Volume 5, Issue 1, June 2016, Page No.23-27
ISSN: 2278-2419

Two Level Decision for Recognition of Human Facial Expressions using Neural Network

M R Dileep[1], M Prasad[2], Ajit Danti[3]
[1]Department of Computer Science, Alva's College, A unit of Alva's Education Foundation, Moodbidri, Karnataka, India.
[2]Department of Master of Computer Applications, Bapuji Institute of Engineering and Technology, Davanagere, Karnataka, India
[3]Dept. of Computer Applications, Jawaharlal Nehru National College of Engineering, Shimoga, Karnataka, India
Email: Prasad.marpalli@gmail.com , dileep.kurunimakki@gmail.com, ajitdanti@yahoo.com

Abstract-Facial Expressions of the human being is the one which is the outcome of the inner feelings of the mind. It is the person's internal emotional states and intentions.A person's face provides a lot of information such as age, gender, identity, mood, expressions and so on. Faces play an important role in the recognition of the expressions of persons. In this research, an attempt is made to design a model to classify human facial expressions according to the features extracted f0rom human facial images by applying 3 Sigma limits inSecond level decision using Neural Network (NN). Now a days, Artificial Neural Network (ANN) has been widely used as a tool for solving many decision modeling problems. In this paper a feed forward propagation Neural networks are constructed for expression classification system for gray-scale facial images. Three groups of expressions including Happy, Sad and Anger are used in the classification system. In this paper, a Second level decision has been proposed in which the output obtained from the Neural Network(Primary Level) has been refined at the Second level in order to improvise the accuracy of the recognition rate. The accuracy of the system is analyzed by the variation on the range of the expression groups. The efficiency of the system is demonstrated through the experimental results.

Keywords— Face Model, Feature Extraction, Facial Expressions, Neural Network, Two-Level Decision, 3 Sigma Limits

I. INTRODUCTION

Expression refers to the facial changes of a person, a message about something internal thoughts of the expresser. In the context of the face and the nonverbal communication, expression usually refers to the change of a visual pattern over time. The concept of facial expression includes:

1. The changes in the expressions of the face represents the mood of the person/expresser.
2. The physical characteristics of the face are identified using unique features
3. By interpreting the identified features of the face, expressions of the person can be recognized.

Facial expression plays a principal and vital role in human interaction and communication since it contains critical and necessary information regarding emotions. The task of automatically recognizing and detecting the different facial expressions in human-computer environment is significant and also challenging. A variety of systems have been developed to perform facial expression recognition. These systems possess some of the common and similar characteristics. First, they classify facial expressions using facial expression databases. For instances, many of the researchers used the JAFFE database to recognize seven main facial expressions: happy, neutral, angry, disgust, fear, sad and surprise. Here, we are also using the same database to recognize the facial expressions. Along with the standard JAFFE database, for our experiments, we have considered some hundreds of other images which are downloaded from the internet.Second, most of the systems conduct two stages.

- Feature extraction
- Expression classification.

In this research, the Feature extraction and expression classification is done by feed forward Artificial Neural Network in multiple level decisions.In information technology, a neural network is a system of programs and data structures that approximates the operation of the human brain. A neuron is a basic information processing unit. A neuron consists of a cell body called Soma, a number of fibers called Dendrites, and a single long fiber called Axon. Soma fires at different frequencies, Dendrites receives electrical signals affected by chemical processes. A perceptron is a simplest form of neural network. The connections between neurons are called Synapses. Neurons in a network are connected by directed, weighted paths. The weights may be Positive(Excitatory) or Negative(Inhibitory). Figure-1 shows a typical structure of a Neuron.

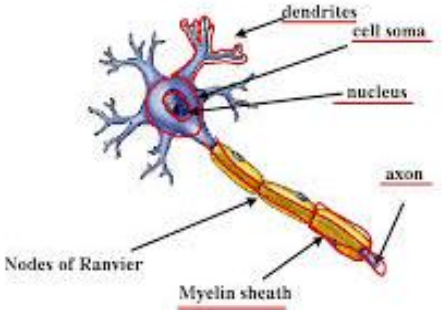

Figure-1: Structure of a Neuron

A neural network usually involves a large number of processors operating in parallel, each with its own small sphere of knowledge and access to data in its local memory. Typically, a neural network is initially "trained" or fed large amounts of data and rules about data relationships. A program can then tell the network how to behave in response to an external stimulus or can initiate activity on its own. In *feed forward* systems, learned relationships about data can "feed forward" to higher layers of knowledge for processing. Neural networks can also learn temporal concepts and have been widely used in signal processing and time series analysis.This paper proposes an effective method for human facial

expression recognition from facial images. Here, the classification of the facial images is done at two levels, namely,

- Primary Level
- Secondary Level

In the Primary Level, the facial images are classified automatically using Neural Network. The second level decision includes, the classification is based on the outcome of the Primary level to improve the classification rate effectively. Proposed algorithm has been implemented to classify input images into one of three expression groups vizHappy, Sad and Anger using Feed-Forward ANN.

II. LITERATURE SURVEY

Automatic human facial expression recognition is a thrust research area in video surveillance and law enforcement applications as a prerequisite for face recognition. Until now much research work has been done on detecting the human faces based on templates, neural networks and example-based techniques. However, some of these methods are computationally expensive, dealt with single frontal view and work on gray scale images. C. Garcia and G. Tziritas [9], 1999, presented a system on face detection using quantized skin color regions merging. Srihari and D. B. Sher [10], 1990, presented a system, which detects faces in photographs of newspapers, but the approximate size and the expected number of faces must be known in advance. R. Chellappa, C. L. Wilson and S. Sirohey [3], 1995, proposed a methodology on Human and machine recognition of faces. J.L.Crowley and J. Coutaz [4], 1997, introduced a method on Vision for man machine interaction.Dileep M.R and AjitDanti [6], 2013, proposed LC face model for recognition of human facial expressions. Dileep M R and AjitDanti [7], 2014, invented a facial algorithm Structured Connectivity-Face model for the recognition of Human Facial Expressions.Facial expression recognition can be applied to medical treatment of patients. Gagliardi, Frigerio E, Burt DM, Cazzaniqa I, Perrett DI, Borgatti R [8], 2003, investigated the facial expression ability for individuals with Williams's syndrome. Bowyer, Kevin W [1], investigated on a survey of approaches to three-dimensional face recognition. D. Chai and K. N. Ngan [2], introduced a methodology of Face segmentation using skin color map in Videophone applications. De Silva, LiyanageChandratilake [5], proposed method of Facial emotion recognition using multi-model information. Since JAFFE database is commonly used in measuring the performance of facial expression recognition systems, we concentrate on applying our system on this database and perform comparisons with other systems.

An approach has been proposed by P.S.Hiremath and Danti [11], 2004 in which the Lines-of-Separability (LS) face model is constructed for finding the eyes and detection of the face.Here, we have worked on the three expressions vizHappy**,** Sad and Anger**.** The probability of finding these three expressions in any of the image is more compared to the above methodologies proposed by different researchers. This implementation is not limited to a single database, but also can be applied to different databases and also the images which can be downloaded from the internet.In this paper, the algorithm has been proposed to recognize the human facial expressions using two level decision Neural Network technique.we present a systematic comparison of classification methods to the problem of fully automatic prediction of facial expressions and to find the optimal solution to it. The rest of this paper is being organized as follows. Section 1.2 describes about the JAFFE database of experimental images. Section 2 presents the proposed methodology. Section 3 provides the proposed algorithm. Section 4 gives the experimental results. Finally, we draw the conclusions in section 5.

III. FACIAL EXPRESSION DATABASE

The proposed methodology is experimented on JAFFE database. JAFFE stands for Japanese Female Facial Expression. This dataset is used as the benchmark database for Performance Comparisons of Facial Expression Recognition. The database contains the faces of ten Japanese females. There are seven different expressions of the face, such as neutral, happy, anger, disgust, fear, surprise and sad. Each female has two to four examples for each expression. There are of 213 grayscale facial expression images in this database. Each image is of size 256 × 256.Figure-2 shows two expressors comprising seven different facial expressions from the JAFFE database.

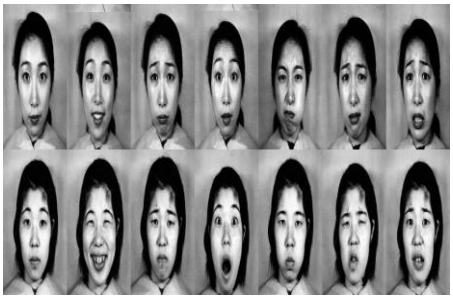

Figure-2: Samples of two expresserscontaining 7different expressions.

IV. PROPOSED METHODOLOGY

This paper proposes an effective method for human human expression classification from facial images. Here, the classification of the facial images is done at two levels, namely

- Primary Level
- Secondary Level

The Proposed algorithm has been implemented to classify input images into one of three groups viz Happy, Sad and Anger using Feed-Forward ANN. In the Primary Level, the facial images are classified using Neural Network. The second level decision includes, the classification based on the outcome of the Primary level to improve the detection rate effectively.
The proposed methodology is experimented on database of the face images. This dataset is used as the benchmark database for Performance Comparisons of expression classification. In this method, first the images containing the face will be read and intensity values of each of the image ranges from 0 to 255. In order to improve the efficiency of the performance, instead of considering all Neurons (64 x 64) into the Neural Network, the mean of each of the image will be given as input to the Neural Network. Mean of each image is represented by 64 standard

International Journal of Data Mining Techniques and Applications
Volume 5, Issue 1, June 2016, Page No.23-27
ISSN: 2278-2419

values.In the first level decision, Neural Network classifies the faces based on the different group of expressionsvizHappy, Sad and Anger. This outcome cannot be used as a conclusion as there may be the chances of misdetection.To enhance the first level decision, an algorithm for second Level Decision is proposed to reduce the misdetection rate and improve the success rate of detection.Sample experimental results of processing of the training of facial images using Neural Network is shown in the figure-3.

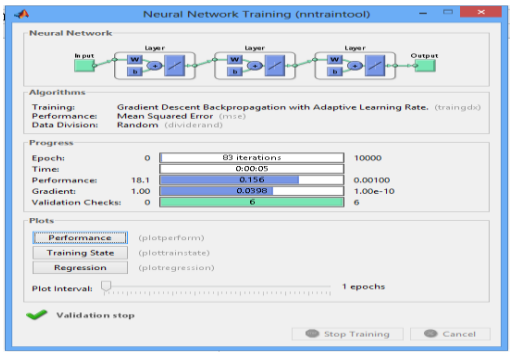

Figure-3: Creation and Training of a Neural Network

A. First Level Decision

In the first level decision, Neural Network classifies the faces based on the different expressions viz Happy, Sad and Anger. This outcome cannot be used as a conclusion as there may be the chances of misdetection. To enhance the first level decision, an algorithm for second Level Decision is proposed to reduce the misdetection rate and improve the success rate of detection as given in the next section.Figure-4 gives the diagrammatic representation of "First level decision".

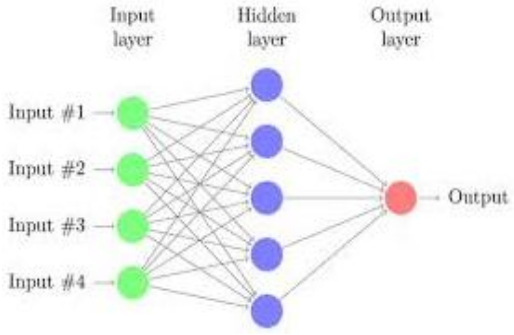

Figure-4: First Level Decision

The output of the built in NN classifier is a standard value that predicts the expression of a person in the first level. This can be represented by,

$$y = \mathcal{F}(N, I) \quad (1)$$

Where y represents the predicted expression of a person in the first level decision.$\mathcal{F}$is a function that represents the value in the Neural Network$I$is the matrix that represents the testing image.simulation of the Neural Network$N$ is the vector that represents the trained .The output generated in the first level, from the standard classifier ANN cannot be considered as the final output. It is not possible to rely on the output that is generated by the ANN since the conclusion should not be dependent on standard classifier. Based on the output generated from the first level, again the classification is done in the Second level by applying 3 Sigma control limits on Neural Network. The application of 3 sigma control limits on Neural Network is so efficient that, it can classify the data with greater marginal levels in terms of range. The upcoming section describes the proposed Second Level Decision.

B. Second Level Decision

Here, the expression of a person is identified by second level decision using Neural Network, in which three sigma control limits are applied on the neural network classifier. Three sigma controls cover more than 90% of the population of the dataset under consideration for decision making. Figure-5 shows 3σ limit describes how data are dispersed around their averages.

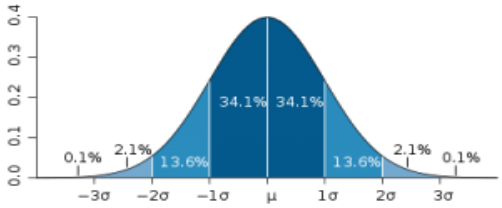

Figure-5:3σ limit dispersed around their averages.

In the Second level decision, 3 sigma control limits are determined by their spread around the mean using the equation (2) and (3).

$$l_h = \overline{y}_h - 3\sigma_h \quad (2)$$

$$u_h = \overline{y}_h + 3\sigma_h \quad (3)$$

Where,

l_h, and$u_h$are the Lower Limit and Upper Limit of Happy faces, respectively.

$\overline{y}_h$: mean of intensity values of Happy faces

σ_h : standard deviations of Happy faces

The Mean $\overline{y}_h$of Happy face images is determined using the equation (4)

$$\overline{y}_h = \frac{\sum y_h}{n} \quad (4)$$

Where, $y_h$represents the predicted expression of happy faces obtained in First level decision.

n is the number of Happy faces.The standard deviation $\sigma_h$of Happy face images is determined using the equation (5)

$$\sigma_h = \sqrt{\frac{\sum (y_h - \overline{y}_h)^2}{n-1}} \quad (5)$$

Similarly, l_s andu_s, andl_a and$u_a$are determined for Sad and Anger faces. The reasonable threshold value is empirically determined by considering the face images of the database. The mean $\overline{y}_s$and σ_s, and $\overline{y}_a$ and $\sigma_a$of Sad and Anger face images are also determined using the similar equations given in (4) and (5).In testing the query image, expression y is determined using the equation (1) as first level decision. The final decision on the expression is determined using equation (6) as second level decision.

$$\begin{cases} Happy & if\ l_h < y < u_h \\ Sad & if\ l_s < y < u_s \\ Anger & if\ l_a < y < u_a \end{cases} \quad (6)$$

International Journal of Data Mining Techniques and Applications
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The experimental results of expression recognition are shown in the figure-6.

(a) Happy (b) Anger (c) Sad

Figure-6: SampleExperimental Results of proposed Methodology

V. PROPOSED ALGORITHM

Proposed algorithm for expression recognition using two level ANN 3 Sigma limit from the given image is as given below:

Input: Query face
Output: Determine Expression viz Happy, Sad or Anger

Step 1:To Train, Input all face images to the Neural Network.
Step 2: Set the Target for the classification of Happy, Sad and Anger categories.
Step 3: Create& Train the Neural Network.
Step 4: Determine the expressions y_h , y_s and y_a for all faces using eq(1) in first level decision.
Step 5: Define lower and upper sigma control limits for Happy, Sad and Anger using equations (2) and (3) respectively.
Step 6: To Test the query image, find the expression y using equation(1)
Step 7: Second level decision on expression is determined using the equation (6)

VI. EXPERIMENTAL RESULTS

In this research, there are 600 gray-scale with 256 gray levels facial images used for experiment. Each image size is normalized to 64×64. Among the 600 experimental images, 400 images are used as training data, and the remaining are used as test images. The face images are trained using neural network, and second level classification is done using three sigma limits. In the testing phase, among 200 images, 100 images were taken as Happy images and 50 images were taken as Sad images and remaining 50 images were taken as Anger ones. Thus, the success rate for Happy, Sad and Angeris 92.00%, 94.00% and 95% respectively. Therefore, the overall success rate for test images is 93.66%. The average recognition time of each test image is 0.45 seconds on a Pentium Quad Core processor with 2 GB RAM.However, proposed method fails to detect the side-view faces, occluded faces and partial face images. This is due to the fact that the proposed model is constrained to detect only the frontal view face. Our proposed method is compared with othermethodssuch as Lines of Connectivity face model for recognition of the human facial expressions [6], proposed by Dileep M R and AjitDantialso Facial emotion recognition using multi-model information [5], proposed by De Silva et al and found higher success rate as shown in figure-7 and figure-8.

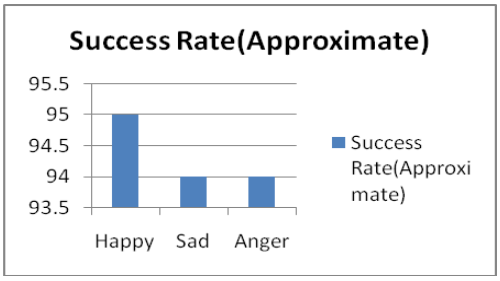

Figure-7: Success rate of the proposed Second Level Decision Model

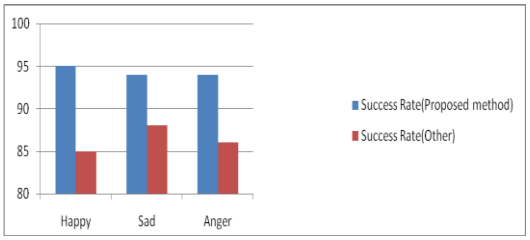

Figure-8: Comparing proposed Second Level Decision model with other[5,6] models.

VII. CONCLUSIONS AND DISCUSSIONS

In this paper, a fast and efficient human expression classification system is proposed to classify a facial image into Happy, Sad and Anger using feed forward Neural network. The final decision is made by employing validation based on three sigma control limits applied on the output of the Neural network classifier. The proposed method is better in terms of speed and accuracy. Single frontal human faces with three expression groups are detected successfully with success rate of 93.66%.

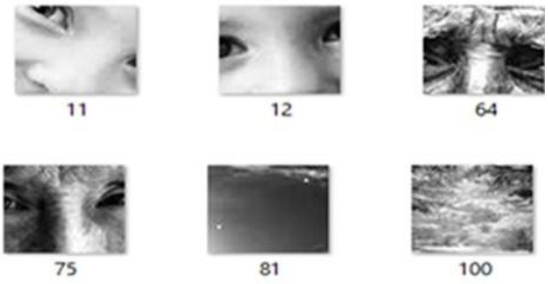

Figure-9: Images which has been mis-detected.

In future studies, misclassifications are reduced by using fuzzy logic approach for further improvement in the proposed system so that it becomes more pertinent to the design of a real-time video surveillance system.

References

[1] Bowyer, Kevin W, A survey of approaches to three-dimensional face recognition, patt.Recogn. vol 1, (2004), pp 358-361.

[2] D. Chai and K. N. Ngan, Face segmentation using skin color map in Videophone applications, *IEEE Trans. CSVT* **9**(4) (1999) 551–564.[3]R. Chellappa, C. L. Wilson and S. Sirohey, Human and machine recognition of faces: a survey, *Proc. IEEE* 83(5) (1995) 704–740.[4] J.L.Crowley and J. Coutaz, Vision for man machine interaction, *Robo. Auton. Syst.* 19(1997) 347–358.

[3] R. Chellappa, C. L. Wilson and S. Sirohey, Human and machine recognition of faces: a survey, *Proc. IEEE* 83(5) (1995) 704–740.
[4] J.L.Crowley and J. Coutaz, Vision for man machine interaction, *Robo. Auton. Syst.* **19** (1997) 347–358.
[5] De Silva, LiyanageChandratilake, Facial emotion recognition using multi-modal information, vol 1(1997)pp 397-401.
[6] Dileep M R and AjitDanti, Lines of Connectivity face model for recognition of the human facial expressions, International Journal of Artificial Intelligence and Mechatronics, volume 2, Issue 2, ISSN 2320-5121.
[7] Dileep M R and AjitDanti, Structured Connectivity-Face model for the recognition of Human Facial Expressions, International Journal of Science and Applied Information Technology (IJSAIT), Vol. 3 , No.3, Pages : 01 - 07 (2014) Special Issue of ICCET 2014, ISSN 2278-3083.
[8] Gagliardi C, Frigerio E, Burt DM, Cazzaniqa I, Perrett DI, Borgatti R, Facial expression recognition in Williams syndrome, neuropsychologia. 2003;41(6):733-8
[9] C. Garcia and G. Tziritas, Face detection using quantized skin color regions merging and wavelet packet analysis, *IEEE Trans. Multimed.* **1**(3) (1999) 264–277.
[10] V. Govindaraju, S. N. Srihari and D. B. Sher, A computational model for face location, *Proc. Computer Vision and Pattern Recognition* (1990) 718–721.
[11] P. S. Hiremath and A. Danti, "Detection of multiple faces in an image using skin color information and LS face model, international journal of pattern recoginition and artificial intelligence, volume20(1), pp 39- 61, world scientific publisher. ISSN 1793-6381, Feb 2006.

AUTHOR'S PROFILE

Mr. Dileep M R is currently working as Lecturer in the Dept. of Computer Science, Alva's College, an unit of Alva's Education Foundation, Moodbidri, Karnataka, India. Research interest includes Image Processing and Database Applications. He has Completed Master of Computer Applications (MCA) from Visvesvaraya Technological University, Belgaum, Karnataka, in the year 2013.

Mr. Prasad M is currently working as Assistant Professor in the Dept. of Master of Computer Applications ,Bapuji Institute of Engineering and Technology , Davanagere,Karnataka, India. He has 9 years of teaching experience. Research interest includes Image Processing and facial expression . He has Completed Master of Computer Applications (MCA) from KuvempuUniversity ,shankaraghatta , Karnataka, in the year 2006.

Dr. AjitDanti is currently working as Director and Professor in the Dept. of Computer Applications, Jawaharlal Nehru National College of Engineering, Shimoga, Karnataka, India. He has 22 years of experience in various capacities such as Teaching, Administration and Research. Research interests include Image Processing, Pattern Recognition and Computer Vision. He has published more than 35 research papers in the International Journals and Conferences. He has authored two books published by Advance Robotics International, Austria(AU) and Lambert Academic Publishing, German which are freely available online. He has Completed Ph.D degree from Gulbarga University in the field of Human Face Detection & Recognition in the year 2006. He has Completed Masters Degree in Computer Management from Shivaji University, Maharastra in the year 1991 and MTech from KSOU, Mysore in the year 2011 and Bachelor of Engineering from Bangalore University in the year 1988.