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A FLEXIBLE AND INTERACTIVE INTELLIGENT AGENT ORIENTED E-LEARNING MODEL OF APPLICATION SOFTWARE FOR GENERAL USERS OF COMPUTER

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ABSTRACT

Web based learning; in other words, e-learning is getting popular now-a-days. This paper presents a flexible and interactive intelligent agent oriented e-learning model of Application Software for easy learning of mass people. The main intention of this paper is to describe the model that would act as a prudent teacher to teach and test the aptitude of Application Software based on available knowledgebase. Here, we provided an overall view of the proposed model and then described in brief about the purposes of different components of the model. This paper provides a visualization model based on Web Online Force-Directed Animated Visualization (WebOFDAV) and also points out the implementation issues. The application software taken under consideration in this paper is the Office Automation package. The proposed model is designed to be compatible with other application software as well. An agent based software system under this model is in development phase with necessary linguistic support.

Key Words: E-learning, Agent oriented learning, Software Agent, Interactive Learning, Easy Learning, Virtual Teacher, Mass Computer Education, and Application Software.

1. INTRODUCTION

With the development of web technologies, the idea of learning on web is gaining popularity day by day. The latest development of web technology is the World Wide Web; which, no doubt, has made the world very small; and it has often led and is leading to significant changes in ways in which things are done. Education is not an exception from that. Education through Web; in other words, e-learning, is now being used as a means of learning in the web.

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The pedagogy of on-line learning is still in it innovations, but it is already a useful tool and, if used well, can increase the range and excitement of learning. There is also a growing provision of e-based learning and many researchers are now working in this field. By realizing the growing trend towards e-learning, in this paper, we have proposed a flexible and interactive intelligent agent oriented e-earning model of application software for general users of computer (Graesser et al. 2001; Koedinger et al. 1997; Gauthier et al. 2000).

The rest of the paper is organized as follows: Section 2 provides an overview of the proposed e-learning model, Section 3 focuses on the model components, Section 4 provides a visualization model of an e-learning lesson based on Office Automation package, Section 5 enlightens the implementation issues and Section 6 concludes the paper.

2. AN OVERVIEW OF THE PROPOSED E-LEARNING MODEL

Figure 1 depicts the proposed e-learning model. It basically contains three parts:

- Agent Enabled User Interface (e.g., Intelligent Agent Interface)
- Interface With Application Software
- The Black Box

In the system we represent "Black Box" as the core of our entire system, which performs the main functionalities of the system. It gets the input from the agent enabled user interface and according to the users' willingness it performs the operations. Users input are given to the black box and accordingly to the input, black box generates the output that is taken by the Application Interface to interact with the Application Software (e.g. MS Word) accordingly. Application Interface maintains the user's state of action with the application software and sends back to the black box that serves as awareness about the user to the black box for flexible and interactive lesson.

3. MODEL COMPONENTS

The proposed e-learning model consists of a number of model components. The users interact with the system through an Agent enabled user interface (i.e., intelligent agent interface); at the heart of the proposed e-learning model is the black box, consisting of major components of the proposed model; and an application interface provides an information visualization of the respective application software. Below we briefly describe different components of the e-learning model:

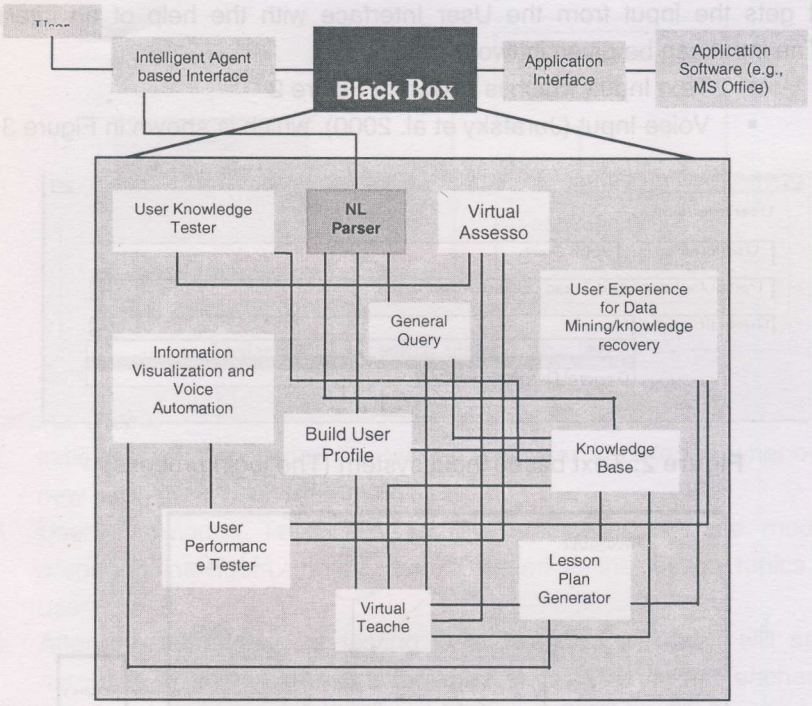

Figure 1: Model of the proposed intelligent agent oriented e-learning system

3.1. Intelligent agent based interface

Key role: This component performs one of the basic operations for the interaction between users and the system.

Operational Steps:

1. It gets input from the user interface, which supports both text and speech input.
2. It then parses the incoming information and interacts accordingly by generating necessary dialogs in order to build the user profile.
3. It produces several patterns (In terms of keywords or lexicons) based on the input.
4. It matches patterns with the predefined grammar (Linguistic model).
5. It tries to generate an output that is understandable and informative to the knowledge base module to load necessary knowledge for interaction.
6. It also provides a mean to communicate in Natural Language with the Virtual Teacher.

Input: It gets the input from the User Interface with the help of an intelligent agent. The input can be given in two forms.

- Text Input, which is shown in Figure 2
- Voice Input (Jurafsky et al. 2000), which is shown in Figure 3

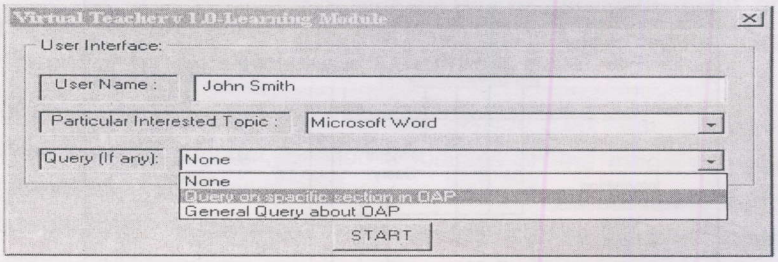

Figure 2: Text based input system (The login process)

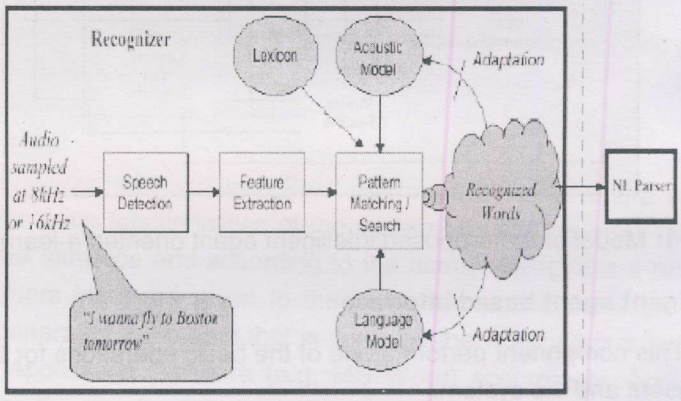

Figure 3: Broad architecture of the voice based input system.

Output: It sends output to the Knowledge Base module. The form of output is a sort of pattern that would be searched inside Knowledge Base to retrieve appropriate knowledge key for knowledge retrieval by Virtual Teacher.

3.2. User Knowledge Tester (UKT)

Key role: The main role of User Knowledge Tester is to test the knowledge of a user. A user may be interested to sit for a test of knowledge regarding the application program directly or he/she has to attend a primary test when he/she first interacts with the system for completing a particular lesson. This is needed to develop a preconception and awareness of the users before starting a lesson. The internal functional modules of the UKT can be viewed in Figure 4:

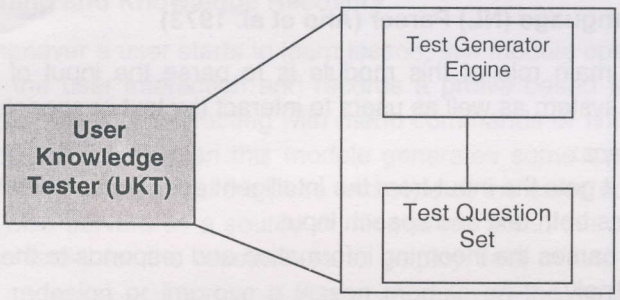

Figure 4: The inner view of the UKT

Operational Steps:

1. Initially User Knowledge Tester will test user knowledge whenever any new user starts his/her learning session.
2. User Knowledge Tester interacts with Knowledge Base module for preparing intelligent questionnaires related to the lesson topics for the user.
3. After the completion of testing User Knowledge Tester will send the responds to the Virtual Assessor which is used by Virtual Teacher for the selection of proper module or make an assessment

Figure 5 below shows a sample model of user knowledge testing session:

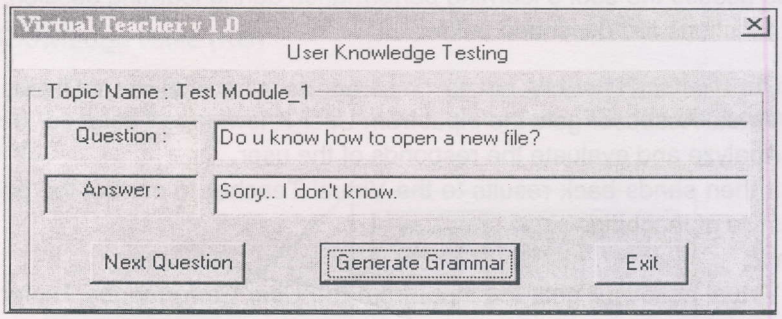

Figure 5: A sample model of user knowledge testing session

Input:

1. User's request for test relevant to a particular level.
2. Virtual Teacher's request to load a test whenever a new user first interacts.

Output: User's answer script along with the question.

3.3. Natural Language (NL) Parser (Aho et al. 1973)

Key role: The main role of this module is to parse the input of the user and respond to the system as well as users to interact (by text or speech).

Operational Steps:

1. At first it gets the input from the intelligent agent based interface, which supports both text and speech input.
2. It then parses the incoming information and responds to the system accordingly.

Input: The user input to the agent based interface (text or speech).

Output: The user profile (i.e., stating general user information) to be stored in the knowledge base.

3.4. Virtual Assessor (VA)

Key Role: User knowledge and performance are two basic criteria by which Virtual Teacher can select the proper and suitable lesson module for the particular user. For this purpose Virtual Assessor assesses the user's knowledge as well as user's skill of performance with the help of UKT generated questions and finally sends the assessment result (on 10 point scale) to the Virtual Teacher for picking up relevant lesson module.

Operational steps: Virtual Assessor is used for two particular purposes: (a) for assessing the user's knowledge level when a user first approach to the system and (b) to assess the user's learning performance during learning session. These different functions are described below.

Function 1:

1. Virtual Assessor gets the input from User Knowledge Tester.
2. Analyze and evaluate the responds of the user.
3. It then sends back results to the Virtual Teacher to control the pace and style of teaching.

Function 2:

1. Virtual assessor gets the input from the User Performance Tester (UPT) module.
2. Analyze user's performances that servers as active awareness about the user.
3. Send back the result to the Virtual Teacher to control the pace and style of teaching.

Function 3:

It stores the correct answers of the given questions from the Knowledge Base to assess the answers and further actions of the user.

3.5. Data Mining and Knowledge Recovery

Key role: Whenever a user starts to learn lesson, this module opens up an eye to be aware of the user interaction and records a profile based users' weakness and strength in terms of interacting with menu commands or time taken to learn etc. Based on this information this module generates some case histories that help Virtual Teacher to control the pace and style of the selected lesson module as well as it also servers as a source of information about the users' interaction and learning history for the researchers to employ data mining and knowledge discovery to redesign or improve a lesson module on the basis of discovered information.

Operational step:

1. It gets users' data from the User Performance Testing module.
2. It clusters lesson module specific different cases according to user data (e.g. data about learning "Creating Table" module of MSWord Package)
3. It implements some conventional data mining algorithms to discover some facts to be used by the researchers of application developer or teaching module designers to improve or redesign module according to facts.

Input: Users' data of interaction, skill performance with respect to lesson modules

Output: Some facts regarding a particular lesson module (e.g. most the users are interested to make tables by "Draw Table" option rather then "Insert Table" option etc.)

3.6. Knowledge Base (KB)

Key role: This module acts as the brain of the Virtual Teacher that guides to perform the correct operation. The functional modules KB can be represented as Figure 6:

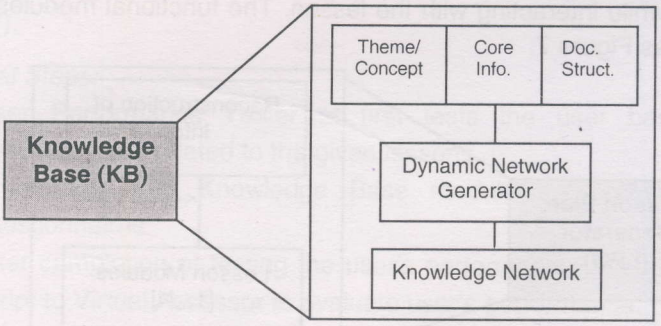

Figure 6: The inner view of the KB

Here, in the knowledge base information is stored as a combination of theme or concept (i.e., the subject area), core information (i.e., the main information) and the document structure (i.e., how the document is structured, information about included visualizations and other related hyper documents etc.)

Operational step:

1. Knowledge Base gets information about the users' query from NL parser.
2. According to the information, it guides Virtual Teacher with some initial knowledge.
3. If user wants to learn the desired application software, it informs Virtual Teacher how to perform the teaching process by providing a knowledge key to load particular lesson module.
4. It helps Virtual Teacher to intelligently handle different user interaction and provides appropriate services.

Input:

1. From NL parser: Linguistic keyword (e.g. General Query about topic 'x')
2. From User Knowledge Tester: Command (e.g. load some questions to assess for level 'y')

Output:

1. It generates knowledge keys based users' interaction to the Virtual Teacher.
2. It provides some clues to User Knowledge Tester (if necessary)

3.7. Lesson Plan Generator (LPG)

This component deals with the reconstruction of information from the knowledge base and generates lesson modules with some glue codes. Mainly, the virtual teacher interacts with this module to retrieve different lesson modules according to user's level and progress. The LPG provides appropriate lessons to users by means of audio, video information rendered in a way that keeps track of user's mental map while interacting with the lesson. The functional modules KB can be represented as Figure 7:

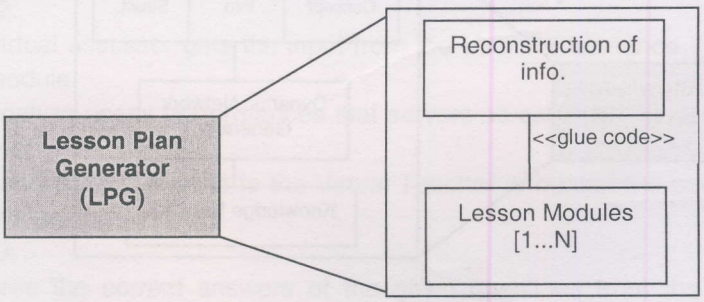

Figure 7: The inner view of the LPG

Operational Steps:

1. Modules are of some predefined levels such as Amateur, Beginner, Intermediary and Expert.
2. The format of each module is: **[Module Name, Level, Key Practices, Sequences, Audio Explanations, Video Demonstrations, Sample Questionnaires, Hints, Hyper document, Next Lessons, Previous lessons, Related Lessons].**
3. The modules are displayed by Information Visualization component with the help of Virtual Teacher.

3.8. Virtual Teacher

Key Role: Virtual Teacher is associated with the LPG and plays an important role all through the teaching process. Basically Virtual Teacher interacts with the users based on some predefine knowledge and currently loaded lesson module.

Operational Steps:

1. Users input are parsed by the NL Parser following some predefined grammar and passed to Virtual Teacher
2. It sets a testing session for the user to assess the level.
3. According to the assessment of the user by Virtual Assessor, it sets lesson modules for that particular level of users to teach.
4. It is responsible to provide teaching sessions in a structured and interactive manner.

3.9. User Performance Testing (UPT)

Key Role: This module examines the user's performance soon after finishing a particular lesson module by asking the user to interact with the application software according to the experience gathered from the lesson module (Gutafson et al. 1997).

Operational Steps:

1. User Performance Tester at first tests the user based on some questionnaires related to the given lessons.
2. It interacts with Knowledge Base module for preparing intelligent questionnaires.
3. After completion of testing the user's performance it sends the answers script to Virtual Assessor to evaluate user's performance.
4. It also gives information regarding the user about the test and lesson to Data Mining and Knowledge Discovery module.

Figure 8 below shows a sample model of the user performance testing session:

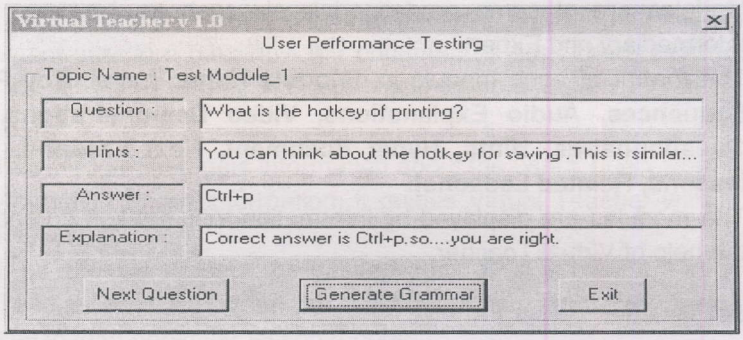

Figure 8: A sample model for user performance testing session.

3.10. Information visualization

Key role: This component of the system accumulates the necessary information based on different lesson modules and visualizes the information for the convenience of users. The key role of this module is to automate interaction.

Input: Information about user interaction sequence necessary for providing visual aids.

Output: Provides visual aids to guide the lessons.

4. VISUALIZATION MODEL

The navigation approach of *Web Online Force-Directed Animated Visualization (WebOFDAV)* (Huang et al.) has been used for the visualization model of the proposed e-learning model with slight modifications. The navigation approach of WebOFDAV allows the users to visualize the entire webspace by navigating through the hypermedia system. For the proposed e-learning model, rather than using the visualization model for the entire webspace; modification has been done on the navigation approach and it has been bound to work within a domain of application software so that its aptitude can be tested based on available knowledge base. The modified navigation approach helps the user, not only by providing a visual aid to guide the lessons journey, but also by preserving the user's *mental map* (Misue et al. 1995) of the view while the user interactively navigates the sections of lessons by swapping of views. This approach does not predefine the geometry of whole visualization at once; instead it incrementally calculates and maintains a small local visualization on-line corresponding to the change of the user's focus. This feature enables the user to explore the current interest without requiring the knowledge of whole graph. This is a concept of *exploratory* navigation, and then describes a system, known as *WebOFDAV* (Huang et al.).The main components of *WebOFDAV* are:

- **Communication manager:** responsible for translating a structured database record to the standard hypertext document.
- **Database generator:** analyses the lexical and syntactic structure of a HTML document, collects the embedded hyperlinks, structures them into a sequence of database records, labels each of them with a short and unique nickname, and then appends them into the database for visualization.
- **Navigational database:** a dynamic database, which is updated on-line with the user's interactions. It contains the information about the navigation history and the structure of the current context (viewing frame) of the viewing window.
- **Layout generator:** deals with the drawing problems. Force-directed layout algorithm to draw the viewing frame is used. The layout adjustment component deals with nodes overlap and edge crossing problems.
- **Animation engine:** animates the updating procedures of views. It assists the user in understanding the change of the viewing frame.
- **Updating processor:** deals with the updating problems. When focus nodes change, a policy is needed to decide which nodes in the current view are to be deleted and which nodes need to be added.

Figure 9 shows the WebOFDAV representation of a lesson based on MS Word.

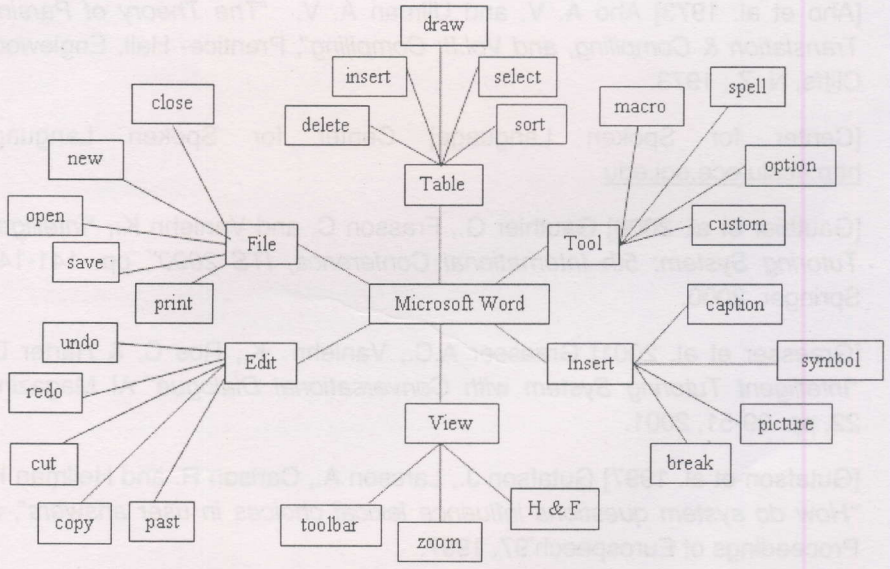

Figure 9: The WebOFDAV representation of a lesson based on MS word.

5. IMPLEMENTATION ISSUES

Implementation of the system puts emphasis on the design of the intelligent agent and the application interface, the structure of the knowledge base and the lesson generator and the formation of the virtual teacher along with other components. We have used some toolkits like CSLU (Schalkwyk et al. 1996; Center for Spoken Language) to give an interactive interface to the users. The intelligent agent is built on Microsoft Agent Technology and Text to Speech APIs. The user knowledge tester component makes use of some predefined grammar. The knowledge base makes use of a NL parser, in-built the system. The virtual teacher component makes use of some predefined knowledge and currently loaded lesson module. The information visualization makes use of the WebOFDAV which reflects the concept of exploratory navigation.

6. CONCLUSION AND FUTURE WORK

It is expected that the proposed e-learning model of Application software will definitely help the mass and naïve users of computer to learn software packages (provided that the appropriate knowledge base and lesson modules are in place) like MS Word, MS Excel etc. in a very easy, interactive and flexible manner. Future work on the proposed e-learning model will look into using the e-learning model among the naïve users to test its usability and performance.

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