Facial Emotion Recognition using Swarm optimization Technique

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Abstract

In modern era which involves human-machine interactions in every walks of life, identification of emotions by an automated system plays a vital role. In order to deal with the frameworks of machine and human, development of emotionrecognition systemsis very crucial. To differentiate various emotions of face, emotion recognition system based on Artificial Bee Colony (ABC) optimization is proposed in this paper. Feature vectors are extracted using HoG and SIFT feature extraction technique. These extraction techniques produce high rate of accuracy. The optimized features are trained using different classifier for the emotion recognition. Among various classifier, Neural Network classifier outperformed other classifiers yielding a classification accuracy of 86%.

Keywords: Emotion recognition, SVM, HoG, SIFT, Artificial Bee Colony, Neural Network

1. Introduction

Emotion recognition is gaining importance in the field of computer and human interaction [1]. Six fundamentals emotions are classified from facial expression recognition, depends on attributes of face. They are happiness, anger, surprise, fear, disgust and sadness. It is a very challenging task to design an effective automatic emotion recognition system. Smooth computer and human interaction can be done using a successful emotion recognition [2,3]. In the field of heterogeneous, various applications used human emotion recognition system [4,5,6], computer and human interaction, antisocial motives inspection, surveillance of patients are most commonly used applications. When features are mapped into high dimension, enhanced results are produced.

Accurately detecting the emotion is still having some challenges [7]. In the proposed work feature selection method based on ABC algorithm is used to improve the accuracy of the classifier in classifying emotions.

Facial emotion detection system (FES) is proposed to recognize the emotions of face automatically. In this system, gradient filter is used to extract the important features and they are classified into different emotions. The proposed system has following stages, normalization, occurrence choices, feature extraction and classification. Feature vectors are extracted by extracting the features and they are optimized to select relevant features. Individuals are classified by doing classification.

The coloured picture is converted into grey scale image in the pre-processing stage of an image. Images with high quality are used for the experimentation. Face locations are separated in the image after pre-processing all the images. So proposed method does not require face recognition stage. Figure 1 shows the proposed methodology.

2. Preprocessing

The facial image can be captured in gray scale or in color format. If it is captured in color format, weighted sum of components of Red, Green and Blue are used to convert it into a gray scale image. The conversion method [5][6][7] is shown in the below equation,

$$g(x, y) = 0.2989 \times R + 0.5878 \times G + 0.1140 \times B \quad (1)$$

where, Red components of color image is represented by R, Blue components of color image is represented by B and Green components of a color is represented G image.

Figure 1: Proposed Methodology Diagram

3. Feature Extraction

Feature extraction is done in this phase were information of the pixels are converted into a representation of notion, texture, shape, spatial information and colour of face. This feature extraction is done by gradient method. Classification of expressions are done based on this extracted features. Emotions may be classified into happy, sad, surprise, aggressive and neutral. Appropriate symbol of statistics is obtained using facial feature extraction methods. This symbols contains the expressions of image or sequence that can be recognized. Collection of minimum information, reducing the information measure are the major objective of this stage. Meaningful information extraction is a goal of this stage.

HoG and SIFT feature extraction techniques are used in this system. Sharp edge characteristic are detected by HoG feature. SIFT is used to recognize the feature that are not recognized by HoG [8]. The proposed system uses some characteristics of an input image to decide which feature extraction technique has to used. The characteristics of images like pointed edges, smooth curves and loops are used to make a decision. The image in divided into spatial bins and histogram of an image is formed by both of the feature extraction techniques. They use image gradients for the same.

Best rate of recognition is produced by SIFT and HoG. Large amount of processing time is required by the SIFT extraction technique when compared to HoG technique. So, HoG is used to recognize most of the characters. The characters with smooth edges are recognized by SIFT. Based on input image, feature extraction techniques are chosen adaptively to improve the accuracy of overall system.

Directions of edge and gradients of intensity are used by HoG. In HoG, one small descriptor is computed by forming the small cells by dividing an image and histogram is computed for all the cells. They are combined to from a descriptor. In connection with illumination and geometric transforms, HoG produces good results. Key point detection, matching, model verification and local descriptor extraction are the major stages of SIFT feature extraction.

4. Feature Selection

Karaboga implemented a swarm intelligence based global optimization algorithm which is known as ABC algorithm in 2005 [9]. Bee colony behaviour is uses as a base for this ABC

algorithm. Bee colony discovers the optimal nectar resource by sharing and exchanging the information of the colony. The ABC algorithms has simple operations and it has high value of precision. In global searching it has good robustness. Objective functions are not required in this algorithm and external information are not utilized by this.
In each iteration of ABC algorithm, local and global search is used which is major advantage of this algorithm. This increases the optimum solution finding probability. In this way, extracted features are optimized by ABC algorithm to produce best features thus in tern produces high value of accuracy.

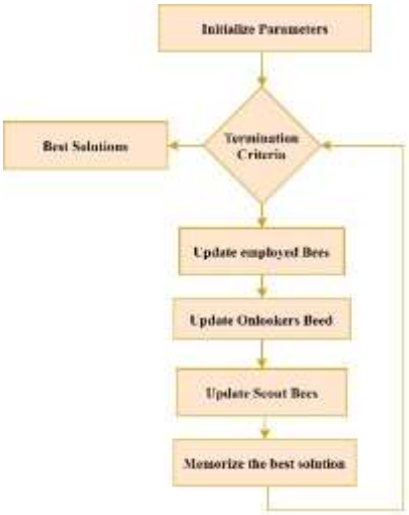

Figure 2: ABC Process Flow

Classification

The features extracted are used to train the classifier. The classifier efficiency in classifying images is tested using test samples. The features extracted using ABC are used to train five different classifiers namely naïve bayes, decision tree, kNN, SVM and naïve bayes classifier.

5. Experimental Results

The proposed system is implemented in MATLAB 2013. In order to prove its applicability experimentally, standard and publicly available dataset as benchmark dataset called Japanese Female Facial Emotion Database (JAFFE) [12]. This dataset has 212 gray scale normalized images. Images are of 256×256 in size. The emotions like happy, surprise, angry, neutral, sad are included in this dataset images. That can be for different testing. The simulation environment has training as well as testing panels.
In training part, panel consist of different emotional categories used for training based on filtering and feature extraction approach. Samples uploaded for testing are shown in Figure 3. Each classifier is trained using 70 images and tested using 30 images.

(a) Input Image

(b) Enhanced Image

(c) Edge Based Image

(d) Filtered Image

Figure 3: Facial feature extraction

	Happy
	Angry
	Disgust
	Surprise
	Sad
	Fear

Figure 4: Facial emotion classification

The ABC optimized features extracted from the images are used to train five different classifiers. The performance metrics used are accuracy, precision and F-measure.
Accuracy is the ratio of total number of samples correctly classified to the total number of samples taken for the experiment. Precision, π is defined as the ratio of correctly assigned class C samples to the total number of samples classified as class C. Recall is the ratio of correctly assigned class C samples to the total number of samples actually in class C.
Let TPbe the number of test samples correctly classified under Class C. FPbe the number of test samples incorrectly classified under class C. TNbe the number of test samples correctly classified under other classes. FN be the number of test samples incorrectly classified under other classes.

$$\text{Accuracy} = \frac{TP+TN}{TP+FN+TN+FP} \qquad (2)$$

$$\pi = \frac{TP}{TP+FN} \qquad (3)$$

The precision summarizes exactness and recall summarizes the completeness of a model. A better descriptor to evaluate the classifier performance is the F1 score. F1 score is nothing the geometric mean of the precision and the recall.
Table 1 shows the performance of the proposed system using Naïve bayes classifier. The classifier shows an average accuracy of 59.17 % and average F1 score of 0.45. Table 2 shows the performance of the proposed system using Decision tree classifier. The classifier performance is highest when Maximum Deviation Reduction (MDR) is used as the splitting criterion and number of splits 100. The classifier shows an average accuracy of 66.83 % and average F1 score of 0.56.
Table 3 shows the performance of the proposed system using kNN classifier. The classifier performance is highest when Euclidean distance is used and k=1. The classifier shows an average accuracy of 71 % and average F1 score of 0.77.

Table 4 shows the performance of the proposed system using SVM classifier. The classifier performance is highest when Gaussian kernel with sigma = 0.1 is used. The classifier shows an average accuracy of 80 % and average F1 score of 0.82 in classifying the emotions.
Table 5 shows the performance of the proposed system using NN classifier with back propagation algorithm. The classifier performance is highest when "traingdx" training function is used with learning rate = 0.6 and momentum = 0.9. The classifier shows an average accuracy of 86 % and average F1 score of 0.92 in classifying the emotions.
Figure 4 and Figure 5 shows the comparison of five different classifiers. From the experimental results, it is explicit that the NN classifier outperformed the other four classifiers with average classification accuracy of 86 %. Next highest performance is yielded by SVM classifier

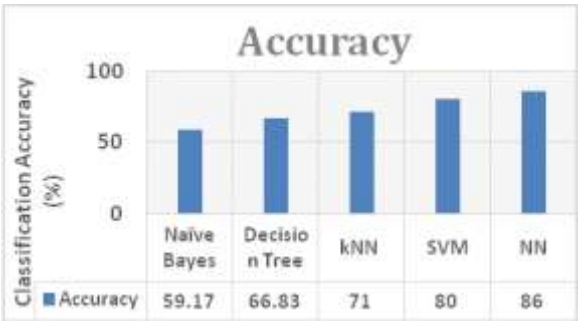

Figure 5: Accuracy of classifiers in emotion recognition

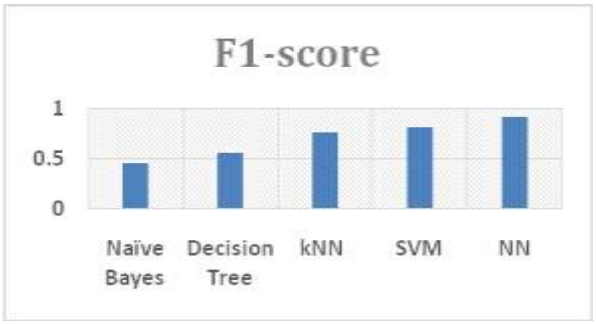

Figure 6: F1-measure of classifiers in emotion recognition

Table 1: Performance of Naïve Bayes classifier in emotion recognition

Target Recognition Rate	Happy	Sad	Angry	Fear	Disgust	Surprise
Precision (%)	61	56	58	55	52	54
Accuracy (%)	63	55	62	65	58	52
F- measure	0.54	0.26	0.71	0.74	0.31	0.41

Table 2: Performance of Decision Tree classifier in emotion recognition

Target Recognition Rate	Happy	Sad	Angry	Fear	Disgust	Surprise
Precision (%)	66	68	68	66	69	65
Accuracy (%)	67	65	65	68	69	67
F - measure	0.52	0.57	0.64	0.56	0.56	0.53

Table 3: Performance of kNN classifier (k=1 and Euclidean distance) in emotion recognition

Target Recognition Rate	Happy	Sad	Angry	Fear	Disgust	Surprise
Precision (%)	65	68	62	69	62	67
Accuracy (%)	69	73	71	69	75	69
F - measure	0.73	0.81	0.75	0.75	0.78	0.79

Table 4: Performance of SVM classifier (Gaussian Kernel , sigma = 0.1) in emotion recognition

Target Recognition Rate	Happy	Sad	Angry	Fear	Disgust	Surprise
Precision (%)	76	78	82	76	80	79
Accuracy (%)	82	78	79	83	81	78
F - measure	0.83	0.85	0.83	0.78	0.84	0.79

Table 5: Performance of Neural network classifier in emotion recognition

Target Recognition Rate	Happy	Sad	Angry	Fear	Disgust	Surprise

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Precision (%)	87	88	91	91	85	86
Accuracy (%)	80	88	88	82	89	88
F - measure	0.91	0.93	0.89	0.91	0.92	0.93

Conclusion

In this work, a system is developed which uses component analysis to recognize facial expression. The major three phases of the system includes, extraction of features, optimization of features and classification. Japanese data based is used for experimentation. Different emotions are contained in that database. Component analysis is used to pool the facial images feature extraction and optimization. Gratitude rate can be improved by gradient filtering when compared other existing techniques. The proposed technique produced better results with different emotions as shown by experimentation. In future, the system can be modelled to notify the dataset diversities and feature optimization can be improved by the process of hybridization. Also, consider the real-life engineering complications in presenting the structure.

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