Applying Navigation Mechanism to Virtual Experiment Environment on WWW with XML-style Teaching Materials

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Abstract: With the navigation mechanism designed in this paper, an intelligent agent then can learn how to solve a specific experiment in a virtual experiment environment such as IVC (Internet Virtual Community), through reading those XML-style experiment teaching materials alone. After storing the mind of experiment agents with knowledge, an agent can capture users' actions and send corresponding commands to Virtual Lab to help learners completed their tasks. Besides, this mechanism could also be used in solving problems, for example, learners can ask for instructions from agents.
Keywords: Virtual Experiment Environment, XML, Agent, Teaching Materials, Interactive Protocols

1. Introduction

A Virtual Experiment Environment (V.E.E) in distance learning systems provides a visualized social learning environment by creating experiment situation on Internet. [Tung95][JCCH96] A set of simulated virtual equipment for doing experiment is also included in V.E.E.. [HSCX98][HHCH99] Recently, V.E.E. on WWW (World-Wide Web) categorized as three major types, Real Lab, Virtual Lab and Visual Lab,

1. Real Lab: needs a set of external experiment devices and software kit. [JJYH97]
2. Virtual Lab: simulated experiment through software. [CCJH96]
3. Visual Lab: using video-media and some manipulation toolboxes. [WCHH00]

Although V.E.E. offers an environment for learners doing lab on Internet, there is difficult for learners to ask question/demonstration or find out what is going wrong when they are doing exercise inside V.E.E. Hence, many researchers proposed some interactive intelligent tutors or environment solutions. [GSCX92][FuL92] In this paper, not only the model of interactive intelligent experiment agent is implemented, but also the mechanism of reading and understanding teaching materials is well analyzed and designed.

2. Analysis of Interactive V.E.E.

Architecture of Interactive V.E.E.

According to V.E.E. mentioned in previous Section, an interactive virtual experiment environment consists of four major components, including teaching materials, user interfaces - UI (visual lab, in this paper), interactive protocols and knowledge base. As Figure 1 shown below, those four components operate cooperatively.

Learners do any scientific experiments as they like with appropriate visual lab interface (UI) and teaching materials, of course, these materials and UI should obey some basic educational concepts such as the seven problem solving stages and science process skills. An experiment agent (or agent, in shortly) might be able to read the teaching materials directly without supervising, and store some well-organized knowledge (or information) into their artificial brains, which is so-called knowledge base. After understanding specific experiment, an agent owns capability to be a navigator as learners processing a lab exercise, agents can provide instructions for next step, demonstrate the whole experiment process through UI and even predict whether a learner's doing will go wrong or not.

User interfaces provide some interactive methodologies to learners for studying materials and doing experiments; Although teaching materials seem easily to develop, how agents can understand it is a big issue;

Interactive protocols include learner-UI (experiment), agent-UI (experiment), agent-material and learner-agent; knowledge base can be divided into two parts, knowledge structure and inference engine.
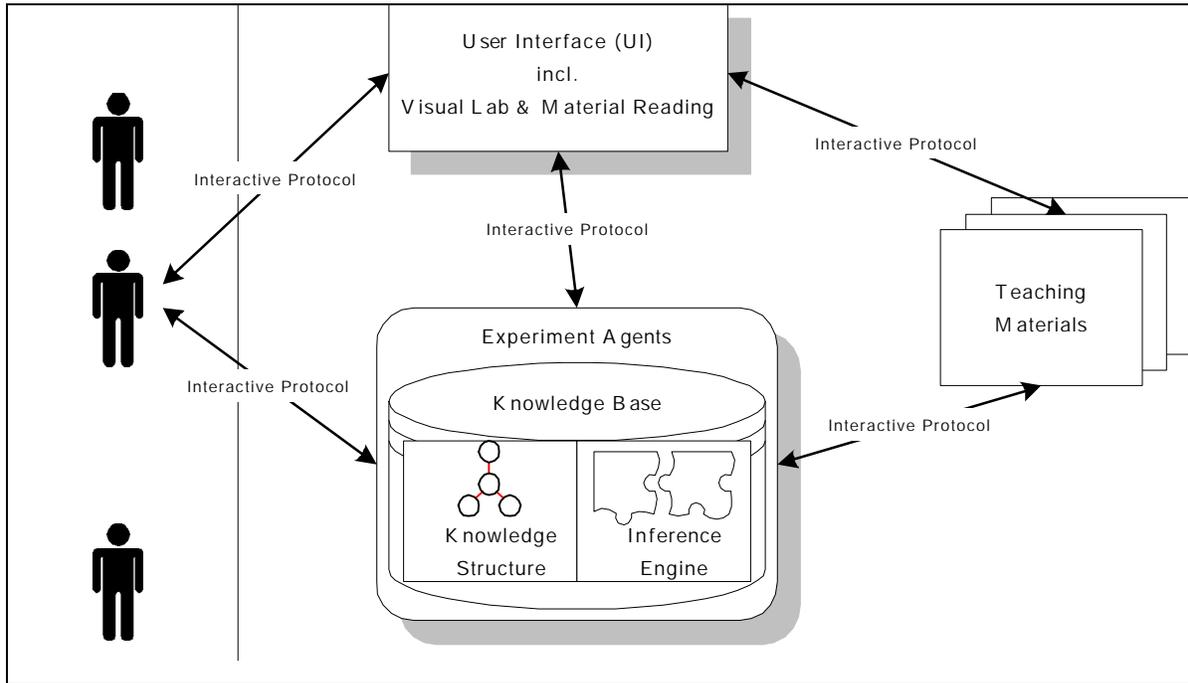

Figure 1. Four components in V.E.E.

The user interfaces, including study interface and experiment interface (visual lab, we called) are well built on WWW during these several years. [HCHH99][WCHH00] Therefore, this paper focuses on the XML-style teaching materials analyzing for reading by experiment agents, and the design of the four interactive protocols described above. Based on the CLIPS and JESS a simple version of knowledge base is also applied to the experiment system implementing in the paper.

Next on this Section we will analyze the protocols between agents and teaching material, agent and user interface (visual lab) at first. Secondly, a flow diagram for the interactions among agents, UI and teaching materials in the instructional system can be designed. About those interactions between learners-UIs and learners-agents are quite simple, and we had done a lots in past, hence, there will not discuss too much in this paper but you can still get some ideas in the experiment system constructed by this paper.

Interactive Protocols and Knowledge Base

Since the agent-material protocol requires the understanding of experiment agents in teaching materials, the W3C standard, XML, is taken into consideration of constructing the experiment teaching material on WWW. XML has capability to form a HTML style document within the concept of object oriented. It is so important to have some properties in the specific learning concept and experiment, take a free-falling experiment for example. We will need both a ruler and a timer when doing this experiment, a ruler should have length property and timer should be able to let us get current time. Following is an XML-style example for the free-falling experiment.

```
<VLaction act="adjust" obj="Ruler">Adjust
        <Obj id="VRuler">Vertical Ruler</Obj>'s as
        <length l="l3">l3</length>
</VLaction>
<VLaction act="getvalue" obj="Timer">Get
        <Obj id="Timer1">Timer</Obj>'s current time
</VLaction>
```

List 1. XML-style teaching material

Where the "\<VLaction\>" tag indicates an action in the visual lab, "\<Obj\>" and "\</Obj\>" create a timer or a ruler object with a special id. We may have some actions, such like adjust and get value, using these actions the properties belong to object can be obtain and modify simply. Besides, agents can read and understand this sort of standard XML-style teaching material by parsing those tags in the document.

After understanding the teaching materials, agent might need to interact with UIs such as visual lab. Through operates equipment and observe data, an agent can demonstrate the whole process of doing an experiment for learners. Hence, to design a communication language for the interaction between agent-UI is necessary. Here we try to design a lisp-like language to simulate what teaching materials tell as List 1 show above.

```
(adjust VRuler l3)
(getvalue Timer1)
```

List 2. Communication language between agents and UIs

Now, flows between these four components in V.E.E. can be drawing down as Figure 2 below.
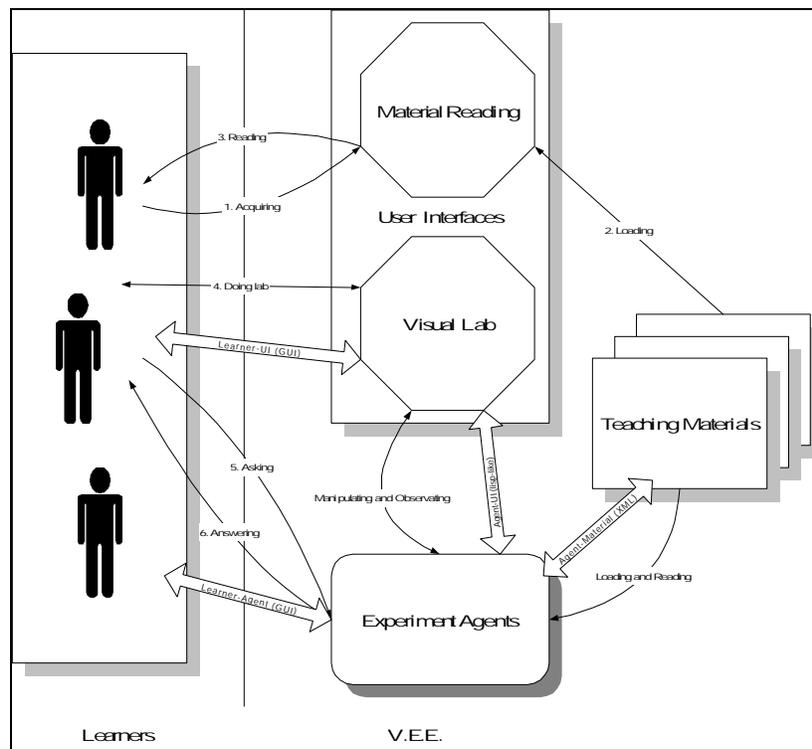

Figure 2. Interactive protocols among four components in V.E.E.

In Figure 2, a learner should acquire and read teaching materials at first through the material reading UI, and doing experiment with the visual lab UI. Similar to learners, an agent also can use its agent-material interactive protocol to read teaching material, and then with agent-UI protocol to manipulate lab equipment and obtain experiment data from visual lab. Besides, depends on the learner-agent protocol a learner can ask an experiment agent for help, and agent can also provide either instruction or demonstration to learner through this protocol.

3. Visual Lab within Navigation Agent

Navigation Agents
Although everything seems going fine as Figure 2 shown above, there is still important issue needed to design. The very important issue is, how to let agents can understand what they read from XML-style teaching

materials, remember it and even inference. As we talk about previously, some exist systems and languages, JESS and CLIPS, are used to achieve this final goal.

Java Expert System Shell (JESS) is a system provides an expert environment in which rules or knowledge can be stored/inferred in CLIPS form. Therefore, a java agent constructed with JESS/CLIPS can direct store/recall/inference relative knowledge/rules from those teaching materials it read. The knowledge structure and inference methodology of agents for navigation in the instruction systems such as V.E.E. is illustrated in Figure 3.

In Figure 3, an experiment agent first use Microsoft Browser Helper Objects (BHO), which can be found in almost Windows operating systems (Windows 95 or above), to get the specific XML-style teaching material. Then the experiment agent can parse the XML-style documents and store some information and rules into knowledge base. When either it needs for demonstrating or learner asks for instructions, JESS can recall these rules/information for inferring and producing results to agent.
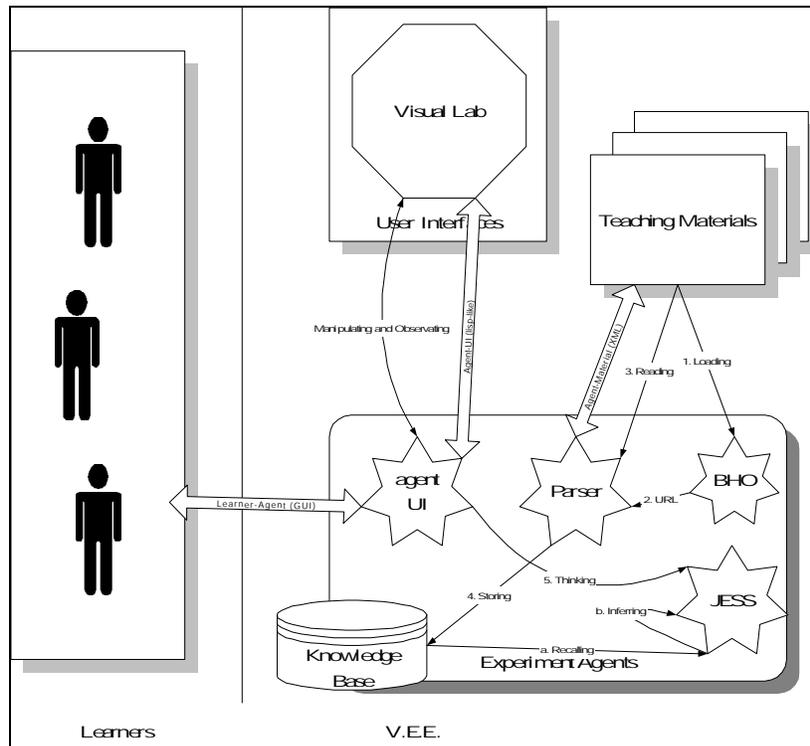

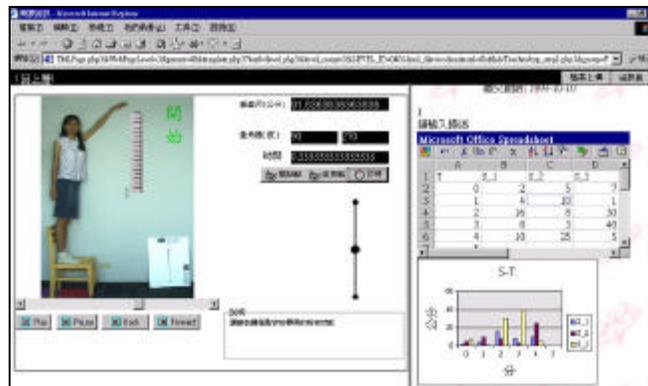Figure 3. Knowledge structure in the JESS based agent

Figure 4. Visual lab without experiment agent

Visual Lab

To extend our past researches, the visual lab in IVC has been modified with those four interactive protocols, knowledge base and navigation mechanism we analyzed and designed in previous Section.[LCH00][CCH00] Figure 4 demonstrates the visual lab in Internet Virtual Classroom, and there is no experiment agent in it but only some equipment as visual lab UI provided for learners. An experiment agent with navigation capability looks like Figure 5. When a learner ask agent for help through the learner-agent UI (protocol), the experiment agent can either demonstrate, tell or explain instructions for learner as Figure 6 shown following.

Figure 5. Experiment agent for navigation

Figure 6. Experiment agent explains for learners in visual lab

4. Summary and Future Works

In this paper we have done the following things,

1. Analyze four components in a V.E.E., including learners, user interfaces, experiment agents and teaching materials.
2. Four interactive protocols, including learner-UI, learner-agent, agent-material and agent-UI.
3. Design specific XML tags for XML-style physical teaching materials.
4. Design Lisp-like communication language for agent-UI communication (protocol).
5. Integrate both JESS/CLIPS and Database.
6. Implement an experiment agent in V.E.E. for demonstrating experiment process, diagnosing errors and making suggestion for next step to learners.

Beside those contributions summarized above, there are still several issues can be taken into consideration,

1. More general XML tags for courses in other fields should be analyzed.

2. Can the knowledge structure inside knowledge base be concept map?
3. Operations for acquiring knowledge base.
4. Knowledge exchange among learning systems.

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