International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-4, April 2019

Human Emotion Recognition with Morphological Segmentation of Facial Features Using Elm

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Abstract: Human emotion detection has been a challenging topic in the field of human-computer interaction. To develop a more natural interaction between human and computer it is expected that the computer is able to perceive and respond to human emotion. In this paper we provide a better approach to predict human emotions accurately. The proposed system employs ELM as its learning algorithm because of its flexible optimization constraints compared to other algorithms like SVM, CNN, etc. In this framework CLAHE is used to normalize the sequences extracted from the Cohn-Kanade dataset. HAAR Classifier is used to detect the edge lines. Gabor filter and two dimensional principle component analysis (2DPCA) are used for feature extraction. ELM is then applied to classify the features. The experiments of facial emotion recognition are performed using Cohn-Kanade dataset, in which 95% recognition rate is achieved. This system provides promising results implemented in personalization face case which can be utilized in developing personalised applications to detect six basic human emotions namely anger, disgust, fear, happiness, sadness, surprise.

Keywords: Emotion recognition, ELM, HAAR Classifier, Gabor filter, 2DPCA, Cohn-Kanade dataset.

I. INTRODUCTION

Successful human interaction often requires monitoring other person's mood and feelings. In everyday life, this is facilitated by the fact that the muscles on our faces allow a wide range of facial expressions, many of which have clear communicative functions. While conveying a message through communication facial expressions plays an important role of adding effects to the message .Yet understanding how we recognise facial expressions has proved surprisingly difficult, with long standing debates and controversies around quite basic questions. In general there are three steps for recognizing facial emotions, namely detection and segmentation of the face from the image sequences , extraction of facial information like shape, texture, and appearance as features, classification of the facial features based on the six human emotions. A wide range of stratification techniques have been employed to detect facial expressions including LDA, SVM (Support Vector Machines), linear classifiers, CNN, KNN, etc. Even though there are a lot of classifiers mentioned above, we face many short-comings in dealing with the expression recognition problems

Manuscript published on 30 April 2019.
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To deal with short-comings and efficiency issues in processing the emotions accurately, we propose a emotion recognition system based on Extreme Learning Machine (ELM). The ELM algorithm used for single hidden layer feed forward neural network training unlike other neural network algorithmss can alternatively provide the number of hidden layer nodes and randomly specifies the value of input weights and hidden layer biases and the weights of the output layer can be acquired by performing evaluations using least square method.The whole learning or taining process is completed by working on a single mathematical expression without any iterations . This proposal is evaluated by experimenting on Cohn-Kanade dataset to achieve 95% recognition.

I. EXISTING SYSTEM

A major limitation when using Conventional Neural Networks is that it cannot recognize the individual facial features and thus it produces unclear results. This is due to the fact that it extracts the features from the whole face instead of identifying the individual features for recognizing the emotions. Compared to conventional neural networks, ELM's recognition performance is a bit high. The existing systems produce large squared errors. Conventional neural network algorithms used in existing systems result in slow training speed and over-fitting problems. Algorithms used with Visual Saliency and Deep Learning cause confusion trends between different facial expressions. The FACS-Facial Action Coding System does not extract properly if there are hairs on face area. In Pyramid of Histogram of Gradient (PHOG) and Local Binary Patterns (LBP) the eye regions were not selected as the features from these regions. The existing procedures to identify and extract the facial features need frontal facial images, so if the user changes their facial expressions even by a little bit the results get affected and thus the effectiveness of the existing algorithms is reduced.

II. PROPOSED SYSTEM

Extreme learning machine (ELM) is a new technique used for the single hidden layer feedforward neural networks. ELM is used to overcome problems like over-fitting and slow training speed that occur when using Conventional Neural Networks. The ELM algorithm is formulated with the support of empirical risk minimization theory. ELM algorithm can identify and classify the emotions in a single iteration thereby avoiding the drawbacks caused by multiple iterations. The algorithm does not support local minimization.

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Thus ELM can be used to overcome some of the major drawbacks of the existing algorithms.

III. ARCHITECTURAL DESIGN OF FACIAL EMOTION RECOGNITION

The Architectural design of facial emotion recognition is split up into two, namely, training and testing. Each part has three sub-processes, they are face detection and segmentation, extraction of features and classification of expression. At first HAAR classifier is used to detect mouth, eyes, eyebrows and face. Then the Gabor filter (linear filter) is used for analyzing the texture, i.e. to extract the various facial features, it basically analyzes and checks around the region of analysis, for any frequencies in the image in a particular direction and those frequencies should be present in a particular localized region. The dimensions of a particular images may cause effects in the final results, thus to reduce these dimensions the two dimensional principle component analysis(2DPCA) is used. The computational efficiency can be improved by using the 2DPCA algorithm. To implement this algorithm a two-dimensional matrix is used. Since it deals with a tow-dimensional matrix the feature vector and feature matrix can be easily identified by the 2DPCA algorithm. Finally to classify the facial expressions ELM is used.

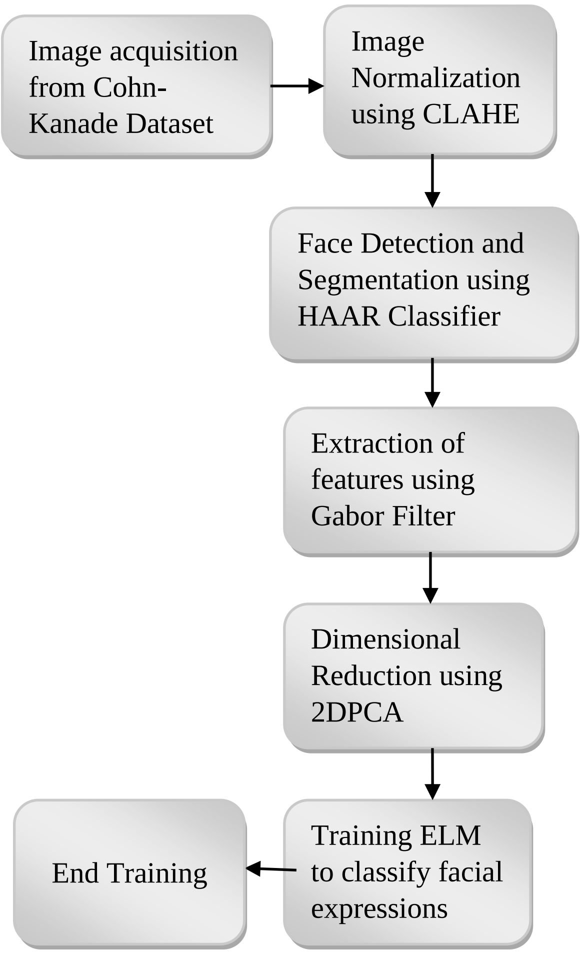

Fig. 1 Experimental Framework for Training

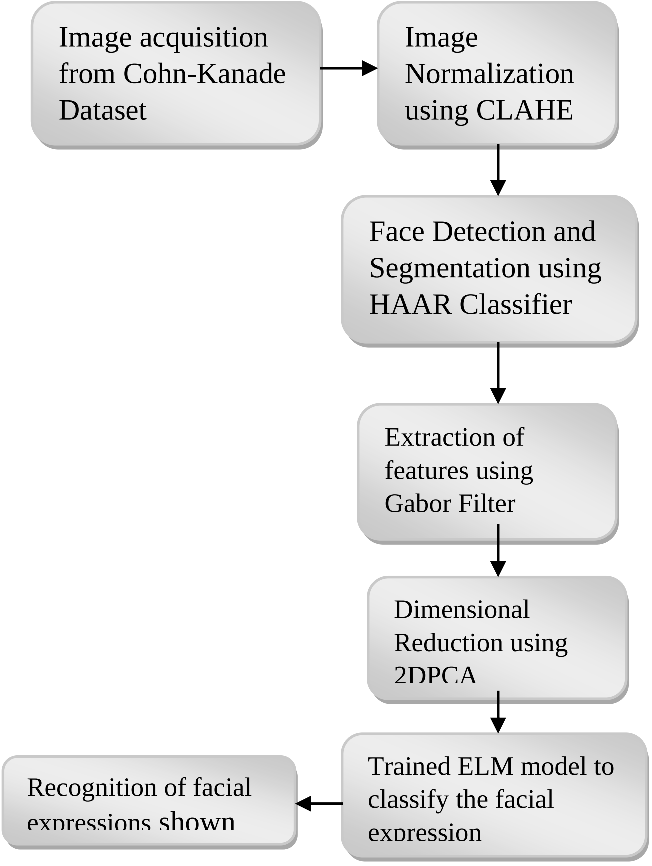

Fig. 2 Experimental Framework for Testing

IV. EXPERIMENTAL PROCEDURE

a) FACE DETECTION AND SEGMENTATION

Both training and evaluation operations of this experiment have been conducted on Cohn-Kanade dataset. The Cohn-kanade dataset consists of subjects showing various expressions. The subjects are from diverse culture thus assuring distinctive facial features and expressions shown. In Cohn-kanade dataset the image sequences are in gray-scale so to improve the contrast and lighting in the images a process called normalization is performed using an algorithm called Contrast Limited Adaptive Histogram Equalization (CLAHE).

Fig. 3 Facial Emotions

After improving the contrast in the images, the HAAR classifier trained by the Adaboost is used to determine if there exits any face in the image. HAAR features are captured and valued by viewing it with two or more rectangles. The rectangle integral is evaluated in HAAR classifier to calculate the value of a features.

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The HAAR feature classifier also helps in multiplying the weight of each rectangle by evaluating its area and the results are then added up together to detect and segment the features.

Fig. 4 Training HAAR Cascades

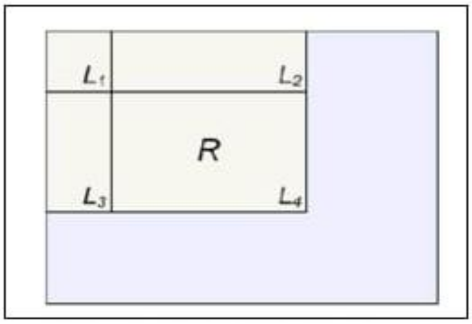

Fig. 5 Calculation of rectangular integral in HAAR Classifier

b) FEATURE EXTRACTION

Gabor filter is used for extracting features for analysing facial information like texture, shape and appearance then it decomposes the image sequences into multiple components with respect to the orientation and scaling of the image .To extract the facial features the whole face image is analysed by the Gabor filter. After analysing the feature extracted image , one dimensional feature vector is obtained which can be used for additional processes in classifying the feature. Similarly gather the feature vectors from all of the image sequences which is then fused together and made to undergo dimensional reduction.The dimensionally reduced images are then finally classified using ELM.

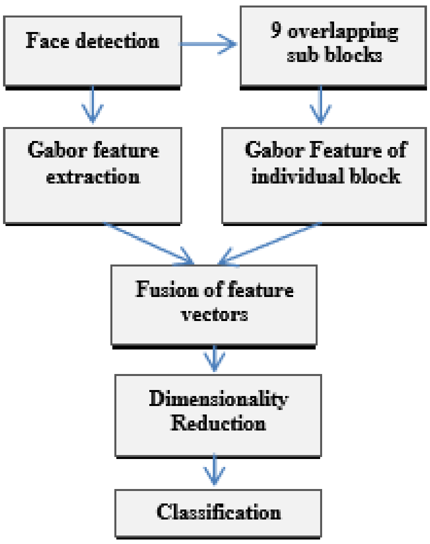

Fig. 6 Gabor Filter Flow Diagram

The two dimensional principle component analysis (2DPCA) is used to reduce the dimensions of the image thereby improving the computational efficiency. 2DPCA can be used to find the feature matrix and feature vector easily by working on two dimensional matrix.

c) CLASSIFICATION OF FACIAL EXPRESSIONS

ELM based classifier is used for the classification of facial expressions.In an image sequence 'x' denotes the feature vector of the image and this feature vector is linked to the input layer. The total count of hidden nodes that can be found at the hidden layer is denoted as 'K'. Each hidden node i has an activation function which is implied as g(**x**; **w**i, bi),the parameters wi and bi represents the input weight vector featured in between the interval where all other hidden nodes and input nodes can be found and bias of that particular node respectively. Here 'i' ranges from value 1 to K. The count of output nodes which appear in the output sublayer is denoted by 'M' which also indicates the total number of classes found in the input and output layers. βi,j is the value of the output weight generated within the interval of the i-th node which is a hidden node and the j-th output node, where the value of j ranges from 1 to M.

$$f_j(x) = \sum_{i=1}^{K} \beta_{ij} \times g(x; wi, bi)$$

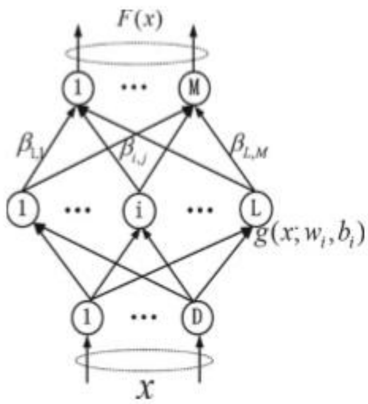

Fig. 7 ELM-based Classifier

V. EXPERIMENTAL RESULT ANALYSIS

The experimental results of facial emotion recognition using ELM is comparatively much more efficient than SVM and KNN. ELM's recognition performance is higher than Convolution Neural Networks algorithm. The recognition rate of ELM is 2% higher than KNN and 1% higher than SVM while experimenting on Cohn – Kanade dataset. ELM exhibits the results in a single iteration. One of the advantages ELM is randomly initializing the input weight and hidden layer.

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This initialization is done by adjusting the count of nodes present in the hidden layer. This initialization cannot be done in BP algorithm. The generalization performance of ELM is also high whereas the generalization performance of BP algorithm as well as SVM method id a bit low. In the proposed system ELM helps overcomes over-fitting problems. When compared with SVM method, the training speed of ELM algorithm is high.

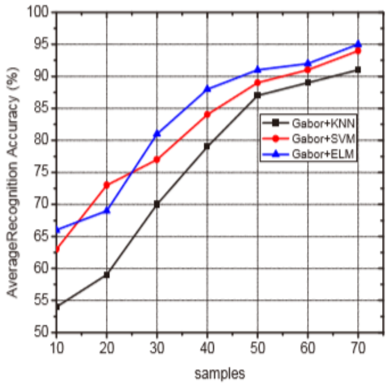

Fig. 8 Results on Cohn-Kanade Dataset

VI. CONCLUSION

This proposal is performed over Cohn - Kanade dataset where each subject exhibits various facial expressions. The various sequences in the dataset are in grayscale. It is then normalized via CLAHE (Contrast Limited Adaptive Histogram Equalization). The HAAR classifier is then used to detect and segment the face region in the obtained normalized sequences. To extract the facial features from the detected face region Gabor filter is used and then the image is dimensionally reduced via 2DPCA. Finally to classify and recognize the expressions shown the trained ELM model is used. Earlier neural networks algorithms like BP algorithm requires a lot of training parameters related to artificial network which is then processed to provide localised optimal solutions whereas in Extreme learning Machine instead of providing training parameters we only have to provide the total number of hidden layer nodes also like in other algorithms it is not mandatory to adjust the weights of network inputs. Thus it can be concluded that ELM provides a better optimal solution considering its fast training speed and generalization performance.

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