Mood-Based on-Line Learning System

R.Sudha Kishore, A.Sudarsan Reddy, R.Chittibabu

Abstract:-Many millennial learners are associated with massive open on-line courses for learning. This online learning to be more interactive and to substitute the teacher observation, it requires the augmentation of those humanly traits, to keep the learner active. This paper proposes such a sub-system to the online learning environments which performs necessary activities to bring the learner into pace of the course. From the reactions of learner while learning from the continuous capturing of face images, this system can analyze the emotions and initiate the necessary actions to continue the learning. The Emotional Back Propagation Neural Networks with successful PCA were used for training and Genetic Algorithm is used for optimizing the results. The system can automatically identify the facial expressions and initiates the counter actions to keep the learning successful.

Keywords—Facial Emotion Recognition, Human Computer Interaction, Massive Open Online Courses, Emotional Back Propagation Neural Networks, Principle Component Analysis, Genetic Algorithm

I. INTRODUCTION

The Facial expression recognition has gained enormous importance in this decade. Many real time contemporary applications are being incorporated with cognitive abilities. The applications are focusing on user experience improvement. Users of many online applications are interacting with the systems in a large extent for accomplishing their desired tasks. While doing this, users and the online applications are considering issues that enhance success of the interactions. The online learning has been turning out as a mandate for all the millennial learners. In the aspect of massive open online courses the online learning can be made successful only by considering the humanistic traits as a physical teacher to improve the experience of learning. This is a Human Computer Interaction issue blended with the cognitive abilities of users. These cognitive abilities can be incorporated into machines by following specific Artificial Intelligence techniques. These techniques include Soft Computing algorithms such as Artificial Neural Network structures. The mood of learners while online learning, can be classified from the continuous facial expressions. In the past ten years, spontaneous facial expression has established a major role in identifying human emotions. Human-computer interaction involves key operations like face detection, face recognition and facial emotion recognition. For the detection of facial expressions many authors implemented techniques that are visible in huge body of research literature over the years. The most successful techniques depend on facial emotion extraction , recognition and classification for further processing.

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In general the facial expressions include principal categories such as: happy, surprise, angry, disgust, sad, fear. Some techniques used geometrical methods while others used cognitive approaches. FACS (facial action coding system) is the basis for almost all methods which is devised by Ekman and Friesen [1]. Each expression is identified by the action unit(AU). The implementing system needs to incorporate these Action Units as per the applications demand.

II.FACIAL EXPRESSION RECOGNITION

A. Facial Expression Recognition

For affective Computing in digital image processing to have automated desired results while interacting with the computer is best described by R.W.Picard et.al [2]. The facial expression recognition and its need as described in S. Mingli, et.al. [3], inspired the human computer interaction in business applications. The integration of emotions to automate the cognitive abilities of users is a related work done by the L. I. Perlovskyet. Al [4] to incorporate the FER based system in the online learning which is an integral part of cognitive science.

B. Face Object Detection

The crucial part of this entire work is to identify the face object properly and then the emotions based on training. The real object detection can be done using several verified methods as suggested by P. Viola et.al [6]. As the entire online learning system that this paper takes as subject, the face object of learners can be extracted from the web cam of the system. The frame work for set up of all capturing mechanism, classification and taking apt post action can be followed by the proposals made by several earlier papers such as I. Fasel et.al [7]. This paper used a suitable method that best fits for this online learning system. The human activity motion using kinematic features as explained in A. Sanchez et.al [8], were understood before implementing this mood based online learning system. While analyzing the facial expressions automatically a fusion of methods as suggested in [9, 10] were observed for improvement.

C. Artificial neural networks

The use of Artificial Neural networks for training the system is from many decades, but an impeccable and effective usage to train the facial expression classification system is felt much needed. The variants of artificial neural networks applied by several researchers [11,12] in different applications were observed.

The use of soft computing tools such as Genetic Algorithms, Particle Swarm Optimization and others are used for optimizing the features extracted.

III. PROPOSED METHODOLOGY

The proposed system is meant for application of important and proven features of Facial Expression Recognition all together in to a frame work establishing the Mood Based Online Learning System. A constrained modular approach is followed for the system to achieve its objectives. The methodology includes the signals and systems approach Principal Component Analysis for extracting the features of faces. Later these features are optimized by using Genetic Algorithms Technique.

The optimized features are then subjected to Emotional Back Propagation neural networks (EmBPNN) for training to classify the emotions on faces in to six application dependent groups. The query face emotion from the online learning is taken and classified based on the trained system of EmBPNN. The classified feature decides appropriate action to be triggered by the Mood-based On-Line Learning System (MOLS).

The entire proposed methodology is depicted in the architecture diagram below Fig.1.

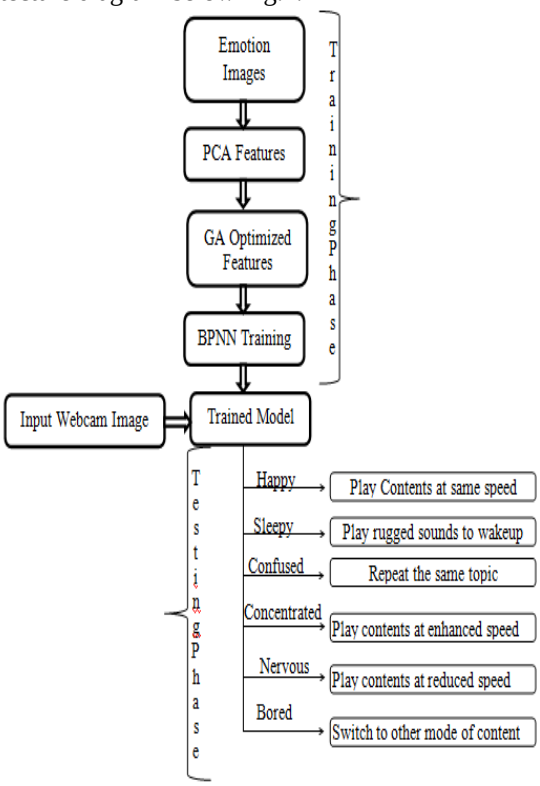

Fig.1 Architecture of proposed System

A. Principle Componen Analysis

The Principle Component Analysis for feature extraction is used as a proven technique in this system. The PCA has alternatives such as Discrete Cosine Transform (DCT) as a Fourier Transform for feature extraction.

Principal Component Analysis (PCA) is an invention of Karl Pearson in the year 1901. It is a linear transformation based on statistical technique. It is used to decrease the dimension of the data or to reduce the correlation between them. It is a way of identifying patterns present in data, and expressing the data in such a way that their similarities and differences are highlight

B. EmBPNN

The proposed architecture uses the feed forward and emotional back propagation neural network [5,13] architectures. The generalized architecture of the proposed system is shown in Fig 5.

Feed forward networks often have one or more hidden layers of sigmoid neurons followed by an output layer of neurons. Multiple layers of neurons with nonlinear transfer functions allow the network to learn nonlinear and linear relationships between input and output vectors. A two-layer forward network is and its neural structure is shown below.

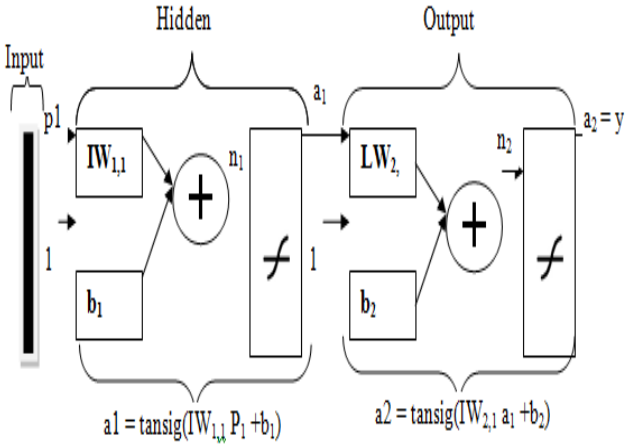

Figure 2 A simple feed forward network

The feed forward network is used in the proposed system because it can deal with nonlinear classification problems. It is able to form from the high-order, extracted features of a face more complex decision regions in separate layers.

An adhoc comparison was done between these two kinds of neural network approaches over the facial expression recognition. A brief functioning of artificial neural networks along with its implementation was described in the following paragraph. The EmBPNN general frame work is in Fig 3 below.

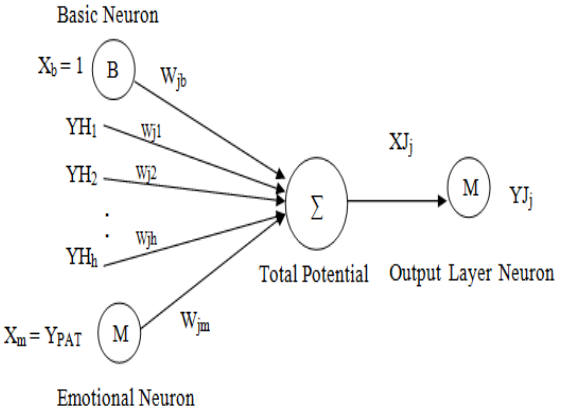

Fig. 3 General EmBPNNFrameWork

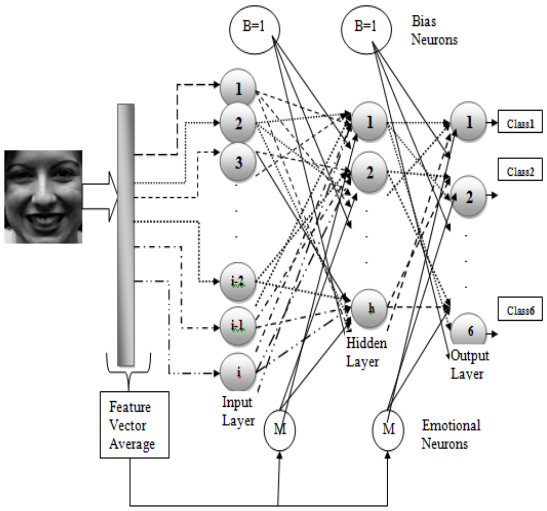

Fig. 4 Generalized EBP-based neural networks

The implementation of neural network consists of training and testing. The training and testing is performed on sample periodic images taken from the online learning system.

C. Genetic Algorithm

Genetic Algorithm (GA) is a kind of soft computing technique that belongs to the evolutionary class of algorithms, used for optimization of processes. The GA has emerged into promising system that can revolutionize computing in future. The concept of GA was first introduced by John Holland, a founder of evolutionary computations, in beginning of the 1970s (Negnevitsky, 2002). This heuristicapproach applies the principles of evolutionary biology to find solutions for computing related problems. This approach employs techniques such as natural selection, mutation, inheritance, and recombination (or cross over) that are bio-logically influenced and generated is adopted by Genetic Algorithm. Inspired by the biological struggle for existence, after undergoing a number of trial solutions by a population and evaluating them to produce fitness, a new generation is created. And this activity is repeatedly done for a number of generations until an acceptable solution is evolved in to the population [82,87].

GA is well known for optimization of nonlinear functions. For a specific problem, a selected fitness function suitable for it is offered by a best optimized value. There are numerous variants of applications in which GA is used. Many non-linear optimization problems got solutions using GA in the areas of image processing, network diagnosis, logistics, Artificial Intelligence, Embedded and Control Systems, Aviation and Aero Dynamic Machine Design, Quality Control etc.(Neo, 1997 rf#58). Computer Vision which is a primary AI concern, which includes a simulation of human brains visual cortex, is also practiced with a row of methodologies in solving several aspects. [16,17]

In the feature extraction stage, the GA is applied to extract the facial features such as the eyes, nose and mouth, in a set of predefined sub regions. Some simulations have been carried out. Genetic Algorithm has proven itself in several problems such as extracting the ROI from several images including the EYE region from a facial image.

The Genetic Algorithms (GA´s) are characterized by a search technique inspired in the Evolutionist Theory by Darwin, uses some selection mechanism, where individuals that is the chromosomes more adapted of a population are the ones that have more survival chances, by getting used easily to changes that occur in its environment. The Genetic Algorithm becomes swift, effective and efficient. And so becomes one of the plausible types of optimization, out of several other techniques which become inefficient and cannot handle the situations when the search space is very huge. The popularity of GA is because of its ability to deliver multiple solutions rather than ending up with a single option less solution.

The Algorithm

Genetic Algorithm follows iterative process and the iterations it passes through are termed as Generations. A chromosome of length of 6 bits and a population of 20 are chosen in our work. The selected chromosome is an approximate solution. Other selected parameters are listed in Equation-set 1.

The GA process is described in the following steps.

Step 1: To represent the problem variable domain as chromosome of a fixed length and population, with suitable cross over probability and mutation probability

Step 2: To defining a fitness function to measure the performance, or fitness of an individual chromosome in the problem domain

Step 3: Togenerate, randomly, an initial population of chromosomes.

Step 4: To calculate the fitness of each individual chromosome.

Step 5: To Select a pair of chromosomes for matting from the current population. Parent chromosomes are selected with a probability related to their fitness. Highly fit chromosomes have a higher probability of being selected for mating compared to less fit chromosomes.

Step 6: To create a pair of offspring chromosomes by applying the genetic operators – crossover and mutation

Step 7: To place the created offspring chromosomes in the new population

Step 8: To repeat from step 5 until the size of new chromosome population becomes equal to the size of the initial population

Step 9: To replace the initial chromosome population with the new population

Step 10: To go to step 4, and repeat the process until the termination criterion is satisfied.

6.1.2 Fitness function

A solution in each iteration or generation is called a chromosome. And it can be quantified by a specific objective function, which in GA is termed as fitness function. And the primary purpose of this function is to rank chromosome against the other all possible chromosomes that evolve during the generations**.** The fitness functions are derived from Equation (1.1). Equations (1.2) and (1.3) are fitness functions respectively for “b1” and “b2” to obtain optimum lip features.

$$f(x) = (\sum_i^m \sum_j^n col(j) - 2\sqrt{x_1^2(1-\frac{row(i)^2}{a^2})})^2 if x_1 \geq 0 \quad (1.1)$$

$$\overline{f(x)} = (\sum_i^m \sum_j^n col(j) - 2\sqrt{x_2^2(1-\frac{row(i)^2}{a^2})})^2 if x_2 \leq 0 \quad (1.2)$$

$$f(x) = (\sum_i^m \sum_j^n col(j) - 2\sqrt{X^2(1-\frac{row(i)^2}{a^2})})^2 \quad (1.3)$$

In Equation (6.1) to (6.3), col(j) is the sum of white pixels occupied by jth column and row(i) is the sum of white pixels in ith row.

This Genetic Algorithm takes the fiducially acceptable features of eye and lip as inputs and gets the values of b1, b2 and b that are proved to be optimal. The dual parameters called the scale, shrink are used to control the variance of Gaussian Mutation Distribution. The variance of first generation is calculated by the parameter variance and as the generations evolve the shrink parameter controls the variance. The dual parameters called the scale and shrink are selected as 1.0 each. Scattered crossover creates a random binary vector. It then selects the genes where the vector is a 1 from the first parent and the genes where the vector is a 0 from the second parent and combines the genes to form the child. The optimization has been carried out for 5 times for each emotion.

IV. DISCUSSIONS AND RESULTS

The experiment conducted on this proposed system yields positive results. The online learning environment was set up in a Client server fashion by usng .Net frame work. The sample images taken periodically from the online learning system were initially processed, classified and then appropriate action has been initiated. The confusion matrix for the emotions was given below in Table 1. It shows the selective emotions pertaining to the online learning were carried out in the experiment against their misclassifications or true/false positive/negatives.

	Happy	Sleepy	Confused	Concentrated	Nervous	Bored
Happy	92	0	2	0	0	4
Sleepy	0	90	0	4	4	0
Confused	5	0	94	0	0	0
Concentrated	0	4	0	91	5	0
Nervous	0	4	0	5	90	0
Bored	3	2	4	0	1	96

Table 1. Confusion matrix of emotions

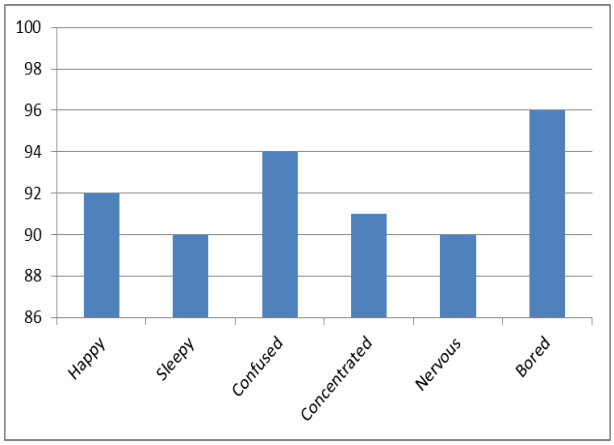

Figure 4. Performance of the proposed system

The actions taken against the emotions predicted were inscribed in the below table 2.

	Recognition Rate (%)	Action Taken
Happy	92	Played Contents at same speed
Sleepy	90	Played rugged sounds to wake up
Confused	94	Repeated the same topic
Concentrated	91	Played contents at enhanced speed
Nervous	90	Played contents at reduced speed
Bored	96	Switched to other mode of contents

Table 2. Actions taken on emotion predicted

The proposed system was implemented in client server architecture using Microsoft dot net environment. The experiments are conducted in a constrained lab environment of 60 computers which are equipped with individual webcams. The client connects to the server with a specific user name and corresponding password. The user then chooses a particular topic of their choice. The webcam of the clients are being accessed every 30 seconds and a snapshot is taken to find the emotion of the student. Once the emotion is predicted, an automated action is taken corresponding to the user's emotion.

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