

2012 International Conference on Applied Physics and Industrial Engineering

## An E-learning System based on Affective Computing

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### Abstract

In recent years, e-learning as a learning system is very popular. But the current e-learning systems cannot instruct students effectively since they do not consider the emotional state in the context of instruction. The emergence of the theory about “Affective computing” can solve this question. It can make the computer’s intelligence no longer be a pure cognitive one. In this paper, we construct an emotional intelligent e-learning system based on “Affective computing”. A dimensional model is put forward to recognize and analyze the student’s emotion state and a virtual teacher’s avatar is offered to regulate student’s learning psychology with consideration of teaching style based on his personality trait. A “man-to-man” learning environment is built to simulate the traditional classroom’s pedagogy in the system.

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*Keywords:* emotional intelligent; e-learning system; affective computing

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### 1. Introduction

In recent years, e-learning is very popular because this kind of learning system uses modern educational technologies to implement an ideal learning environment through integrating the information technology into curriculum, which can embody the learning styles of students’ main-body function, reform the traditional teaching structure and the essence of education thoroughly [1]. It can provide individualized instruction by being able to adapt to the knowledge, learning abilities and needs of each individual student, but this kind of e-learning system is indifferent to the learners. The learning systems are lack of emotional interaction in the context of instruction. They cannot simulate the traditional classroom scenario: The teacher and students can face to each other in the class. Emotion deficiency refers to the separation among students and teachers, students and students, which make students and teachers, students and students can’t carry on face to face communicating promptly like conventional education. Thus, some learning problems of the learners in the learning process can’t be solved and perplexity of the psychology can’t get help. If students gaze at indifferent computer screens for a long time, they do not feel the interactive pleasure and

emotion stimulation, and they may have antipathy emotion. Thus, learners are lower effective in this learning system. An effective individualized learning system should be not only intelligent but also emotional. Researchers in neurosciences and psychology have found that emotions are widely related to cognition, they exert influences in various behavioral and cognitive process, such as attention, long-term memorizing, decision-making and so on[2].

Affective computing is a hot topic in Artificial intelligence, it is computing that related to, arise from, or deliberately influence emotion [3], which is firstly proposed by Professor Picard at MIT in 1997. Affective computing has attracted education technologists' eyes. In order to establish good web learning environment like the real world, Qi Luo [4], Xi-Rong Ma [5], P.A. Jaques[6] have explored the potential of affective computing in e-learning models one by one. These e-Learning system models emphasize particularly on the evaluation of the learner's emotional states and adjustment of teaching strategies, and ignore how to evaluate learning performance and how to adjust teaching strategies according to the contents of evaluation module.

To solve the problems, we proposed an e-Learning system model based on affective computing. In this paper, which can detect and aware the learner's emotional states by using facial expression and posture recognition technologies, modify teaching strategies automatically according to the learning performance and emotion transition, and provide emotion stimulus according to special cognitive states, thus solving the problem of emotion deficiency radically and providing better learning conditions.

## 2. The emotional Intelligent E-learning System

From brain control mode of artificial psychology, we know that the person's emotion, feeling and consciousness can control and influence the person's behavior. The behavior of the person would also show the person's emotion. When person faces the things that he is interested in, he will concentrate on it very much and his behavior also perform a kind of attraction and tendency. On the contrary, when person facing the thing that he is not interested in his attention will transfer, the behavior also performs a kind of rejection and elusion.

In this project, we construct two agents. One is learner agent and the other is teacher agent. The learner agent's main task is to collect the student's emotion and analyze his learning psychology or motivation in the emotional intelligent e-learning System. The teacher agent is a virtual teacher. His main task is to communicate with students in the process of learning. The virtual teacher can respond to learner's current state to regulate their emotion to optimum by words or expressions. Thus we can establish a harmonious environment for human and computer's interaction.

Basing on it, the traditional E-learning model is added the affective computing module. The model of E-learning system based on affective computing is shown in Figure 1.

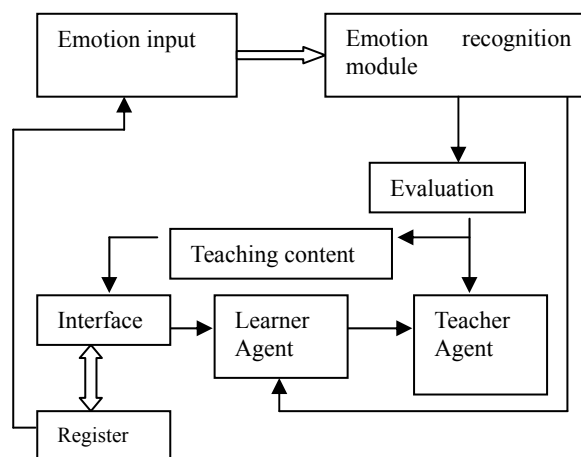


Figure 1. The model of E-learning system

The system model is composed of several modules as follows:

#### *Register module*

This module's main work is to identify and verify students' identity, acquire the student's characteristic information. When a learner register the system, his information such as register number, name, sex, age, educational background, academic degree and so on would be recorded. The system will give him on-line tests to classify him. After the student passes the verification, he can start his class with a virtual teacher.

#### *Interface module*

Affective computing input (facial emotion recognition input )is added to human machine interface of traditional E-learning system, which collects learners' emotion feedback information primarily, thus emotion compensation is realized. This module is constructed according to the paper<sup>[7]</sup>.

#### *Emotion Recognition module*

Human facial expression plays a crucial role in interpersonal communication. It contains extremely abundant information of human's behavior and can further reflect human's corresponding mental state.

The change of learners' emotion is more complex in the learning process. How to classify emotions is an interesting but difficult issue. Researchers on emotion recognition differ on the number of categories and the kinds of categories to use. Some classification systems that have been used include: Neutrality, joy, boredom, Sadness, anger, fear, indignation<sup>[8]</sup>. Neutrality, happiness, sadness, anger, fear, boredom, disgust<sup>[9]</sup>. We dealt with four emotional states such as①surprise②puzzle or bewilderment③depression or despair ④self-confidence in our study. When the learner contacts with a new knowledge point, two kinds of attitudes such as interested state surprise and indifferent state may appear . Interested state is to explain the change process of learner's emotion, and learner's emotion state is divided into four categories approximately in the paper. With the learning process advancing, learner's emotion is changed. For instance, the learner has an idea to solve this problem. If the learner defeated repeatedly, he will suspect himself and changes into the state③, this kind of state is disadvantageous to learning. The system should apperceive this kind of emotional change and carry one motion intervening, which let him turn to self-confident state ④. When he contacts with a new knowledge point, the emotion turns to state①and② too. The process is show in Figure 2.

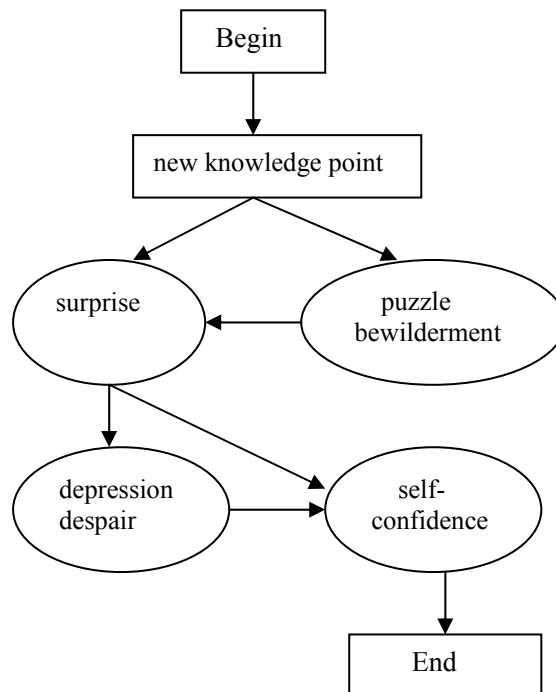


Figure 2. . The change of emotion state.

So, we expect machine to recognize as many emotions as possible through facial expressions. To achieve the goal, abundant and effective data of facial expressions is necessary, and methodology of multiple facial expression recognition is to be studied. These emotional behaviors are quite important feedback signals of learners. We may use these feedback signals effectively and adjust teaching strategies to serve personalized learning.

The emotion recognition module is composed of input, pre-processing, feature extraction, feature selection, emotion recognition and output. Basing on it, the appropriate evaluation of learning is obtained.

#### *Evaluation module*

The module collects evaluation results and transforms into a corresponding evaluation parameters. Simultaneously, Learning records are extracted from learners' model. Teaching strategy adjusting algorithm module: teaching strategies are adjusted according to the evaluation parameters and learning records of learners' model. Appropriate teaching contents and teaching mode are provided to learners. Simultaneously, emotional encouragement and compensation is provided.

#### *Teacher agent module*

Since there is not a real teacher or a real classroom in an e-learning environment, we construct a teacher's avatar as a virtual teacher to analyze student's emotion state and give proper regulation to adjust their negative emotion. The virtual teacher will record the student's learning state, analyze the student's state and decide how to regulate the student's state by doing some activities like words or facial expression. As every person has his own personality, we take the virtual teacher's teaching style as his personal trait. For example, some teachers are rigorous while some are easy-going with his students. And

the words and phrases will be different according to their teaching style as well. For instance, when the teacher wants to give the student suggestion, rigorous teacher may express as “You should...”, “let’s...”, while the easy-going teacher will say “I suggest that you...”, “Perhaps you would like to...” or “Maybe you could...” etc.

### *Learner agent*

A personal agent fetches different information according to different users' demands. In the on-line learning environment, the system offers very scattered materials and users have to browse these materials one by one in order to get their interesting information. The agent is responsible for compiling the scattered information and recommending users' interesting materials to them voluntarily when they login next time.

The learner agent can discover learners' personal interests voluntarily without bothering the users. It is very suitable for personalized e-learning by voluntarily recommending learning materials. The major work of learner agent in e-learning can be divided into two categories: Adopt the association rules to analyze the browsing sequence. Then give suggestion of composing learning materials and sequence of learning in order to reduce the time of searching and provide high quality learning materials. Analyze learners' browsing profile to understand their learning status. Then offer information to teachers or instructors or learners in order to improve students' learning performance by proper guiding.

### *Teaching content module*

This module's work as follow: First, Listening to the student's changing state especially emotional state. Second, analyzing the student's emotional and cognitive data to decide next action. Third, regulating the student's state by doing some activities such as words expression or facial expression. Fourth, receiving student's question and return the answer to the student.

## **3. The Realization Of The System**

In the E-Learning system, the situation is one teacher face many students. In order to meet this situation and reach the multi-agent monitoring function, the system adopts Client / Server structure. Student machine is the client, teacher computer is the server. Every client is equipped with a camera and the camera can catch the learner's facial emotion.

When the learners' computer completes their own calculations and determination, these conclusion only are transmitted to the teacher computer and display the contents transmitted from teacher computer. Each student computer is an agent and so that multi-agent monitoring implementation is carried. The teacher can face many students as if it is real-time monitoring. Thus this system reaches the emotion exchange as if the teacher faces the students.

The key technique of this system is as follows:

### *Facial Feature extraction and Classification*

Human facial expression is expressed by the shape and position of facial components such as eyebrows, eyes, mouth, nose, etc. The geometric facial features present the shape and locations of facial components. The facial feature points are extracted to form feature vector that represent the face geometry. Accordingly, we locate feature points firstly, and then calculate the geometric feature. There are many methods for feature points locating, such as Active Contour Models(ACM)<sup>[10]</sup>, Active Shape Models (ASM)<sup>[11]</sup>, and Active Appearance Models(AAM)<sup>[12]</sup>. AAM has been successfully used for deformable objects locating. In this paper, AAM is adopted to locate feature points. The emotion classification is introduced before.

### *Adjusting teacher agent*

The aims of processing of affective information are to track learners' emotional and cognitive states, discriminate cognitive attitude, figure out the integral emotional state in an e-learning course by statistics, and transmit this information to learner agent. A learner's emotional states are very complicated in a learning process. Positive (interest) or negative (disinterest) change may occur in a new e-lesson. At the beginning of a new lesson, a learner always feels surprised or confused. As time passes by, his emotional state will be changed. If always be confused, he will doubt about his ability and feel frustrated. This negative change will delivered to the teacher agent immediately, and teaching strategy will be modified. When proper teaching strategy is employed, the learner will feel confident and yearn for new knowledge. Processing of affective information is the key to individual teaching. The affective information can be delivered to the learner model. Once negative attitude was detected, teaching strategy will be modified by the teacher agent.

### **Conclusion**

The model of E-learning system based on affective computing is proposed in the paper. We have designed and implemented a one-class-in-one network for emotion recognition module. This study demonstrates that emotion recognition is feasible, and that neural networks are well suited for this task. Multi-module emotion recognition including facial, speech, and other features such as gesture should be studied in the near future.

### **Acknowledgement**

The author thanks her colleagues for their helpful discussion.

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