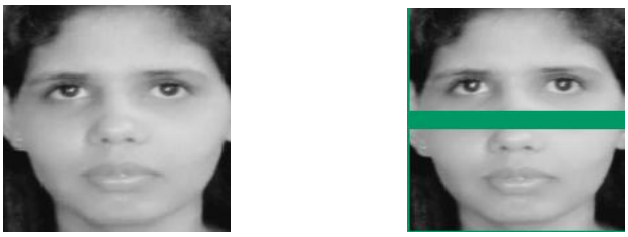

Figure 6: Partition of face image in two equal parts

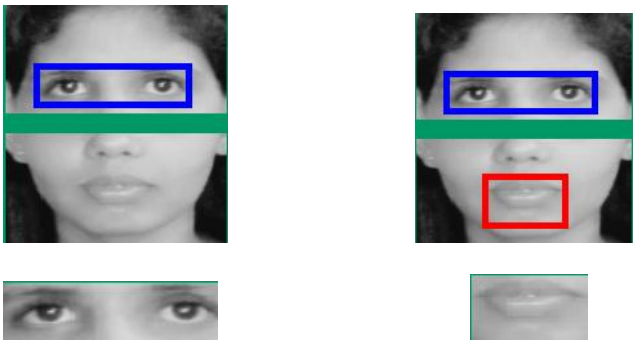

Figure 7: Eye pair and mouth detected for LBP feature extraction

Figure 8: LBP of Eye Pair Region

Figure 9: LBP of mouth Region

2.4 Adaptive Neuro Fuzzy Classifier (ANFIS) for feature classification

Facial expression classification is the last step of facial expression recognition system. In this system ANFIS classifier is used for expression classification. A hybrid system named ANFIS has been introduced by Jang. ANFIS is a kind of Neuro-fuzzy model and it has the advantages of neural networks as well as fuzzy logic. In feature extraction process LBP features are obtained and these features are efficiently classified by using ANFIS classifier. The basic principle of this modeling process begins with analyzing the values of LBP features getting from various facial expressions. Now in the modeling process of adaptive neuro fuzzy classifier have following steps:

Step i: Save the LBP features of all five facial expressions to make a complete LBP feature database**.**

Step ii: Training of ANFIS for LBP features database to achieve correct expressions .

Step iii: Test the developed ANFIS classifier with training data set.

3. Result and Discussion

In this project work, a novel Automatic Facial Expression Recognition System is presented, which efficiently recognizes five principal expressions. The proposed approach used to recognize the expressions is fast and efficient. Complete Indian database is created from 110 live Indian face images and these are used during the development and training phase of the proposed system then all 110 trained images have been tested to determine the expression recognition efficiency of the developed system as well as 54 untrained facial images have been used to determine the recognition efficiency of new or untrained images.

Result of developed system is determined on the basis of time requirement and recognition efficiency for trained images as well as untrained images.

3.1 Result of Time Requirements

In this subsection the total time requirement as well as time needed for the different phases of facial expression recognition of the developed system is presented. Table 1 shows the total time requirement for the developed technique for single facial expression recognition is 1.1651 sec (approximately), which is very less as compare to the available facial expression recognition techniques.

Table 1: Time requirement for different subsections of the developed system

S.No.	Subsections	Time Required
1	Image Loading	0.2325sec
2	Preprocessing	0.0659 sec
3	Face Detection and Partition	0.3556 sec
4	ROI Detection	0.3594sec
5	LBP Feature Extraction	0.0517sec
6	Facial Expression Recognition Using ANFIS	0.1000 sec
	Total time requirement	**1.1651 sec**

3.2 Result of Recognition Efficiency for Trained Images

Now Table 2 contains the facial expression recognition rate of each expression of images and recognition rate of the developed system for all the expressions for trained images. Table 2 shows the recognition efficiency that is 85.45% of trained images for the developed system.

Table 2: Facial Expression Recognition Rate of the developed system for trained images

S. No.	*Expressions*	*No. of Images*	*Recognition*		*Recognition Rate (%)*
			TRUE	*FALSE*	
1	Happy	25	24	1	96
2	Natural	22	17	5	77
3	Sad	19	17	2	89.5

4	Angry	22	18	4	81.8
5	Disgusted	22	18	4	81.8
Total Images used		**110**	**94**	**17**	**85.45%**

Figure 10 shows the recognition Rate of five facial expressions for trained images of developed system in which X axis shows .the five basic facial expressions and Y axis shows the Recognition Rate in percent.

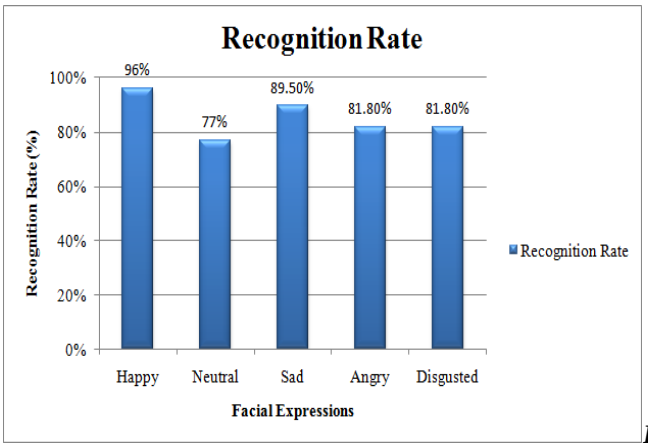

Figure 10: Recognition Rate (%) of five facial expressions for trained images

3.3 *Result of Recognition Efficiency for Untrained Images*

Table 3 contains the facial expression recognition rate of each expression of images and recognition rate of the developed system for all the expressions for untrained images.

Table 3: Facial expression recognition rate of the developed system for untrained images

S. No.	*Expressions*	*No. of Images*	*Recognition*		*Recognition Rate (%)*
			TRUE	*FALSE*	
1	Happy	13	7	6	53.84
2	Natural	11	6	5	54.54
3	Sad	10	3	7	30
4	Angry	10	3	7	30
5	Disgusted	10	2	8	20
Total Images used		**54**	**21**	**33**	**38.89%**

Table 3 shows the recognition efficiency that is 38.89% of 54 untrained images for the developed system.

Here, Figure 11 shows the recognition Rate of five facial expressions for untrained images of developed system.

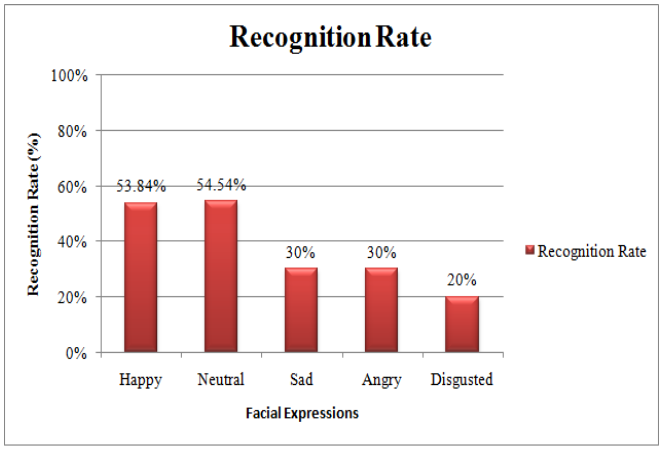

Figure 11 : Recognition Rate (%) of five facial expressions for untrained images.

4. Conclusion

In this paper, a novel and efficient method for facial expression recognition is introduced by using ANFIS classifier, which recognizes the five basic expressions i.e. Happy, Sad, Neutral, Angry and Disgusted. The system is developed on live Indian images that have frontal facial expression. After implementation and testing of developed system experimental result shows that, the developed facial expression recognition system using ANFIS provides good recognition rate and less time requirement.

- After evaluation and analysis of the total time required for expression recognition using developed system, it is found that the developed system takes very less time about 1.1651 sec (approximately) for recognition of an individual expression. This time requirement is very less as compare to other developed methods; thus the developed system is very much feasible for the real time processing and recognition.
- Apart from this the expression recognition efficiency of the developed system it is found 85.45% accuracy for trained images and 38.89% accuracy for untrained or new images. For the implementation of Facial Expression Recognition system the software platform that used is MATLAB R2012(b).

For the future work, New expressions can be recognized with other interested regions such as eyes, nose and mouth with more live databases.

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