INTELLIGENT INTERFACE TO SUPPORT WEB-BASED INTELLIGENT TUTORING SYSTEM

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Abstract

World Wide Web is an important medium for the education in the present millenium. To date, some courses have been made available through Internet (DeVoe, 1998; Finkelstein and Dryden, 1998). Most of the courses available on the web are static hypertexts that do not promote interactive teaching and learning. Other courses have been developed as Web-based Intelligent Tutoring System. Research on the past and the current trends of web-based courses reveal that it is vital to provide an interface so that the interaction between students, instructors and course contents are guaranteed. This paper proposed an intelligent interface suitable for any web-based education, particularly to support Web-based Intelligent Tutoring System. Such an interface utilizes Speech Recognition and Natural Language Processing.

1.0 Introduction

Particularly, teaching and learning can be divided into two categories namely, offline learning and networked learning (Goeller, 1998). Offline learning limited to the physical environment where the interactions can be performs. Whereas in networked learning, the learning experience is held through a computer network and collaborated using knowledge base.

Offline learning such as classroom learning refers to the traditional educational system, where teaching and learning are performed in a physical environment; usually classroom. Teaching is usually conducted by human teacher or tutor in direct conversation. Additionally, students can give feedback to the presentation. Such conversation is a two-ways communication network where two parties can involve and participate in the conversation at the same time. Online learning such as web-based learning and networked CD-ROMs are virtual learning systems where teaching and learning do not require physical place. Virtual learning is performed over computer networks such as Internet or Intranet. Mostly, Internet receives high attention due to its availability and accessibility.

To date, World Wide Web has become one of the most important mediums for teaching and learning. It has been discovered as a supremely flexible and convenient tool to support education at all levels (primary, secondary or high level of institution). Web-based applications give an advantage to the student to control the accessibility of the materials and class attainability (Owston, 1997). This implies that the student can simply access the material from any places such as cybercafe, library, computer lab or home. The flexibility offered by Internet, is however can turn into an extensive waste of time, effort and resource if the users do not have enough knowledge and skill in using the Internet effectively.

Instructors for example, need to have the knowledge, required skills and adequate training to utilize the computer and facilities. Instructor's roles are guiding the students into the right direction, preparing the course materials, answering the student's questions and providing the students with the latest information. Such responsibilities will never be fulfilled if the instructor himself do not have enough knowledge on the current information and the technology itself. Therefore, organizations need to provide the instructors with basic knowledge of developing and preparing the course materials on the web. On the other hand, students need to have the basic knowledge on how to use the computer and browse or navigate the Internet. In addition, the students need to have the ability to use the skills effectively to support their learning process (Papenfuse, 1995).

In supporting web-based education, WWW itself has several weaknesses such as interactivity, navigation tools and simulation (Fadzilah and Wan Hussain, 1999). Limitation of WWW as an interactive learning tool is HTML (Hypertext Markup Language) which cannot handle sophisticated interactive applications. Hence, several applications such as Flash and VR (virtual reality applications) require installations of specific engine to support the applications. In addition, limitations in WWW navigation tools could cause the "lost in cyberspace" problems, where users fail to return back to where they start and loose their trail while browsing.

Such limitations however, are not the main issues in delivering web-based education. Mostly, researchers in this field believe that interaction and interactivity are the most important aspect to consider when developing web-based education programs or application. Hence, many researches has been conducted to design and develop the best model for web-based education, which includes the graphical interfaces, simulations and animations. Some of the models employed are multimedia techniques (Kaplan, 1997; Tengku Siti Mariam, 2000), artificial intelligence techniques such as intelligent tutoring systems (Koedinger *et al.,* 1997; Warendorf and Tan, 1997; Goldstein, 1997), and intelligent agents (Lewis *et al.,* 1998; Andre *et al.,* 1997),

This paper discusses web-based education, which concentrates, on web-based Intelligent Tutoring System. An intelligent interface, that utilizes speech recognition and natural language processing to support the web-based ITS is also discussed. The combination of Intelligent Tutoring System and intelligent interface forms the electronic model for interactive teaching and learning in cyberspace.

2.0 Intelligent Tutoring System and WWW

Many web-based educations are expected to be used by different groups of users without the assistance of human teacher (Brusilovsky *et al.,* 1998). The approach is ideal in reducing instructors' workloads. However, a study by Dyreson (1996) indicate that instructors have to increase their working hours and do additional works, such as replying students email, updating the course material and others. The limitation of Dyreson approach in developing web-based applications is the lacking of advance features such as automatic feedback or intelligent tutor, which can handle the interaction automatically. Accordingly there is a need for systems which can adapt to users with very different backgrounds, prior knowledge of the subject and learning goals (Brusilovsky *et al.,* 1998). Therefore, an Intelligent Tutoring System is vital in supporting web-based education.

Intelligent Tutoring Systems is one of the artificial intelligence techniques that can simulate the human tutor in delivering courses. Generally, Intelligent Tutoring Systems (**Figure 1**) consists of four main components namely, expert system, pedagogy module, student model and user interface. Expert System has the ability to guide the student in solving the problems and measure the student performance. Pedagogy module is used to control the interaction between the student and the system. Student model is used to determine student level and their progress during the teaching and learning process. Communication between student and systems is through the interface. The interface used for the proposed model is the WWW. ITS will provide the student with suitable course material and guide the student to increase their performance (see Warendorf and Tan, 1997; Stern and Woolf, 1998).

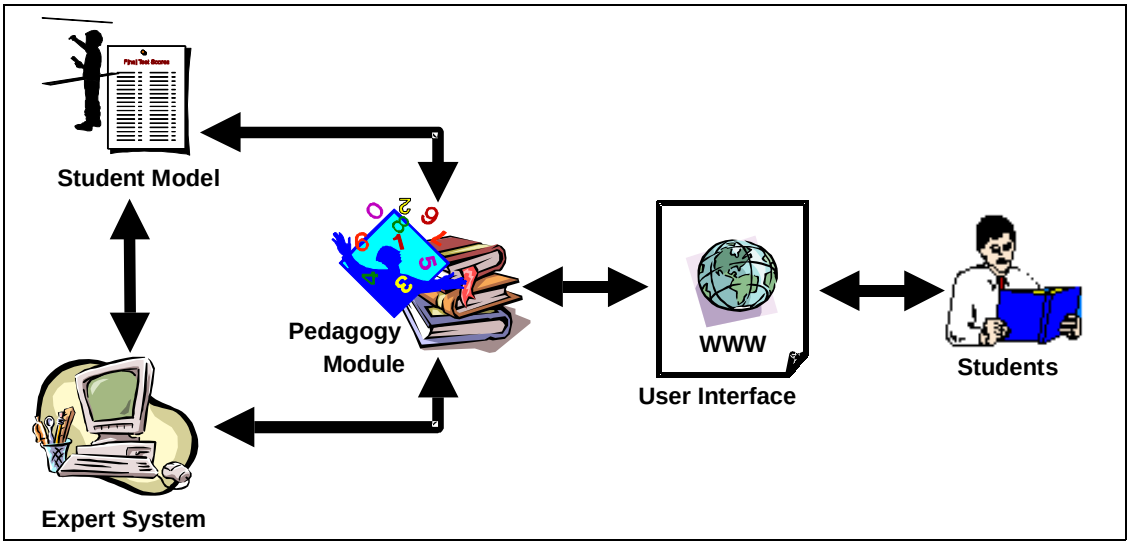

Figure 1: Intelligent Tutoring System

ITS was developed as an alternative to Computer-Assisted Instruction (CAI) or Computer-Asisted Learning (CAL) (Jamaludin *et al.,* 1989; Meenakumari and

Radhakrishna, 1991). At once, central issues regarding delivery of learning material are the distribution of CAL, sharing of learning materials and collaborative development (Robinson *et al.,* 1998). However, structured and proper design of ITS for the web-based education could enhance the distribution of course material and encourage collaborative learning. Meenakumari and Radhakrishna (1991) indicate that ITS exhibits intelligence in the following ways:

1. ITS has knowledge of the subject being thought (Domains Expertise).
2. ITS has current information regarding the student knowledge (Student Model).
3. ITS can articulate the solution or the thinking process and can communicate with the students (Communication Expertise).
4. ITS possesses the knowledge regarding the pedagogical aspects of teaching and is able to choose the best teaching strategy (Teaching Knowledge Expertise).
5. ITS has learning capability (Learning Expertise).
6. ITS has the heuristic problem solving capability.

Many ITS have been developed by focusing on specific domains such as Algebra (Koedinger *et al.,* 1997), Data Structures (Warendorf and Tan, 1997) and military program (Goldstein, 1997). Koedinger *et al.* (1997) indicates that ITS called PAT (PUMP Algebra Tutor or Practical Algebra Tutor) is a practical approach mainly in its pedagogical and going beyond as a fully functioning system. The study shows that students in experimental classes outperformed students in comparison classes (*see* Koedinger *et al.,* 1997 *for details on the study*).

Goldstein (1997) developed and evaluated the effectiveness of ITS for U.S. military distance learning program. ITS was directed to increase the effectiveness of training by tailoring it to students' backgrounds and knowledge and reduce the cost for training. ADIS (or Animated Data Structure Intelligent Tutoring System) was integrated with Graphical User Interface (GUI) to enhance students' understanding of data structures for Data Structures course (Warendorf and Tan, 1997). The graphical interface was used to display the course materials and allowed graphical manipulation of the data structure. ADIS allow platform-independent standalone usage or Internet delivery so that it can be accessed using any browser.

Current development of web-based ITS is to develop the teaching and learning space suitable for both instructors and students and decrease the cost. Instructors prepare the course materials and monitor students progress (outside the system). In addition, instructors evaluate the performance of ITS and maintain the knowledge base. Therefore, ITS is always updated and is able to handle students with different background and level of knowledge. On the other hand, students have the flexibility to access the materials regardless of the place and time. Hence, the interactions between the students and other students, students and the course contents and students and instructors will be maintained.

Such interactions however, could not be fully performed if users are constrained with the available devices such as keyboard and mouse. It is believed that the nature of educational processes and the capabilities of educational technologies should be adequately considered in designing an ITS (Kinshuk and Patel, 1997). Although, it is an

advantages for an ITS to be used over WWW without special interface programs (see Okazaki *et al.,* 1997), WWW alone is not enough. A special interface facility to support interactive tutoring would be an adequate approach. The interface is cooperated with WWW for easy access by users.

3.0 Intelligent Interface

An interface is a medium for two or more people to communicate among each other. In general, interface is a link or connections between two elements, in this case the human and the computer (Malone *et al.,* 1984). Study has indicated that the natural behaviour of the user interface is a primary determinant of the "friendliness" or "usability" of the systems (Scvaneveldt *et al.,* 1984). It was agreed that intelligent interfaces should make an application easier to use and understand (Bonar and Liffick, 1991).

According to Chignell (1987), the first step in the development of intelligent interface to allow the students to have direct access to the online database is the construction of a conceptual representation that maps the user's model of the topic area onto the database. Chignell's work was on the development of computer assisted instruction (CAI) based on hypertext and the concept of navigation, and the development of improved interfaces for online information retrieval based on the concept of referential instantiation. Chignell's idea on improving humanities in interfaces reflects the objective of this paper to proposed an intelligent interface using artificial intelligent technology for an ITS.

Neal and Shapiro (1991) introduced CUBRICON (the CUBRIC Intelligent CONversationalist) using artificial intelligent technology, combining speech recognition, natural language processing, graphics and pointing gestures for interactive dialogues between human and computer. CUBRICON was designed for air force army with complex architecture to support the army needs. Even though, the system was so complex, the main idea of CUBRICON is to have an interface, which can support interactive direct communication between computer and human.

The proposed intelligent interface (as in **Figure 2**) consists of speech recognition and natural language processing. Both techniques are cooperated with the WWW technology, where WWW will become a medium for connecting users with the ITS. Preprocessing is performed through user input (voice and natural language text) by extracting lexicons or keywords. The keywords are then transferred into ITS. ITS will respond to these keyword after matching the keywords with the knowledge base. The feedback from ITS would be in the same form as the input.

The complex operations will be performed by in intelligent interfaces through Natural Language Processing (NLP) and Speech Recognition (SR). The complex process and architecture in NLP especially in Malay language have been discussed in earlier works by Ahmad Zaki (1987), Ahmad Zaki *et al.* (1989), and Ahmad Zaki (1991). The current research on NLP focuses on representing the advanced features in NLP by extracting the meaningful information from word history (Chelba, 2000) and provide meaningful

representation of the language (Androutsopoulos, 2000). In addition to the NLP, SR plays an important role in any proposed model. SR is one of the most interesting and challenging aspects of man machine interface (Wan Jalaluddin *et al.,* 1990). Voice input will go through the SR before the NLP. Features from the voice will be extracted and a complete representation of a sentence will be developed and passed to the NLP for further process.

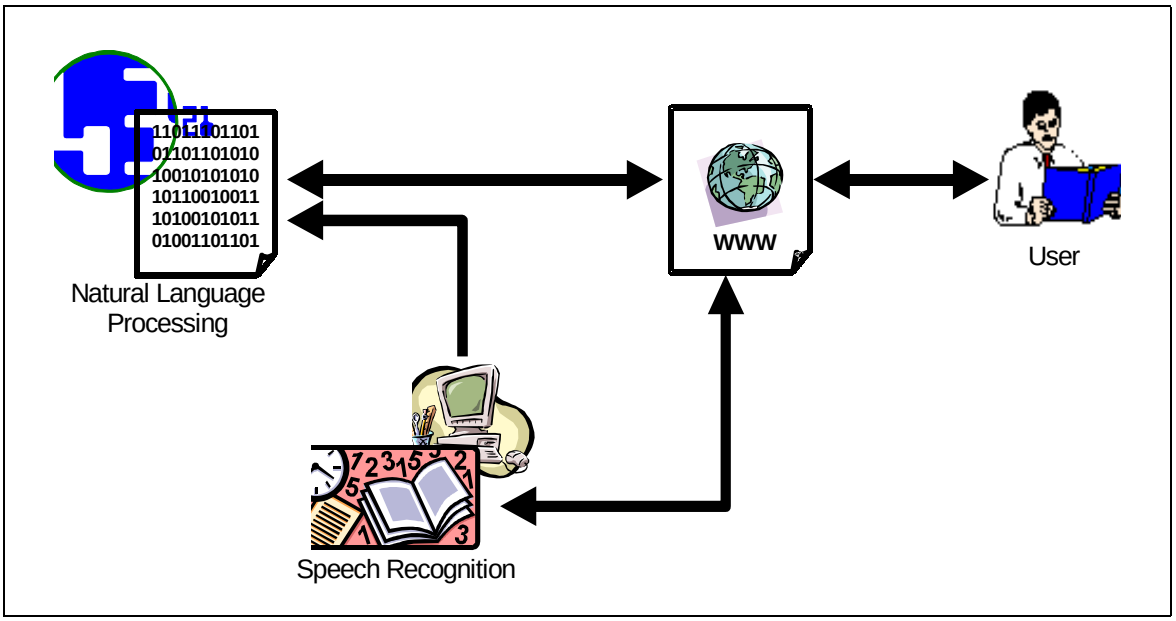

Figure 2: Intelligent Interface

4.0 Conclusion

The current and future trend of education focuses on WWW as a medium for the interactive teaching and learning. The WWW browsers overcome the shortcomings of traditional Computer Based Training by affording platform independent and improve the process of preparing and updating training materials (Goldstein, 1997). In addition, WWW provides the educational environment according to the following main options (Or-Bach, 1998):

- Collaboration-among the students and between the teaching agents.
- Integration of multiple sources of relevant knowledge consisting of various types and media.
- Increase in number and variety of students.
- Evolution of learners communities (and teachers communities).

Studies show that different students have different needs in terms of teaching methods: discovery learning, presentation, rote learning etc. Hence, it is difficult to provide many teaching strategies within the same framework. However, with the assistance of ITS, teaching and learning would be more organized, reducing an instructor's workload.

However, to ensure ITS provides an interactive teaching, learning plus maintaining interactions between: students and course materials, students and instructor and students and other student, an intelligent interface is essential to support ITS.

The limitations of current Graphical User Interface (GUI) put barriers in a user's mind. Users need an interactive interface that can support natural input and receive the output or the feedback in the same form. Wallace *et al.* (1995) indicates that errors and speed in menu selection interface will increase user stress. Therefore, artificial intelligent techniques such as NLP and SR are the potential techniques in enhancing communication and interaction between man and computer.

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