Cyber Assistant: Interface for Online Children Education
(サイバーアシスタント　子供オンライン教育インタフェー)

開発代表者：Hua Wang

１．Abstract (要約)

In our project, eye movement tracking and other physiological measures were used to personalize character agent behaviors (affective and instruction) in an e-learning environment for children. A prototype system reacted to learner's eye information in real-time, recording eye gaze and pupil dilation data (plus hear rate and skin conductance) during learning process. Based on these measures, character agents inferred the attentional and motivational status of the learner from eye tracking data and respond accordingly with affective and instructional behaviors. Character agents (avatars) engaged and directed the learner's attention while providing both generalized system help, and personalized advice about the learning content. Observations from preliminary usability studies with our system suggest that e-learning character agents reacting to eye gaze and physiological measures may heighten learner, especially young children's concentration and lead to more effective learning. Implications for design of multi-avatar learning interfaces are also discussed.

２．Background (背景及び目的)

2.1 Motivations

Children can lose motivation and concentration easily, especially in a virtual education environment that is not tailored to their needs. As Palloff and Pratt noted "the key to success in our online classes rests not with the content that is being presented but with the method by which the course is being delivered" (p. 152) In traditional educational settings, good teachers recognized learning needs and learning styles and adjusted the selection and presentation of content accordingly. One challenge in developing productive online learning is to create more effective interaction between online educational content and learners. A related concern is how to achieve a more natural and friendly environment for children in e-learning.

We identified the following strategies for addressing these concerns: a) increase motivation by stimulating children's interest in learning; b) Detect the learning styles of each student and study performance record and use character agent to provide interactions according to each student.

３．Project Summary (プロジェクト概要)

In this part, we describe the way that Cyber Assistant works, focusing on the following inputs to the character agent that is acting as a mediator between System and Learners:

- Real-time Eye-awareness and Interaction (including eye input and pupil dilation)
- Non real-time feedback from eye trace data and eye movement information, plus physiological data

- Stored Study Performance Information

Figure 1 shows the basic diagram of CYBER ASSISTANT. Real time feedback from eye movement is detected by eye tracking, and the character agents use this information to interact with learners, exhibiting emotional and social behaviors as well as providing instructions and guidance to learning content. Feedbacks are also obtained from the student performance knowledge base. The information about student's past behavior and performance is available and agent can react to learners based on the information.

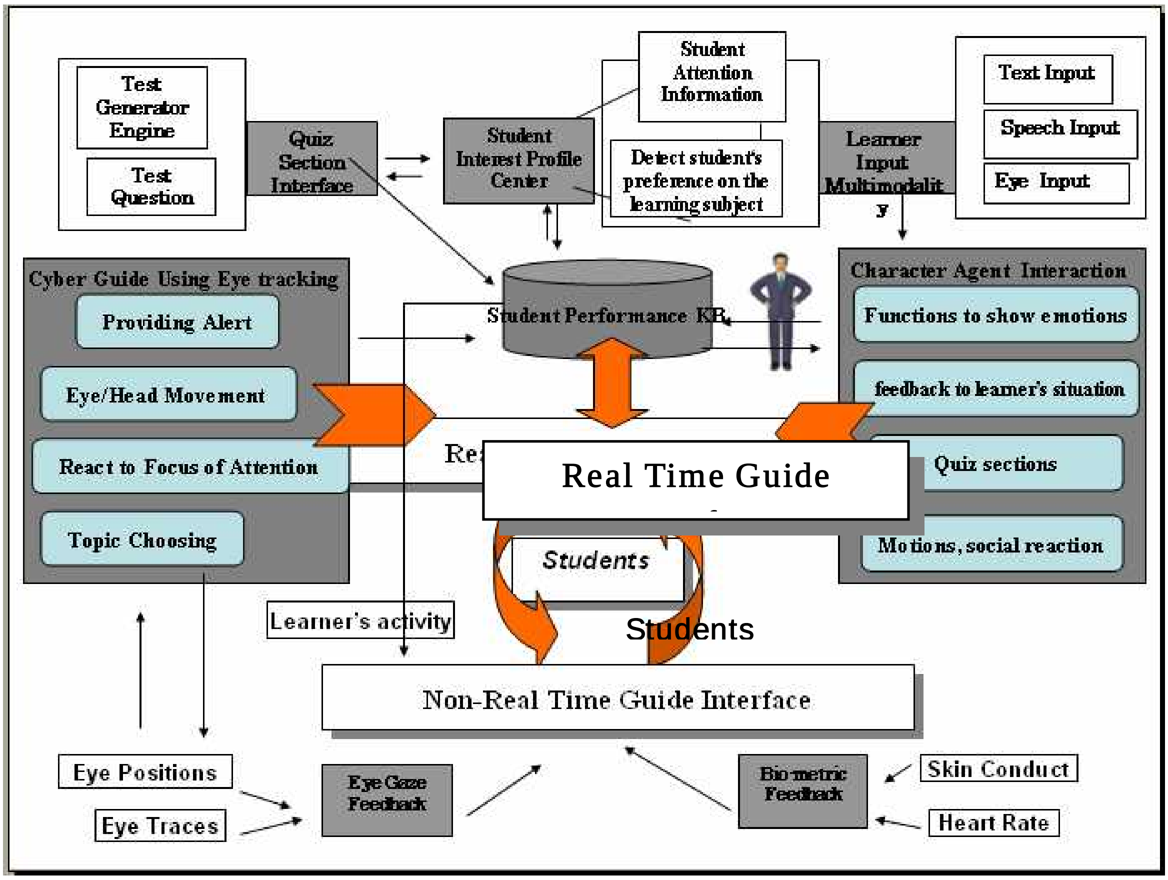

Figure 1 System Structure

4. Development Result

In CYBER ASSISTANT, one or more character agents interact with learners using synthetic speech and gestures (the present system focuses on gestures created by head movements which are inferred based on changes in the position of the eyes). The characters are controlled by a version of MPML. The character agents perform several functions/behaviors including the display of different types of emotion. Agent emotional response depends on the learner's performance. For instance, an agent shows a happy/satisfied emotion if the learner concentrates. In contrast, an agent shows mild anger, or alerts the learner, if he or she seems to lose concentration. The agent also shows empathy when the learner is stuck or gives a wrong answer. In general, the agents have roles as mediators between the educational content and the learner.

The character agents carry out the following tasks.

- Mediate between the learner and the application (helps to find more information, helps to decide which information to use explains the educational material.
- Explain the study material, give hints (if learner is very frustrated, give a hint), get attention (if learner

does not look at the target object, alert the learner).

- Move around the screen to direct user attention and highlight information
- Administer quizzes and provide personalized feedback based on the results
- Display emotions, with appropriate accompanying facial expressions
- Maintain, a knowledge base contains the log of the agents' feedback to learners as well as the activity records of the learner.

One of the main tasks of the character agent is to administer quizzes and provide personalized responses. Here the agent acts as a tutor and also displays empathic emotions (Figure 2).

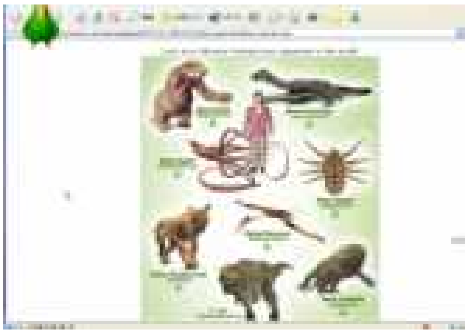

Figure 5 Interface Appearance

Eye-tracking Interface Overview

Analyzing eye movements provides information on how learners look at images, principally in terms of where they look and how long they spend looking at different objects. Changes in eye position can also be used to infer head movements. Applications using eye-tracking can be diagnostic or interactive. In diagnostic use, eye movement data provides evidence of the learner's focus of attention over time and can be used to evaluate the usability of interfaces. In interactive use, a system responds to the observed eye movements which can thus serve as an input modality. In our system, we use eye gaze information for both real time feedback and non real-time collection of eye-tracking statistics.

Eye Information in Real-Time

Topic Choosing

Information about where learners are looking shows what they are currently focusing or concentrating on. For instance, in Figure 7 there are three pictures or panels and the learner is looking at the middle one. If the learner "gazes" at that panel (indicated by the eye dwell time being longer than a chosen threshold), then the system will treat it as a selection input and will zoom in and give more details on the associated topic.

System Alert

Character Agent can remind learners to concentrate on a topic. For instance, if the student keeps looking away from the screen, the agent may give warning feedback.

Feedback on Concentration: Get Students' Interest or boredom

When learners show interest in the current content the character agents provide positive reactions. However, if a learner shows less interest (as indicated by a smaller amount of pupil dilation in the eyes) then the interface will inquire if the learner is tired or bored. Boredom or fatigue may also be interred based on lower overall activity in terms of mouse clicks and key selections.

Rest and Change Learning Topic to remove student's boredom

When agents find out that the student keeps lower concentration on current topic after agents provide positive feedbacks, the interface will provide the rest time or change to other topics to re-establish the concentration. In this example, the eye tracker collects eye gaze information and the system then infers what the learner is currently attending to (focusing on). This information is then combined with the learner's activity records, and an appropriate pre-set strategy is selected. The character agent then provides feedback to the learner, tailoring the instructions and emotions (e.g., facial expressions) to the situation.

Input Modality

When students wan to show yes, no responses, or ask the questions, they can use the gesture of eyes/head. Light of sight goes up to down indicate yes, left to right indicates no, head moves clockwise rotation indicates questioning.

Physiological feedback from learners

Affective arousal can be determined from skin conductance (SC) data and valence (positive vs. negative reactions) can be inferred from measures of Heart Rate. SC varies linearly with the overall level of arousal and increases with anxiety and stress. Skin conductance and heart rate are currently used as bio-signals in CYBER ASSISTANT although other physiological measures (signals) may be added in future.

Bio-signal Interface

In order to investigate subjects' overall affective state during the presentation, their bio-signals were analyzed. Since the signal values of subjects may vary significantly depending on individual differences, room temperature, and other factors, physiological values were first normalized. Figure 11 shows the sensors we used in the system. The physiological sensors were attached to the learner during the learning process. Figure 12 shows the appearance of the Bio-signal interface. In the interface, the GSR and HR data are

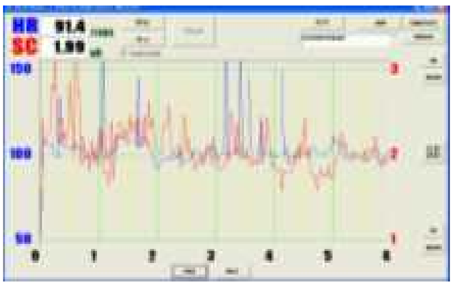

Figure 12 Bio-sensor Interface Appearance

We also got feedbacks from the subjects (Figure 16). Compared to the one avatar interface, the multiple (two) avatars interface was easier for students to get information in. The subjects indicate that with only one avatar in the interface, they felt that they were learning by rote (like being lectured to), but with two avatars they could listen to the interaction between the two avatars and this made them feel that they could be more active participants in the learning process. As an example of the beneficial effect of inter-avatar interaction in the multiple avatar interfaces, one avatar sometimes asked the other avatar a question which was responded to. This type of interaction helped make the learning process seem more natural and provided the students with more time to think.

Our system uses a two-dimensional graphical window to display avatars and education content. We use MPML to create motion and emotion functions for character agents. In addition, the system is built on Java, JavaScript, XML and HTML. The interface shows the education content, flash animations, movie clips, and agent (avatar) behaviors. The interface is built on several different layers to provide different levels of content. (Figure 20)

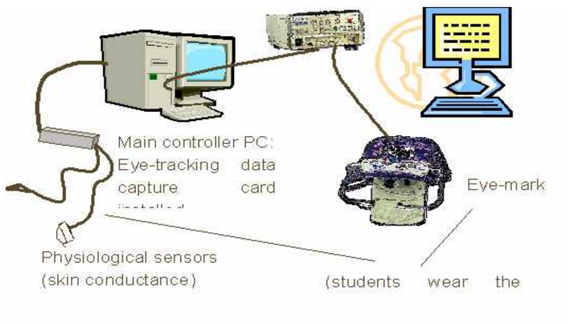

Figure 20 Experiment Setup

5. Feature of the development result

Current, there are a lot of kinds of e-learning software for children. But they are more concentrating on the education contents. As we mentioned before, Palloff and Pratt noted “the key to success in our online classes rests not with the content that is being presented but with the method by which the course is being delivered” (p. 152). The key to success in developing productive online learning especially for children is to create more effective interaction between online educational content and learners. A related concern is how to achieve a more natural and friendly environment for children in e-learning. Our software is more focused on the way to convey the learning contents to the learners and the interaction between them by using eye movement and pupil dilation and etc.

The characters have the following characteristics:

– Personalized response based on quiz.

The quiz section tests how well students learn (thereby providing feedback on the learning process). Here the agent acts as a tutor and also displays empathic emotions (Figure 3).

– Display of Emotions and Detailed explanation

Agents have tens of emotion and facial expression to interact with learners and give emotional feedbacks. Agents speak to the learner to emphasize the knowledge and attract attentions.

– Feedback from learner’s performance

In contrast to the Data Base that contains the educational content, the knowledge base contains the log of the agents’ feedback to students as well as the activity records of the learner.

– Real-time Eye trace information

By getting learner’s eye position information and concentration, agents can move around to highlight the current learning topic to get learner’s attention. For instance, with eye gaze data, agents react to the Eye information in real time such as moving to the place, showing the detail information of the content people are looking at, etc.