Remote physical education using affective computing

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ABSTRACT: The Hidden Markov Model (HMM) was used in this study, to construct an affective emotion model of human emotional change. This model can be applied to research on remote physical education, by adding emotional interactions. Practice has shown that affective, emotional interactions in remote physical education make the system more human-like, with a more harmonious human-computer interaction.

INTRODUCTION

Affective computing is a research area that is attracting a substantial amount of attention in information science, cognition science and psychology. It is based upon making computers react appropriately by taking account of human emotions and feelings. Research in this field must take account of human pattern recognition and the expression, synthesis and transmission of human emotions, so that the computer can respond appropriately and competently.

EMOTION INFORMATION

Emotional information is manifested either internally or externally. External affective information refers to voice, body and facial gestures, as well as other signals. External affective information can be observed, and so can be obtained using mature multimedia technology. Inner emotional information is different and refers to the internal physiological response and is not observed. These include heart rate, blood pressure, pulse rate, respiration, skin vasodilatation, colour and temperature. The more changeable physiological inner emotional information needs biosensors so as to capture the transient changes of information [1]. Therefore, capturing internal and external emotional information is a complex process, because it involves, as stated earlier, voice, gestures and facial expressions, as well as physiological factors, such as blood pressure and hormone levels, which may require special test equipment.

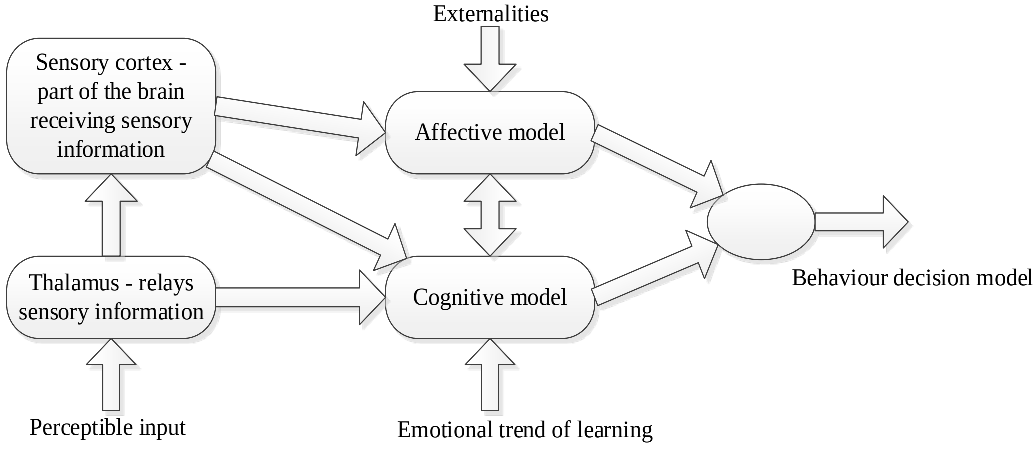

Figure 1: Model of emotion.

The model of emotion is presented in Figure 1. Human behaviour is driven by external stimuli but governed by the existing emotional state. So consideration must be given to the mechanism that changes emotions. Emotional expression is centred on the amygdala, which is a part of the brain that expresses emotions.

Cognition affects emotions, which can lead to a positive internal emotion (reward) or a negative internal emotion (punishment). This can be represented by the following formula [2]:

$$EC = |MO| \cdot \sum_{i=1}^{6} \sum_{j=0}^{2\pi} (e_i W_j)$$

The e_i (i = 1, 2,... 6), represents the six basic human emotions (commonly thought of as disgust, sadness, happiness, fear, anger and surprise) and W_j is the emotional intensity, because the six kinds of basic emotion can be considered to form a ring structure in a two-dimensional co-ordinate system $j \in [0, 2\pi]$. In this model, the external environment provides the sole input signal. The signal can be any factor affecting emotions, such as the weather, noise, temperature, fatigue or another individual displaying an emotion. The external stimulus leads to the sensory input which, in turn, leads to the emergence of an emotion. The emotion may be reward or punishment. Therefore, one can assume the initial learning rate k_1, k_2 = 0. When the value of emotional source function, EC, is positive, the cognitive benefit will increase, otherwise it will decrease [2].

EMOTION MODELLING USING THE HIDDEN MARKOV MODEL

Emotions can change rapidly, driven sometimes by random stimuli. The emotions of sports students may be unobservable. In the establishment of an emotion model, the hidden Markov Model (HMM) was used for the simulation of human psychological activity.

The HMM is a statistical model, based on a Markov chain, proposed at the end of the 1960s and early 1970s. It is a parametric representation, used for describing the statistical properties of a random process, and is shown in Figure 2.

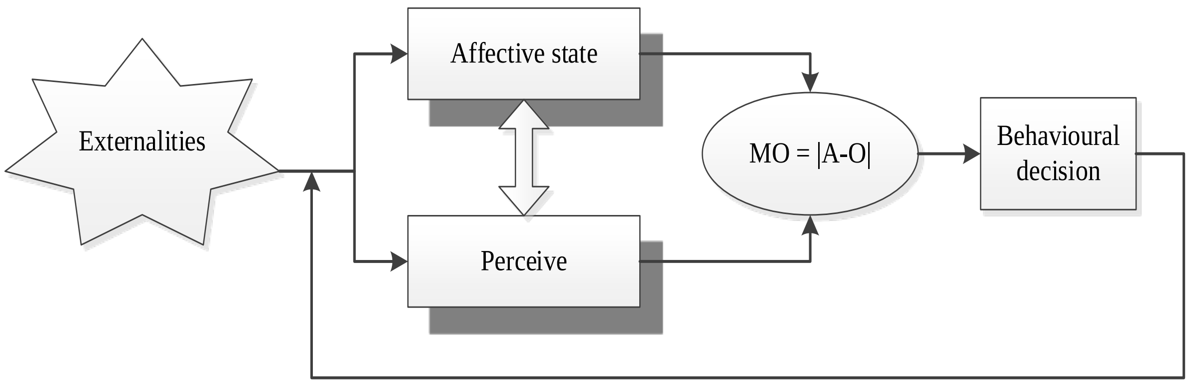

Figure 2: Hidden Markov Model.

Physical Education Model Based on Affective Interactions

The development of distance learning has led to a profound change in physical education. It uses computer networks and breaks the personal constraints of when and where to learn, i.e. learners can learn independently at the appropriate time and place [3]. But, there are still shortcomings in distance learning of physical education. This is especially so in two-way communications, which lack emotional content. This could affect the students' cognitive learning and, perhaps, even mental health. So, some compensation for this lack of emotional content must occur for guaranteeing the quality of long-distance physical education teaching.

The aim here is to construct a model of emotion with a transfer matrix to provide a quantitative calculation method to model a virtual human character. The analysis of affective model test results show that the emotion reaction model simulation is consistent with human affective behaviour. The emotion model can make an unbending machine into a virtual human, with a harmonious human-computer interaction [4].

The emotion model has some simple modelling characteristics:

1. Mood is divided into: general, good mood, bad mood. The number of mood states M = 3, in a hidden Markov Model;

2. Expression is divided into: expressionless, joy, no joy. The number of observing states N = 3, in a hidden Markov Model.

For each mood, a variety of expressions occur, each with some probability. The three-state Markov chain is shown in Figure 3.

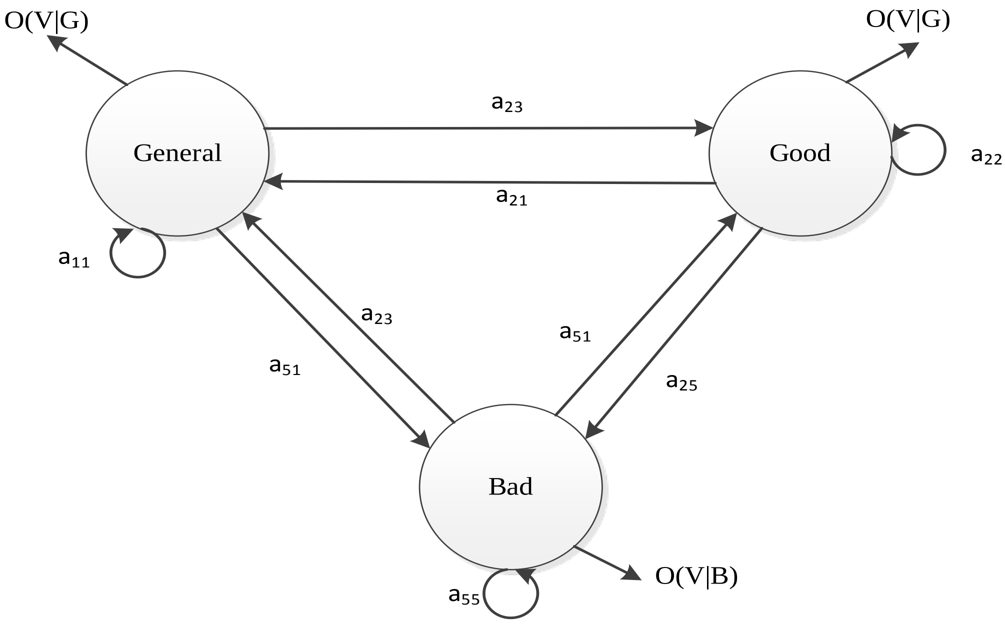

Figure 3: Markov chain.

In the model, any state can be reached from any other state in a finite number of steps. Each a_{ij} coefficient is positive, that is, for any ij, $a_{ij} > 0$. The observed mood values are O(V|G), O(V|B) for the general, the good and the bad moods.

The initial probability vector corresponds to the initial emotional state and is modified according to the history of external stimulation [5]. The mood fluctuations decay with time, unless there is a new stimulation.

Most of the time people are calm. A virtual human interacting with a human should initially be in a calm state of mind. With human-computer interaction, the virtual human's emotions will vary in accordance with human emotional responses. A virtual person without incentive will have an initial probability vector:

$$\pi = (\pi_1, \pi_2, \pi_3) = (1, 0, 0)$$

In this, the *calm* state probability is 1 and the probability of *happy* and *unhappy* is 0. With human-computer interaction, virtual human emotions will gradually accumulate, triggered by stimuli, in accordance with human emotional reactions.

Emotional Virtual Human Simulation

Humans like other animals, respond to *reward* and *punishment* signals. *Reward* signal refers to the stimulation of the brain's pleasure centre; *punishment* refers to stimulation of the brain's pain centre. Because of this, the emotional system signals can be seen as two dimensional; namely, positive stimuli consisting of *little reward* to strong *reward* signals, and negative stimuli consisting of *little punishment* to strong *punishment* signals. Different signals correspond to different emotion model parameters, as shown in Table 1. The emotional reaction of a virtual human is determined by different combinations of parameters [6].

Table 1: Different emotion model parameter.

Stimulus signals	Emotion model parameters	Stimulus signals	Emotional model parameters
A little reward	$A_R(1)$, $B_R(1)$, $O_R(1)$	Little punishment	$A_P(1)$, $B_P(1)$, $O_P(1)$
Reward	$A_R(2)$, $B_R(2)$, $O_R(2)$	Punish	$A_P(1)$, $B_P(1)$, $O_P(1)$

According to different combinations of emotional virtual human stimulation, there will be various emotional reaction results of virtual human [6].The simulation study was performed using MATLAB software. Subliminal stimuli were divided into four types: *a little reward*, *reward*, *a little punishment* and *punishment*. Thus, for each stimulus, there was a corresponding state transition probability matrix and visible symbol probability matrix.

The initial value used for the model can be determined by experience. The effect of external stimuli on various emotional states varies depending upon individual characteristics. The emotional state transition probability array for a virtual human accepting a *reward* signal is:

$$A_R(2) = \begin{bmatrix} 0.216 & 0.782 & 0.002 \\ 0.0063 & 0.935 & 0.002 \\ 0.341 & 0.632 & 0.026 \end{bmatrix} \qquad B_R(2) = \begin{bmatrix} 0.166 & 0.834 & 0 \\ 0.095 & 0.905 & 0 \\ 0.287 & 0.713 & 0 \end{bmatrix}$$

CONCLUSIONS

Emotion modelling technology, such as emotion recognition and face output technology can be used to capture students' emotional state information. These can be quantified using statistical methods to determine input stimuli. Remote physical education teaching systems can use affective responses to produce virtual PE teachers.

The main work reported here was to establish the emotion model and the ability to give the machine emotional responses to stimuli. The emotion model simulates the human brain, with input stimuli, simulation of the emotional state resulting in an emotional output.

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