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Recognition of Facial Expression Using AAM and Optimal Neural Networks

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ABSTRACT- Human communication is a combination of both verbal and nonverbal interactions. Facial Expressions convey non-verbal cues, which acts an important role in interpersonal relations. Facial Expressions play significant role wherever Human-computer interface required. In this paper, an optimal Neural Network has been presented to recognize from facial images. In this proposed work, firstly the image is acquired and preprocessed by using adaptive median filter and then using Active Appearance Model to extract the eye feature from the preprocessed image. Finally using Optimal Neural Networks to classify the facial expression of the image. Experiments are carried out on JAFFE facial expression database.

Keywords: **preprocessing, Feature Extraction, Classification, Active Appearance Model, Neural Network.**

1. INTRODUCTION

Expression is the most important mode of non-verbal communication between people. Facial Expression Recognition (FER) is really a rapidly growing and an ever green research field in the region of Computer Vision, Artificial Intelligent, Robotics and Automation etc. Facial expression carries crucial information about the mental, emotional and even physical states of the conversation. Facial expression recognition has practical significance, it has very broad application prospects, such as user-friendly interface between man and machine, humanistic design of goods, and emotional robot etc. With facial expression recognition systems, the computer will be able to assess the human expressions depending on their effective state in the same way that human's in the intelligent computers will be able to understand, interpret and respond to human intentions, emotions and moods.

Facial expression recognition (FER) has attracted significant research attention because of its usefulness in many applications, such as human-computer interaction, security and analysis of social interactions. Developing a facial expression recognition system, it is important to realize that there are many possibilities that exist to represent a facial expression. Facial expressions can be represented through: Pictures, Video, Cartoons, Smiley, Facial characteristic points, Active Action Units. A commonly used facial expression recognition approach is to classify each given facial image into the basic expression types, e.g., happy, sad, disgust, surprise, fear and angry, defined by Ekman and Friesen [1,2].

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Fig 1: Sample Facial expressions

2. System Architecture

Facial Expression Detection means finding the Expression of an image and recognize the which expression it is such as Happy, Sad, Angry, Disgust, Neutral etc. The technique used for Facial Expression Recognition is Optimal Neural network. The Optimal Neural network is one of the most successful classification method that have been used to recognize Facial expressions in given images. The proposed method was carried out by taking the JAFFE database. The database was obtained with photographs of each person at different expressions. These expressions can be classified into some discrete classes like happy, anger, fear, surprise, sad, disgust and neutral. Absence of any expression is the "neutral" expression. Architecture of a system which describes the overall system model in a single diagram as shown in Fig 2.

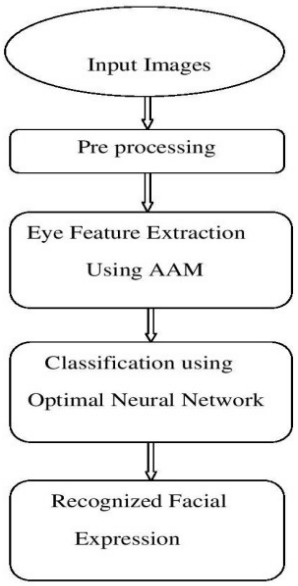

Fig 2: System architecture of Facial Expression Recognition system

Facial expression analysis deals with visually recognizing and analyzing different facial emotions and facial feature changes. The problem of Face recognition of human facial expression includes three sub problem areas i) Finding faces in the scene, ii) Extracting facial features from the detected face region, iii) Analyzing the motion of facial features and/or the changes in the appearance of facial features[5].

3. PROPOSED METHODOLOGY

Initially, the face image will be preprocessed by using Adaptive median filter. And then it will be normalized by employing a face detection algorithm. In Feature Extraction ,extracted the unique features (key points) from the images such as texture, shape and regions. Estimating the expression of a face is not an easy task. To overcome this difficulty, we have to identify the uniqueness of each image under various expressions. The eye part has more important whatever the person having the different expression. So the eyes of the persons are extracted separately. For region area or key points, the eye portion, mouth, and nose will be segmented from the detected face image. The shape feature can be extracted by Active Appearance Model (AAM). In the final stage classification will be done using Optimal Neural Network. The proposed approach will be implemented in MATLAB and planned to be evaluated using various input images.

3. 1 Modules

Expression classification consist of Three major steps such as

1. Image Pre-Processing
2. Feature Extraction
3. Facial expression recognition

3.1.1 Image Pre-Processing

The Recognition process begins by first acquiring the image using an image acquisition device like a camera. The image acquired then needs to be preprocessed such that environmental and other variations in different images are minimized. Usually, the image preprocessing step comprises of operations like image scaling, image brightness and contrast adjustment and other image enhancement operations. In this proposed work, an existing image database of human facial expressions is used to train and test the performance of the classifier. The reason is to obtain pure facial images with normalized intensity, uniform size and shape. The steps involved in converting a image to a normalized pure facial image for feature extraction is detecting feature points, rotating to line up, locating and cropping the face region using a rectangle, according to the face model. Detecting faces in a single image involves four methods Knowledge based, Facial invariant, Template matching. In proposed work for image pre-processing using Adaptive median filter to get image with normalized intensity, uniform and shape[6,7].

3.1.2. Active Appearance Model (AAM) for eye feature extraction

Active Appearance Model (AAM) is a generalization of the widely used Active Shape Model (ASM) approach. But uses all of the information in the image region covered by the target object, rather than just near modeled edges. It contains a statistical, photo realistic model of the shape and grey-level appearance of faces which can be generalized to almost any valid example. Matching to an image involves finding model parameters which minimize the difference between the image and a synthesized model example, projected into the image. In order to realize these benefits, the model of object appearance should be as complete as possible to synthesize a very close approximation to any image of the target image. AAM is particularly suited to the task of interpreting faces in images. Faces are highly variable, deformable objects and manifest very different appearances in images depending on pose, lighting, expression and identity of the person. Interpretation of such images requires the ability to understand this variability in order to extract useful information[8].

For example, happiness is characterized by a larger separation between the left and right corners of the mouth as compared to the upper and lower lips. Eyebrows and eyes tend to be relaxed for a happy expression. On the other hand, surprise/ fear is generally characterized by the mouth being wide open, which

means a smaller separation between the left and right corners of the mouth as compared to the upper and lower lips. Also, eyes tend to be wide open and hence larger in size. For recognizing the expression of the face it is needed to analyze its geometric features. The eye part has more important whatever the person having the different expression. In proposed work used Active Appearance Model (AAM) for extracting the eye feature[9].

3.1.3.Classification using Optimal Neural Network

A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationship. A neural network is represented by weighted interconnections between processing elements. These weights represent information being used by the net to solve a problem and they are actually parameters which are defined as the non-linear function performed by the neural network. Back propagation is a systematic method for training multi-layer perceptron networks. The back propagation algorithm defines a systematic way to update the synaptic weights of multi-layer perceptron (MLP) networks. The learning algorithm is performed in two stages: feed-forward and feed-backward. In the first phase the inputs are propagated through the layers of processing elements, generating an output pattern in response to the input pattern presented. In the second phase, the errors calculated in the output layer are then back propagated to the hidden layers where the synaptic weights are updated to reduce the error. This learning process is repeated until the output error value, for all patterns in the training set, are below a specified value. The ability of the network to approximate the error function is decides the number of nodes in the hidden layer[10].

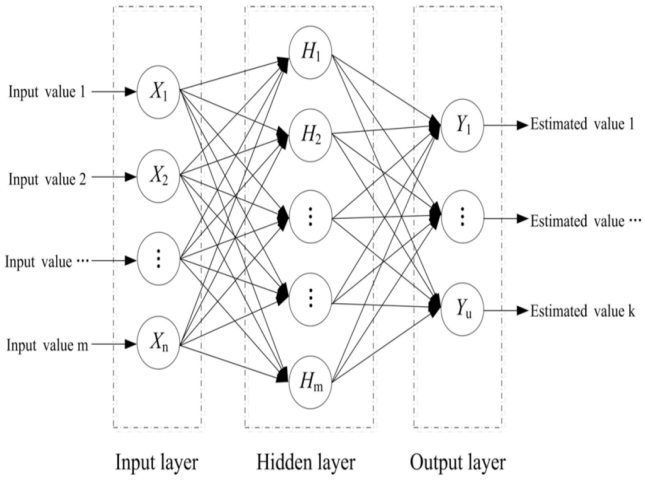

Fig. 3. Neural Network multi layered function

❖ **NN Function Steps**

1) The Firefly algorithm modernized values are furnished as input, Fix loads for all the neurons except those in the input layer.

2) The neural network is designed with the extracted features $\{A_1, A_2, A_3, A_4, A_5\}$ as the input units, HU_a Hidden units and age f as the output unit.

3) The evaluation of the proposed Bias function for the input layer is characterized by Equation1 given below

$$X = \beta + \sum_{n=0}^{H_{NH}-1} w_{(n')} A_1(n') + w_{(n')} A_2(n') + w_{(n')} A_3(n') + ... + w_{(n')} A_5(n') \quad (1)$$

The activation function for the output layer is evaluated by Equation 2 shown below.

$$Active \quad (X) = \frac{1}{1 + e^{-X}} \quad (2)$$

4) The learning error is represented as follows.

$$LE = \frac{1}{H_{NH}} \sum_{n'=0}^{N_{NH}-1} Y_{n'} - Z_{n'} \quad (3)$$

where, LE - learning rate of FFBNN.

$Y_{n'}$ - Desired outputs.

$Z_{n'}$ - Actual outputs.

The ML uses the algorithm of Gradient FFBNN for training to update *W*.

❖ **Learning Algorithm – Back Propagation Algorithm**

In the Feed Forward Neural System, the Back Propagation Algorithm is effectively utilized as the Learning algorithm. The Back Propagation Algorithm actually represents a supervised Learning strategy and further it characterizes the breakdown of delta rule. For the purpose of carrying out collection, it is in need of a dataset of the essential productivity for various inputs. Characteristically, the Back Propagation Algorithm is the ideal one for the Feed-Forward Networks and the Learning algorithm

requires that the service purpose employed by the neurons must be differentiable.

Back propagation Algorithm Steps for FFBNN

1) The loads for the neurons of hidden layer and the output layer are designed randomly choosing the weight. However, the input layer possesses the constant weight.

2) The anticipated Bias function and the activation function are evaluated by means of Equations (1) and (2) for the FFBNN.

3) The Back Propagation Error is evaluated for each node and thereafter the weights are modernized as per the following Equation 4.

$$w_{(n')} = w_{(n')} + \Delta w_{(n')} \quad \text{_____ (4)}$$

4) The weight $\Delta w_{(n')}$ is adapted as per Equation 5 shown below.

$$\Delta w_{(n')} = \delta . X_{(n')} . E^{(BP)} \quad \text{____(5)}$$

Where, δ - Learning Rate, which is habitually in the range of 0.2 to 0.5.

$E^{(BP)}$ - BP Error.

5) The process is repeated with the help of steps represented in Equations (2) and (3), till the BP error is reduced to the minimum i.e. $E^{(BP)} < 0.1.$

6) On attaining the minimum value, the FFBNN emerges appropriately eligible for the screening phase.

As a result, the FFBNN classifier is effectively qualified and the association principles are tested by exploiting the attributes. The classification of flaws is carried out which classifies the entire flaws generated from the classifier[11].

4. RESULT AND DISCUSSION

The proposed method is implemented in MATLAB platform. Speech signal are given as the input for the implementation. By utilizing the performance measures namely, Sensitivity, Specificity and Accuracy, the performance of the system is estimated. Sensitivity, Specificity, and accuracy are used by these measures. Both the emotion classification and the classification by efficiency are examined by our proposed work.

Sensitivity

The metrics of the sensitivity is the proportion of actual positives which are accurately recognized. It is related to the capability of test to recognize positive results.

Specificity

The measure of the specificity is the proportion of negatives which are accurately recognized. It is related to the capability of test to recognize negative results.

Accuracy

We can calculate the metric of accuracy from the metric of sensitivity and the specificity as declared below.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \times 100$$

Where TP-Number of true positives, TN-Number of true negatives, FP-Number of false positives, FN-Number of false negatives.

Above equations are as well appropriate for finding the efficiency of classification of the signals.

Table I: Comparison results for the image classification in Specificity, Sensitivity, Accuracy

Expression	Specificity	Sensitivity	Accuracy
Angry	76	75	81
Disguise	76	76	82
Fear	78	76	86
Happy	79	82	87
Neutral	84	84	88
Sad	88	87	86
Surprise	84	91	90

The work provides very good for the emotion classification result and gives improved accuracy outcomes. The above Table I gives information about Comparison results for the image classification in specificity, sensitivity, accuracy. The accuracy for the ONN are 81%, 82%, 86%, 87%, 88%, 86%, and 90%, also the values for specificity are 76%, 76%, 78%, 79%, 88%,and 84%, the values

for Sensitivity are 75%, 76%, 76%, 82%, 84%, 87% and91%.Therefore, the propose work shows 86% accuracy for the classification of the emotion.

5. CONCLUSION

Expression classification consists of three major steps namely image pre-processing then feature extraction and finally expression recognition. In this paper, adaptive median filter is used for pre-processing and Active Appearance Model can be used to extract the only eye feature and finally optimal neural network is used to recognize the facial expression. The proposed method to recognize the facial expression accuracy is 86%. In future work an attempt can be made to develop hybrid approach for facial feature extraction and recognition accuracy can be improved.

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