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Learner attending auto-monitor in distance learning using image recognition and Bayesian Networks

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ABSTRACT

Distance learning is one of the common education methods. Its advantage lies in that the student can learn at anytime or anyplace. However, such a learning mode relies highly on the dependence of the student. Under different environments and conditions, not all the students can be attentive. In this research, an auto-detection system has been designed, using image processing and recognition technique, for defining the facial expressions and behavior easily found when a learner is inattentive or in bad mentality under distance learning environment. From the learner's facial expressions and behavior features, the attentiveness of the student during distance learning can be determined by Bayesian Networks Model.

After implementing the system of this research, and performing practical test, it is found that the accuracy of identifying the features of bad mentality and inattentive behavior is high. From Bayesian Networks assessment and inference, the learning attentiveness of the student can be determined precisely to have the teacher control the learning condition of the student explicitly.

1. Introduction

Distance learning has been developed rapidly in the past few years. Many information technologies are applied to the tools of distance education. Currently, the most common distance learning method is to learn with personal computer and computer network (Harasim, Hiltz, Teles, & Turoff, 1995). In an attempt to enhance the interaction between the teacher and student, and truly understand the student's learning process and condition, generally, e-mail and discussion forum are used as interaction tools (Eisenstadt & Vincent, 1998; Wolfe, 2000). The student can login to the website freely, and decide the time for learning online. As long as the schoolwork given by the teacher is completed, and the related reports are handed in or the evaluation is made, then, the student can earn the credit.

Although the student can choose to learn at the time convenient for himself/herself, the time chosen might not be the time when the student can learn with the best mentality and greatest attention. According to the study, effective time management is the best learning strategy, and also a significant factor for academic achievement (Walter & Siebert, 1993). However, in distance learning, how can the teacher know whether the student is attentive, and whether the student has left the seat or not? If the student does not have an active attitude towards learning, it is quite difficult for the teacher to have the student obtain the learning achievement (Kimble, 1967). In an attempt to understand the student's learning condition, in many researches, focus has been placed on computing the number of times in interacting in the discussion or the hours of participating in the course as the base for evaluating the student's participation (Hwang & Yang, 2008; Pena-Shaff, Martin, & Gay, 2001). However, the number of times is unequal to the quality of discussion content. A student with a high participation frequency is not equivalent to a student who really participates attentively (Mason, 1997). As the technique for precisely analyzing the discussion content is not mature enough yet (Rourke, Anderson, Garrison, & Archer, 2001), in order to earn the credit hours, many distance learning students might just login online without sitting in front of the computer or participating attentively. However, by doing so, the student can still earn the credit hours. As this does not nurture the attitude of the student towards learning, it makes the credits of distance learning fail to be completely accepted.

If the teacher can monitor the learner, and supervise the undesirable learning conditions, for instance, drowsy, distracted, or doing other things, then, the learning process of the learner can be controlled effectively. Image recognition technique, mostly applied to the fatigue detection of drivers, can detect the mentality by facial images (Hamada, Ito, Adachi, Nakano, & Yamamoto, 2002; Smith, Shah, & Lobo, 2004; Ueno, Kaneda, & Tsukino,

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1994). Nevertheless, as the focus is mainly on fatigue features, and either no desirable comprehensive assessment is made or other special device is needed, it is not suitable to be applied to distance learning directly. Moreover, learning inattention involves not simply mentality, but also other inattentive behavior.

However, by modifying and adding the inattentive behavior detection to such a technique, it can be applied to the distance education for detecting the students' learning conditions, for instance, the increase of blinking frequency induced by fatigue, yawning, gazing around inattentively, starting other computer programs, or leaving the computer. As the inattentive conditions of the student in learning process is recorded and reported to the teacher, it can help the teacher to control the attentiveness of the student and urge the student to participate attentively for ensuring that the student of distance learning is in good learning conditions (Hwang & Yang, 2009).

In this research, the existing defects of distance learning are explored from the perspective of learning attention. In order to help the teacher or parents take hold of the student's learning to ascertain that the student is learning in good condition, and being attentive to the study while accumulating the participation hours, a mechanism is designed and implemented for determining the student's learning condition. In this mechanism, no other device is required to be installed. Only a Webcam is needed for capturing the facial image in real time. Then, just detect the student's mentality and attentiveness in participating the course by auto-detection with image recognition technique. Finally, with Bayesian Networks assessment, the probability of misjudgment can be reduced. The detection performed by the mechanism can help the teacher to control the student's learning condition, and avoid the student to have a lazy attitude towards distance learning so as to guaranty the effects of distance education.

Section 2 is focused on exploring the use of image recognition for identifying the expression features in detecting the possible learning condition of the learner, and on exploring the application of Bayesian Networks assessment. Section 3 is the description on the technique of the design and implementation of the full-time auto-detection mechanism. Section 4 is the practical evaluation of the accuracy of the features detection of image recognition and that of Bayesian Networks assessment. Finally, the conclusion and the directions of future researches are proposed.

2. Related work

The learning achievement of students is the knowledge acquired from formal curriculum arrangement and education design (Brown, 1981). Students with lower learning achievement are usually those who are passive in learning, who only think of completing the schoolwork quickly, and who fail to better understand a problem actively (Anderson, 1981). Thus, to achieve the expected learning achievement, it is essential for the learner to be attentive in participating in the course.

In distance learning, it is also necessary to urge the student to be attentive to the course. Using the number of times in interacting in the discussion or the hours of participating in the course as the base for evaluating the student's participation (Pena-Shaff et al., 2001) cannot really take hold of the student's learning condition. The number of times is unequal to the quality of discussion content. A student with a high participation frequency is not equivalent to a student who really participates attentively (Mason, 1997). Especially in distance learning, as it is not easy for the teacher to know the student's condition, the student can easily be distracted, for instance, drowsing, turning head, or accessing other application windows. Consequently, some norms are needed to change the learner's attitude (Saleem, 1994).

Under the rapid development of information technology, it is no longer a difficult technique to detect and control the condition of the student in participating in the course. When the learner is drowsing, there are the following mentality features: eyes closure, gaze around, yawning, head turn, and wrinkle appearance (Gu & Ji, 2004). Drowsy detection has been applied to the drivers (Hamada et al., 2002; Smith et al., 2004; Ueno et al., 1994). When the driver's attention is decreasing, the system has to alert the driver through some warning messages, because the appearance of drowsiness may result in a traffic accident. There are many mentality detection techniques. Most of the researches have focused the mental measurement on eyes closure and yawning through the image processing and classification techniques to obtain the driver's mentality (Haralick & Shapiro, 1992). This includes single feature detection and integrated features detection. Eriksson and Papanikotopoulos (1997) have used the tracking techniques to find out the location of the eyes. After the process of eyes gray scale, the eyes pixels distribution is calculated for getting the histograms which represent eyes opening or eyes closing. Then, the driver's mentality could be determined by the histograms. Ito, Mita, Kozuka, Nakano, and Yamamoto (2002) have obtained the locations of the upper and lower eyelids and calculated the vertical pixels distribution. If the pixels distribution exceeds the threshold, the system would infer that the driver is with closed eyes. When the period of eyes closure exceeds the threshold, the driver would be inferred to be drowsy.

Horng, Chen, Chang, and Fan (2004) have indicated that when the eyes are closed over five consecutive frames, the system would define that the driver is dozing. Other mentality detection has been applied in yawning detection. When the mouth open exceeds the threshold T, it means that the driver may be drowsy (Wang & Shi, 2005). The measurement of the mentality detection is classified to four types, physiology, behavior, vision, and subjective performance. In the measurement of physiology and behavior, some devices are needed to be equipped on the body (Wang & Shi, 2005).

Gu and Ji (2004) have indicated that the Bayesian Networks is the best option to deal with such an issue of the mental detection. Bayesian Networks is one of the tools for making decision, which is presented by the graphics. Probability Networks, Causality Networks, and Knowledge Map are all the aliases of Bayesian Networks. It can process fragmented data according to the evidences input to infer the posterior probability. Bayesian Networks can be used for assessing and predicting the learner's behavior (Xenos, 2004).

Most researches only focused on mentality detection, but students could do other things before computer in distance learning, not bad mental (Li & Ji, 2005 #52). Some researches utilize real time questions in the courses of studying (Pena-Shaff et al., 2001 #6). But students could be attention when the question appeared, others could be not attention. If questions too appeared often, it would influence students. If questions were too simple, they could answer it currently, and need not participate in learning. It is hard to control the difficult degree and frequency. The research mechanisms can detect it voluntarily, need not interrupt the learning. Integrating the related image recognition with detection technique for detecting the mentality and attentiveness of the learner, and making assessment with Bayesian Networks can reduce detection misjudgment and enhance the assessment accuracy. Applying such a technique to distance education can help the teacher control the learner's learning condition, and avoid the student from being distracted and lazy.

3. System structure and detection procedure

The system of this research is configured with Pentium 2.4 MHz CPU, 256MB memory, Webcam (0.3-Megapixel), for development