



Recognising Natural Emotions Using Artificial Neural Network In A Classroom Setting

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Abstract: The advent of computer and its related technologies had brought much advancement. Still the interactive ability of computer is limited in many ways. One such area is the ability to understand and interpret ongoing emotions in human-computer interface. Such ability could be referred to as 'emotional intelligence'. Computers today are quite emotionally challenged, as they neither recognize nor possess emotions of their own. In this paper we propose a novel approach for emotion recognition using artificial neural network in which we will try to examine the emotions of the students. The subjects for the study will be taken from the psychology department studying in a classroom, and their natural occurring emotions during the lectures would be captured with the help of video cameras installed in the classrooms. The still photographs of the students exhibiting different emotions(happy,sad,anger,disgust,neural) would then be subjected to backpropagation algorithm, which will filter the students who showed negative emotions (anger, sadness, disgust, etc.) consistently over few days. Lastly the pedagogical approaches would be employed in order to explore the causes behind such consistent pattern of negative emotions and improve upon that using the data from self-reported questionnaires and psychological counselling of students by the experts in the field.

Keywords: emotion recognition, pedagogical, emotional intelligence

I. Introduction

The human face plays an important role in many aspects of verbal and non-verbal communication. Regarding verbal communication, the face is involved in speech and as far as non-verbal communication is concerned, the face communicates through expression of emotions and gestures such as nods, winks. A.Mehrabian (1968) mentioned in his paper that the verbal part of a message contributes only 7% of its meaning as a whole; the vocal part contributes 38% while facial movement and the expression gives 55% of the effect of that message and so one can say that the facial part does the major contribution in human communication [1]. Computer scientists and engineers have worked on the face from the viewpoints of graphics, animation, speech recognition and pattern recognition but the work on human-computer interaction is still to achieve its desired efficiency. Reason for this may be attributed to the technical limitations of the development of practical applications rather than any intrinsic lack of relevance to HCI. The attention of HCI researchers is shared by Eye gaze tracking technology, pattern recognition and facial emotion recognition. Gaze tracking technology is so advanced that several companies provide with commercial working systems which are usable even without special technical expertise. The research on face classification, through pattern recognition is also exploited but facial emotion recognition is still in its infant stage as the desired efficiency is still lacking [2].

The aim of this research is to make some advancement in human and computer interaction by electronically perceiving and understanding an image. With recent advances in image analysis, the possibility of automatic detection and classification of emotional and conversational facial signals has slightly increased but is yet to be developed so that it could be used in a reliable manner. Real-time automatic facial expression analysis would incorporate facial expressions into man-machine interaction and make interaction tighter, rational and more efficient. Such a system could also make classification of facial expressions widely accessible as a tool for research in behavioural science and medicine.

A. Emotions

What are emotions? This question has intrigued mankind ever since the ancient philosophers. Aristotle was one of these early philosophers with clear ideas about emotion, and wrote in Rhetoric (1378b, English translation by W. Rhys Roberts) that: "The Emotions are all those feelings that so change men as to affect their judgements, and that are also attended by pain or pleasure. Such are anger, pity, fear and the like, with their opposites."

In words of Jonghwa Kim, an emotion is a concept involving three components:

- Subjective experience
- Expressions (audiovisual: face, gesture, posture, voice intonation, breathing noise)

- Biological arousal (ANS: heart rate, respiration frequency/intensity, perspiration, temperature, muscle tension, brain wave)

A.1 Significance of emotions in human computer interaction

When humans interact, a lot of communication is done using facial expressions or emotional states of the face. This idea can be incorporated in human computer interaction as well because it would lead to reduction in the gap between humans and computers and will make computers to act according to humans by judging their expressions. Thus we can summarise that:

- Knowing the user emotion, the system can better adapt to the user needs.
- Sensing (and responding appropriately!) to the user's emotional state will be perceived as more natural, persuasive, and trusting and will shorten the gap between humans and machine.

II. Classification approaches

There are several approaches taken in the literature for classification of emotion. Lien, cohn and kanade [8] have used Hidden-Markov Models (HMM) for classification. Other proposed systems use linear neural net classifiers [9] [10] [11] or support vector machines [17]. Support vector machines finds a hyperplane based on support vectors calculated from data to analyse data and recognize patterns. The complexity of the resulting recognizer is characterized by the number of support vectors rather than the dimensionality of the transformed space. The goal in training SVM is to find the separating hyperplane with the largest margin. We expect that the larger the margin, the better is the generalization of the recognizer.

Backpropagation [10] is a type of artificial neural networks in the supervised learning category which is commonly used as a classifier. A sigmoid or radial activation function along with a bias is used to find the output neuron which better represents the inputs. The neural net is used when dimensionality of the input data is high. It gives higher recognition rates.

Hyeob Kim, Chul Huh, Myoung-Ae Chung [19] have used Self organising maps and Naïve-Bayesian classifiers for emotion recognition. The Naïve Bayes algorithm is a classification algorithm based on Bayes rule and particularly suited when the dimensionality of the inputs is high. When the dependency relationships among the features used by a classifier are unknown, then it is assumed that the features are conditionally independent given the category. This so-called naïve Bayes rule often works quite well in practice, and it can be expressed by a very simple belief net.

III. Methodology

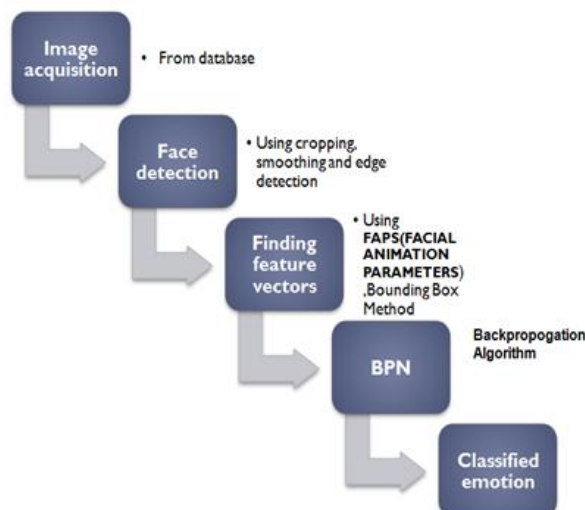
Our aim is to study and design an efficient high-speed facial emotion recognition system in MATLAB. Emotion recognition, although a trivial task for the human brain has proved to be extremely difficult to imitate artificially, because although commonalities exist between faces, they can vary considerably in terms of age, skin colour, orientation, facial expression and presence of facial furniture such as glasses or facial hair. The problem is further complicated by differing light conditions, image qualities and geometries, as well as the possibility of partial occlusion and disguise. Hence, a robust emotion recognition system should be capable of correctly identify the facial features of an image and use this information to identify the emotion depicted by the image. Research objectives are enlisted as

- To design a fully automatic real-time system model for an ideal facial emotion recognition system, this is invariant of background conditions, illumination variance and noise.
- To develop a program in MATLAB based on the designed model.
- To create a database set of web-cam clicked face images.
- To validate and test the facial emotion recognition system.
- To be able to recognize spontaneous expressions.
- To be robust against different lighting conditions.
- To develop a person independent face recognition system.
- To be able to work on people from different cultures and different skin colors.
- To filter out people exhibiting negative emotions and try to improve them.

IV. Proposed System

After studying various a techniques and algorithms for facial emotion identification .We proposed our system in which images are acquired from image databases. Commonly used databases are Cohn-Kanade and JAFFE. Images in the database can be coloured or gray-coloured. For the project we have created our own database of hundred web-cam clicked images. The images of database are coloured. Pre-processing is normally performed before feature extraction, in order to increase system performance. The aim of this step which includes cropping, scaling and smoothing is to have images, which contain a face, expressing a certain emotion. Sometimes, histogram equalization is also used to adjust image brightness and contrast. Pre-processing is done in three

steps: Cropping the image to remove unwanted areas from the image ('imcrop' function in MATLAB). Scaling of the image ('imscale' function in MATLAB). Filtering or smoothing the cropped image to remove noise ('imfilter' function in MATLAB). Facial animation parameters are used to extract features. Bounding box method is used to find the area of interest. These features are first normalised and then used for training and testing the classifier for the purpose of facial emotion recognition. The classifier used is artificial neural network which is trained using backpropagation algorithm. Classification technique is using the log sigmoid function as the activation function of the neural network.



A. Facial animation parameters (FAPs)

Moving Pictures Experts Group (MPEG) introduced the Facial Animation (FA) specifications in the MPEG-4 standard. The MPEG-4 standard supports facial animation by providing Facial Animation Parameters (FAPs). In this approach, it is assumed that an image sequence represents only one expression. The neutral face is used as a baseline face, and for every input image, difference between the baseline and the input face image is calculated to determine image features. The MPEG-4 model defines a face model in its neutral state to have a specific set of properties like a) all face muscles are relaxed; b) eyelids are tangent to the iris; c) pupil is 1/3rd the diameter of the iris and so on [24]. The standard defines 84 key feature points for neutral face as shown in the figure 1.2

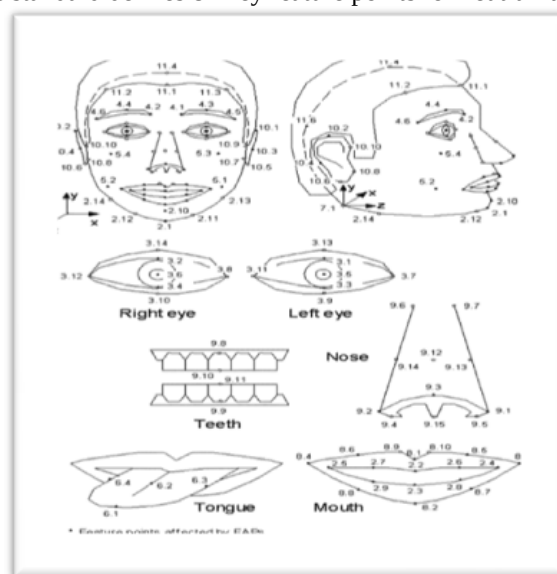


Fig. 1.2 : 84 FAPs of a neutral face [22]

FAPs are a set of parameters that represent a complete set of facial actions along with head-motion, tongue, eye and mouth control. In other words, each FAP is a facial action that deforms a face model from its neutral state to one of the six expression states. The FAP value indicates the magnitude of the FAP which in turn indicates the magnitude of the deformation that is caused on the neutral model. The Facial Animation Parameters (FAPs) that are utilized in the framework of MPEG-4 are strongly related to the Action Units (AUs) which form the core of the Facial Action Coding System (FACS) [25]. Facial Action Coding System (FACS) is an expression descriptive method which was proposed by Ekman and Friesen, and is widely applied to the researches about facial expressions. There are more than 40 AUs[9][10] and it is said that every sort of facial expression can be

described by the AUs. For example, the combination of nation of AU6 (rise cheeks) and AU12 (pull up edges of mouth) can express "smile".

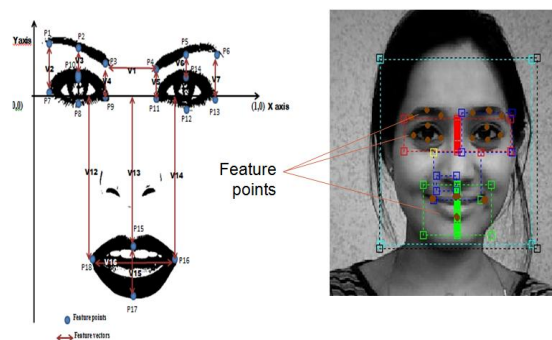


Fig. 1.3: Facial Action Coding System and Bounding Box Method to find area of interest

B. Backpropagation algorithm

The back propagation technique actually depends on the three main factors: No. of Iterations, No. of local maxima and local minima and Error difference rate. . First phase is the **forward phase**. This is the phase where the activations propagate from the input layer to the output layer. The second phase is the **backward phase**. This is the phase where the error between the observed actual value and the requested nominal value in the output layer are propagated backwards so it can modify the weights and bias values. Our designed application would be able to judge the efficiency on all the parameters but the most efficient one is the error difference rate. This parameter would just help to provide a stopping condition or a stopping parameter to our algorithm. According to this parameter as the in one reading of a face the value is suppose 76.37 while matching with a neutral face and in next reading for the same expression reading is 76.3705 the algorithm would stop and say that the result is obtained for the neutral expression i.e. it will match the expression as neutral. The technique of the back propagation used forms a six layered network with one input layer, two output layers and three hidden layers. It actually contains 16 inputs for the 16 input feature values in input layer, then it contains 5 nodes in the first hidden layer 40 units in the second and third hidden layer and finally 5 in the first output layer for the 5 expressions and 2 in the second output layer for detecting the male and female facial organs. This classification technique is using the log sigmoid function as the activation function of the neural network.

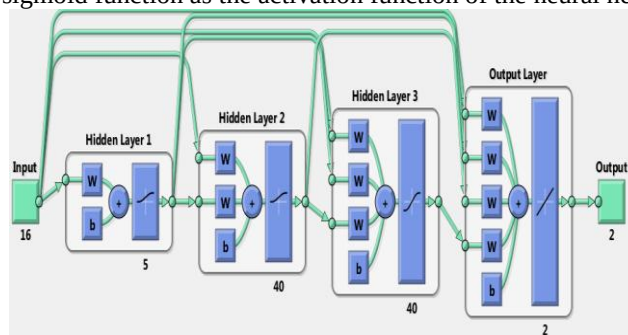


Fig. 1.4: Artificial neural network trained with backpropagation algorithm

V. Discussion and Conclusion

After emotion classification we will filter out the students showing negative emotions (sad, anger, disgust) consistently over few days. Lastly the pedagogical approaches would be employed in order to explore the causes behind such consistent pattern of negative emotions and improve upon that using the data from self-reported questionnaires and psychological counselling of students by the experts in the field. We chose backpropagation algorithm over other because of its ability to cope with noise data, prediction (reduction in mean square error) and effectiveness with large number of input fields is excellent. Apart from emotions our algorithm could also recognize gender which is one of the improvements over previous approaches. The facial emotion recognition program developed can be used as an education tool to study and learn how to develop an efficient facial emotion recognition technique. It can be used by intelligent systems to anticipate user behaviour and needs and act accordingly. System can be used to add rationality in human computer interaction.

Another application of Automatic face expression recognition systems is in robotics, especially humanoid robots. As robots begin to interact more and more with humans and start becoming a part of our living spaces and work spaces, they need to become more intelligent in terms of understanding the human's moods and emotions. Expression recognition systems will help in creating this intelligent visual interface between the man and the machine. Apart from the two main applications, namely robotics and HCI, expression recognition

systems find uses in a host of other domains like Telecommunications, Behavioural Science, Video Games, Animations, Psychiatry, boxes and televisions, Educational Software, etc.

Many interesting and practical real-time applications have also been demonstrated. Bartlett et al. have successfully used their face expression recognition system to develop an animated character that mirrors the expressions of the user (called the CU Animate) [20]. They have also been successful in deployed the recognition system on Sony's AiboRobot and ATR's RoboVie [20].

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