IJETST- Vol.||04||Issue||08||Pages 5669-5675||August||ISSN 2348-9480 2017

Open access Journal International Journal of Emerging Trends in Science and Technology
IC Value: 76.89 (Index Copernicus) Impact Factor: 4.219 DOI: https://dx.doi.org/10.18535/ijetst/v4i8.38

Facial Expression Recognition Using Improved Artificial Bee Colony Algorithm

Authors

S. Saravanan[1], K. Ranjith[2], Dr.G.Dalin[3]

Assistant professor & Head[1] ,Assistant Professor[2],

Department of Electronics and Communication Systems, AJK College of Arts and Science,Coimbatore-641 020, India.

[3]Asst Professor & Placement Officer PG & Research Dept of Computer Science Hindusthan College of Arts & Science

Abstract : In recent year, Emotion recognition can be done through different modalities, such as speech, facial expression, body gesture etc. Emotion recognition through facial expression has attracted a lot of interest. Generally the emotions are classified as anger, disgust, fear, happiness, sadness, and surprise. The accurate prediction of facial expression is difficult due to the illumination, pose facial occlusions and different shape. To solve this problem the previous system introduced salient facial patches based facial expression recognition. However it has lower true positive rate. In order to improve the face recognition accuracy, the proposed system introduced Improved Artificial Bee Colony algorithm (IABC) based facial expression recognition. In this proposed work, the face image is detected by Viola-Jones approach. By using low pass filter the noises in the images are removed. Then the active facial patches with respect to the position of eyes, eyebrows, nose, and lip corner are extracted from preprocessed images. In order to obtain salient patches, the active patches are further processed. After that an optimal features are selected by using IABC algorithm. Finally the different facial expression anger, disgust, fear, happiness, sadness, and surprise are classified by using multiclass Support Vector Machine (MSVM). The experimental results show that the proposed system achieves better performance compared with the existing system in terms of accuracy, precision and recall.

Key words: Active feature, salient feature, support vector machine and facial expression.

1. Introduction

Now a day's facial expression recognition is an active research area. Different people have various appearances for various expressions. The appearance changes on the face are signifies the facial expression. In order to evaluate human nature, feelings, judgment, opinion the facial expression prediction is an important factor [1]. There are many algorithms are introduced to analyze the facial expression. Due to the illumination, pose facial occlusions and different shape the recognition system does not produced an efficient result [2].

There are so many machine learning approaches for classification task, namely: Support Vector Machines, artificial neural network, Bayesian Networks fuzzy neural network. Selection of good feature set, efficient machine learning approaches and diverse database for training are major problems in classification. The feature is combined to form a feature set which is important for analyzing the expression. The Machine learning approach is selected by the variety of a feature set. At last, database is used to store the training set [3].

In order to analyze the particular person mood or emotional state such as sad, happy, anger the facial expression is used [4]. In [5] the six emotions such as sad, happiness, anger, fear, disgust and surprise are recognized. Sentiment analyzes via facial expression has been getting a lot of interest due to its raise in application such as Robotics where the communication among and human is to be improve. There surveillances, safety, biometrics, customer care center and human computer interaction are major applications of emotion recognition. In order to identify the face from raw images the face detection is performed [6]. The background images are considered as raw images. In face detection all background objects are discarded from images. Then the detected image is divided into several regions. After the feature extraction, the machine learning algorithms are utilized for classification .It classify the emotion as sad, happiness, anger, fear, disgust and surprise [7].

2. Literature Survey

Yang et.al (2012) designed an efficient Monogenic Binary Coding ((MBC) method to extract local features, which is utilized for feature extraction. It spilt the signal into amplitude, orientation, and phase. The local region monogenic variation and each pixel monogenic features are encoded. After that computes the statistical features of the mined local features. From the corresponding monogenic components such as amplitude, orientation, and phase the local statistical features mined. In order to achieve high recognition accuracy the extracted features are fused. The experimental results show that MBC based feature extraction method achieves high accuracy with lower time and space complexity [8].

Tang et.al (2012) introduced a novel face recognition method which is based on contourlet transform and Coupled Subspace Analysis (CSA). An energy aggregation, multiresolution and directional image expansions are significant properties of contourlet transform. In order to reduce the dimension, the CAS exploits an optimal bi-directional projection based matrix. Because of the reduced dimension the designed system achieves better recognition result with lower computational complexity. In this work face image decomposion is done by using contourlet transform. And then fused the frequency coefficients which in the similar scale and different directions. By using improved CSA approach, the face discriminant features are mined from face images. The experimental results show the designed system achieves better recognition rate [9].

Gokberk & Akarun (2013) presented a fully automatic 3-D face recognition system which is robust to occlusions. The designed system generally considered the two major issues. First one is occlusion handling for surface registration and second one is missing data handling for classification, which is done based on subspace analysis methods. An adaptively-selected-model-based registration approach is introduced for where a face model is choose for an occluded face such that only the valid non occluded patches are exploited. After the completion of registering process, occlusions are predicted and discarded. In the classification phase, a masking strategy, which the system calls masked projection, is designed to allow the use of subspace analysis methods with unfinished data. Furthermore, a regional approach suitable for occlusion handling is merged in classification to increase the overall performance results [10].

Ryu et.al designed a new face descriptor called Local Directional Ternary Pattern (LDTP), to recognize the facial expression. By utilizing the directional information, information of emotion-related features such as eyes, eyebrows, upper nose, and mouth are encrypted by using LDTP. In this work, the face image is splitted into different region and codes are sampled consistently. By using two level grid the face descriptors are constructed when sampling the expression-related information. In order to achieve stable code the coarse grid is used. In order to achieve finer grain description of facial images multi-level method is enabled. The experimental results show the designed system achieves better accuracy [11].

3. Proposed Methodology

For various facial expressions the facial patches are active. It is described that most of the facial patches are common while elicitation of all common expressions and few are narrowed to a single expression. Generally these active patches are placed below the couple of eye, in between the eyebrows, around the nose and mouth corners. The facial components are located to extract the patches from face images. In this work, learning-free method is introduced for localization of face. Then extract the active patches of face with respect to location of nose, eyes, eyebrows and lip corners. The flow diagram of the proposed system is shown in figure 1.

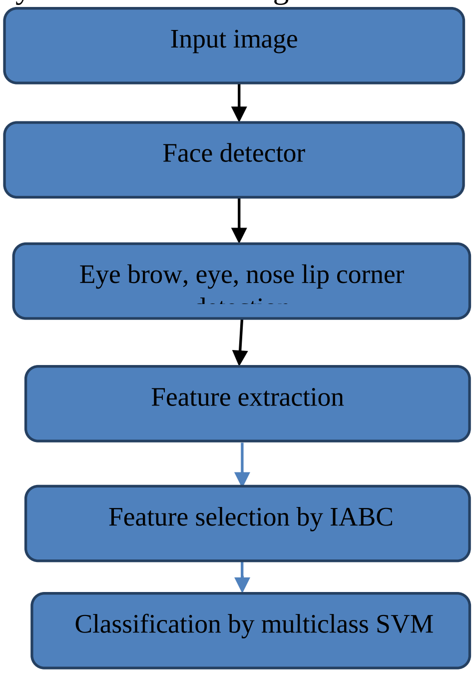

Figure 1. Flow diagram of the proposed system

3.1 Pre-processing

At first the face image is detected by using Viola-Jones method of Haar-like features with Adaboost learning. It is an accurate method to detect the front and upright position of face images with lower complexity. After the completion of face detection, noises in the face image is removed by using low pass filtering method. In order to perform lighting correction histogram equalization is used.

Figure 2. Face detection

4.2 Eye and Nose Localization

The Region Of Interest (ROI) for eyes and nose are chosen by using geometrical positions of face to achieve minimum computational complexity and false detection rate. Haar classifier is trained for eye, which is used for detect both eyes separately. And also it taking the vertices of the rectangular area of perceived eyes. Finally the eye centres are calculated as the mean of these coordinates. By using the Haar cascades the nose location is predicted which is shown in figure 3.

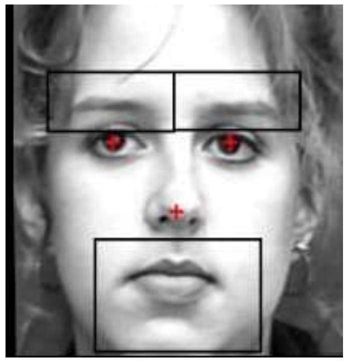

Figure 3. Eyes and nose detection

3.3 Lip Corner Detection

By assuming the location of nose as a reference, the ROI for the mouth is mined. In this proposed work, the upper lip is detected by using horizontal edge detector. In order to detect the various expressions, lot of edges are found and it is continuously threshold by using Otsu approach. In this work, binary image is attained comprising lot of connected regions. Using connected component analysis, the spurious components having an area less than a threshold were removed. Finally, the connected component with largest area which was just below the nose region was selected as upper lip region. The algorithm steps are given below.

Algorithm 1. Lip corner detection

Input: ROI and nose position

1: choose coarse lips ROI and nose location

2: Gaussian blur on the lips ROI

3: Assign horizontal sobel operator for edge detection

4: Assign Otsu-thresholding

5: Assign morphological dilation operation

6: Discover the connected components

7: Eliminate the spurious connected components by utilizing threshold method to the number of pixels

8: scan the image from the top and choose the first connected component as upper lip position

9: compute the left and right most positions of connected component as lip corners

Figure 4. Detection of corners of lip and eyebrows

3.4 Extraction of Active Facial Patches

Based on the location of facial muscles, the local patches are extracted during an expression. For various expressions, appearance features are different. The patches in the face image are does not have a fixed location. Their position based upon the location of facial landmarks which are shown in figure 5.

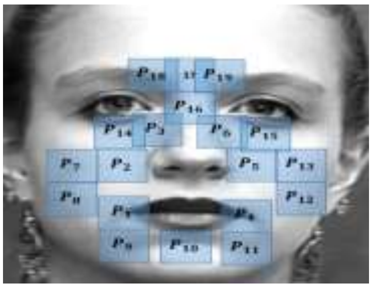

Figure 5. Position of facial patches

3.5 Feature extraction

Most commonly used illumination invariant feature descriptor is LBP. This operator computes a binary number by relating the pixel value of adjacent with the center pixel value. The pattern with 8 adjacent is represented by

$$\text{LBP(x,y)}= \sum_{n=0}^{7} s(i_c - i_c)2^n \qquad (1)$$

Where i_c- pixel value at coordinate $(x,)$

i_n- pixel values at coordinates in the adjacent of $(x,)$,

$$\text{s(x)}=\begin{cases}1, x \geq 0\\0, x < 0\end{cases} \qquad (2)$$

The histograms of LBP image is used as feature descriptors, represented by

$$H_i = \sum_{x,y} I\{LBP(x,y) = i\}, i = 0, n-1 \qquad (3)$$

Where, n- number of labels . To find out the various features, histograms are combined using various bin widths. The proposed system computes the saliency of all facial patches for all pair of expressions. The saliency is denoted in term of score which is called as saliency core. This saliency denotes the capability of the features from the patch to correctly categorize a pair of expressions. The saliency score is computed by using PCA-LDA for classification. It is used for classifying the expression accurately. The features are extracted from facial patches which have maximum score value.

3.6 Feature selection using IABC algorithm

In this work, an optimal feature selection is performed for choose efficient features from extracted features. It is done by IABC algorithm and used for increasing the searching efficiency by reducing the number of iterations. In this proposed algorithm, bees are categorized into scout bees, employed bees and onlooker bees. The total amount of employed bees is equivalent to the onlooker bees. The employed bees are used to find a food and collect the evidence regarding the superiority of the food source. Based on this collected information Onlooker bees search the food. The scout bee, searches new food sources arbitrarily in places of the abandoned foods sources. Same as the other population algorithm, ABC solution search process is an iterative process. After, initialization of the ABC parameters and swarm, it needs the monotonous iterations of the three phases namely employed bee phase, onlooker bee phase and scout bee phase.

In ABC, any potential solution updates itself using the evidence provided by an arbitrarily chosen potential solution within the current swarm. In this process, a step size which is a linear mixture of an arbitrary number $\Phi_{ij} \in [-1, 1]$, current solution and an arbitrarily indicated solution are utilized. Now the quality of the updated solution extremely depends upon this step size. When the step size is too high, this may occur if the variance of current solution and arbitrarily assigned solution is high with large absolute value of Φ_{ij}, when the step size is low then the convergence rate of ABC may considerably decrease. Therefore, to balance the exploration and exploitation, the proposed work modified the solution update policy based on the fitness of the solution.

In the basic ABC, the food sources are updated, as represented in equation.

$$v_{ij} = x_{ij} + \Phi_{ij}(x_{ij} - x_{kj}) \qquad (4)$$

Where,

v_{ij}-determined through the modification of an optimization parameter j, that is, $x_{ij}$is modified . Indices j and k - random variables. In the employed bee phase, a change in the current solution (food source) is finished by employed bees based on the information of individual experience and the new solution fitness value. When the fitness value of the new solution is superior to that of the old solution, then the bee updates the position to the new solution and old one is rejected. In order to increase the exploitation, take merits of the information of the global best solution to direct the search of candidate solutions, the solution search equation defined by equation is modified as follows:

$$v_{ij} = x_{ij} + \Phi_{ij}(x_{ij} - x_{kj}) + (2.0 - prob_i) \times (x_{bestj} - x_{ij}) \quad (5)$$

Algorithm 2:

1. cycle =1
2. Assign ABC parameters
3. Estimate the fitness of each individual feature
4. Repeat
5. Compute the solution by employed bees

For i form 1 to m

- Allocate feature subset configurations (binary bit string) to each employed bee
- compute new feature subsets v_i
- Pass the computed feature subset to the Classifier Ensemble
- compute the fitness (fit $_i$) of the feature subset based on the ensemble's mean accuracy
- Estimate the probability p_i of feature subset solution

6. Compute solutions by the onlookers

For i form 1 to m

For j form 1 to m

- choose a feature based on the probability p_i
- calculate v_i using x_i and x_j
- Perform greedy selection between v_i and x_i

7. calculated the scout bee and the abandoned solution
8. Compute the best feature subset of the cycle
9. Memorize the best optimal feature subset
10. Cycle = Cycle + 1
11. Until pre-determined number of cycles is reached
12. Compute the same searching procedure of bees to generate the optimal feature subset configurations
13. optimal features

3.7 Multi-class Classification

The SVM is used for classification of selected features into various expression classes. SVM is one of the popular machine learning algorithms, it maps the feature vector to various plane. In this work, multiclass SVM is used for various facial expression classification. In training phase, SVM classifier is trained among each pair of expressions. It concatenates LBP histogram features mined from the salient patches with more important characteristics between the given pair of expression classes. Here k represent the number of classifier and c2 represent the total number of classes. The accurate prediction of facial landmarks increases the localization of the salient patches on face images.

4. Experimental Results

The experimental results shows that the proposed IABC based facial expression recognition and existing salient feature based facial expression recognition. The performance metrics were conceived namely accuracy, precision and recall metrics were computed by current IABC based facial expression recognition and existing salient feature based facial expression recognition.

Accuracy comparison

Accuracy is determined as the overall correctness of the facial expression recognition. The accuracy is computed as like :

$$\text{Accuracy} = \frac{T_p+T_n}{(T_p+T_n+F_p+F_n)} \quad (6)$$

Where,T_P -True positive , T_N – Ture negative , F_P -False positive , F_N – False negative

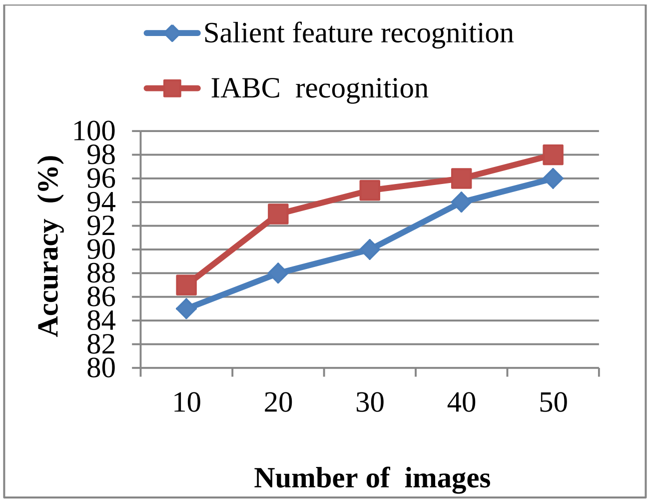

Figure 6. Accuracy comparison

Figure 6 shows the comparison of accuracy performance for proposed IABC based recognition and salient feature based recognition approaches. In x axis number of images are taken and accuracy is taken as y axis. In the proposed system, machine learning algorithm called multiclass SVM is used for classify the various facial expressions. It improves the accuracy rate. The experimental results show that the proposed system achieves high accuracy compared with the existing system.

Precision

Precision is defined as the proportion of the true positives against both true positives and false positives results to retrieve relevant document retrieved.

$$\text{Precision} = \frac{\text{True positive}}{\text{True positive+False positive}} \quad (7)$$

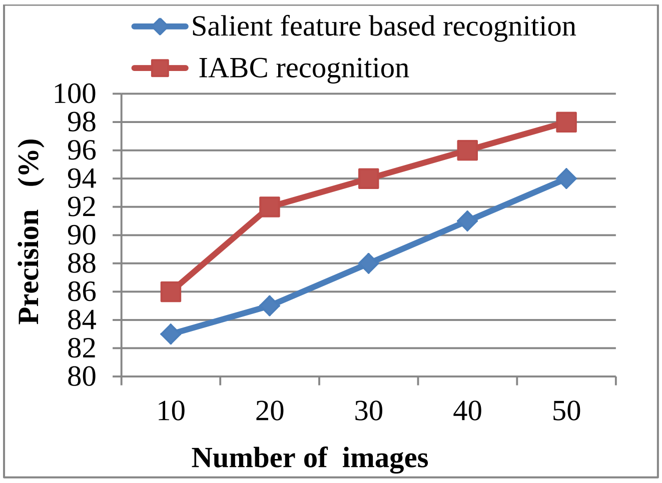

Figure 7. Precision comparison

`Figure 7 shows the comparison of precision performance of proposed IABC based recognition and salient feature based recognition approaches. For x-axis number of images is taken and in y-axis the precision value is plotted. In this proposed work, IABC algorithm is used for select optimal features which improves the true positive rate.

Recall

Recall value is computed on the root of the classification at true positive forecast, false negative. It can be represented as like:

$$\text{Recall} = \frac{\text{True positive}}{\text{True positive+False negative}} \quad (8)$$

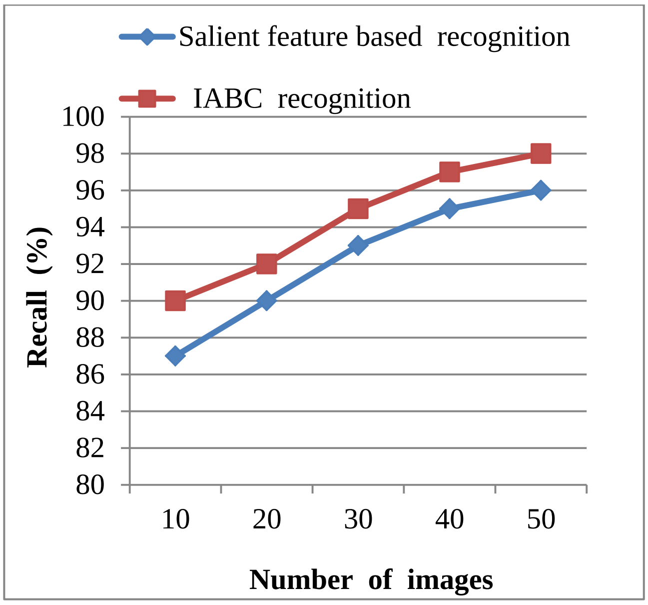

Figure 8.Recall comparison

From the above Figure 8 the recall results is evaluated using existing salient feature based recognition and proposed method IABC based recognition in terms of Recall. For x-axis number of images is taken and in y-axis the Recall value is plotted. The experimental results show that the proposed system achieves high Recall value compared with the existing system.

5. Conclusion

In this proposed work, an Improved Artificial Bee Colony algorithm (IABC) based facial expression recognition is introduced. By using learning-free approach the facial images are detected from background. After the preprocessing, active facial patches and salient features are extracted from preprocessed facial images. Then the best features are selected by using IABC algorithm. Finally the different facial expression anger, disgust, fear, happiness, sadness, and surprise are classified by using MSVM classifier. The experimental results show that the proposed system achieves better performance compared with the existing system in terms of accuracy, precision and recall.

References

1. F. Cheng, J. Yu, and H. Xiong, “Facial expression recognition in jaffe dataset based on gaussian process classification,” IEEE Transactions on Neural Networks, vol. 21, no. 10, pp. 1685–1690, 2010
2. S. Yang and B. Bhanu, “Understanding discrete facial expressions in video using an emotion avatar image,” IEEE Transactions on

Systems, Man, and Cybernetics, Part B: Cybernetics, vol. 42, no. 4, pp. 980–992, 2012.
3. A. Mollahosseini, D. Chan, and M. H. Mahoor, "Going deeper in facial expression recognition using deep neural networks," 2016 IEEE Winter Conference on Applications of Computer Vision (WACV), pp. 1–10,2016.
4. M. S. Bartlett, G. Littlewort, I. Fasel, and J. R. Movellan, "Real time face detection and facial expression recognition: Development and applications to human computer interaction." In Computer Vision and Pattern Recognition Workshop, 2003. CVPRW '03. Conference on, vol. 5, 2003 .
5. F. Ahmed, H. Bari, and E. Hossain, "Person-independent facial expression recognition based on Compound Local Binary Pattern (CLBP)." Int. Arab J. Inf. Technol., vol. 11, no. 2, pp. 195–203, 2014.
6. L. Zhong, Q. Liu, P. Yang, B. Liu, J. Huang, and D. N. Metaxas, "Learning active facial patches for expression analysis," IEEE Conference on Computer Vision and Pattern Recognition (CVPR),. 2012, pp. 2562–2569.
7. J. Yang, D. Zhang, A. F. Frangi, and J.-y. Yang, "Two-dimensional PCA: a new approach to appearance-based face representation and recognition," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 26, no. 1, pp. 131–137, 2004.
8. Yang, Meng, et al. "Monogenic binary coding: An efficient local feature extraction approach to face recognition." IEEE Transactions on Information Forensics and Security 7.6 (2012): 1738-1751.
9. Tang, Pingfeng, et al. "Face feature extraction and recognition using contourlet transform and coupled subspace analysis" , 5th International Conference on Biomedical Engineering and Informatics (BMEI), 2012.
10. P. J. Grother, G. W. Quinn, and P. J. Phillips, "MBE 2010: Report on the evaluation of 2D still-image face recognition algorithms," National Institute of Standards and Technology, NISTIR, vol. 7709, pp.1-61, 2010.
11. Ryu, B., Rivera, A. R., Kim, J., & Chae, O. (2017). Local Directional Ternary Pattern for Facial Expression Recognition. *IEEE Transactions on Image Processing*.