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Collaborative Question-Answering System for e-Learning

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The paper describes a teaching assistant facility to activate question answering in computer programming practice using Collaborative Question-Answering System. This system applies various technologies, such as multi-agent, collaborative learning, and Communication agent, integrating them in a flexible and efficient way to support e-Learning. This system makes it possible for participants to use the communication space for their own needs. The students can send a question message to this system and then receive an answer message from the teacher or other students in the classroom. An agent in the system sends the question message to teacher and/or the students being active to answer questions. The facility activates question answering between students as a form of collaborative learning.

1. Introduction

At present, there are many systems support e-Learning, using different types of learning methods as well as different technologies to implement these methods. Collaborative Question-Answering System is one of those systems. It is messaging-system applied with Open Collaborative Agents technologies [Wongvibulsin02]. The advantage of this system is that the students from various levels of ability are able to study the lesson on their own. By the advantage of collaborative learning [Barbara92] that refers to teaching strategy for small group, the student are able to work together on academic tasks with a few members to improve their understanding and help their teammates in learning together. Not only the communication among the students, but the communication between the students and the teacher is also required in order to support question- answering in the class. The paper describes a teaching assistant facility that enables the collaborative learning on the Java programming practice at Nippon Institute of Technology.

2. Issues of e-Learning System

There are a number of definitions of e-Learning, such as at HP [HP-Lab]; e-learning is about a virtual classroom for interactive online training and meetings, or definition by Sloman [Sloman01]; e-learning is the learning or training using electronically based approaches. Therefore, the term "e-Learning" in this paper refers to collaborative learning [Barbara92] using the power of the computer technology (multimedia technology, network technology) to extend learning skill or practice in learning lesson.

At Nippon Institute of Technology, there is a tool for developing Java programming language called "J/Edit" (shown in Fig.1). Students use this J/Edit to complete their subject given in the lessons. When students have a problem, they will ask teacher. However, it is rather hard for the teacher to answer many kinds of questions simultaneously. For example, in a lesson of computer programming practice, students are stuck on various stage of programming according to their knowledge and skills on the programming. In fact, there are various kind of problems ranging from a trivial syntactic mistake in program to complex issue on the algorithm design. Another problem is student is shy or afraid to ask their friends or some student did not become to intimate friend (in case of first year students). Some students try other e-Learning tools to help their understanding (ex. Web Base Teaching WBT [Ishikawa01]). Although the WBT material for the lesson provides references that allow the students to solve these problems by themselves, but some of them need to be assisted by the teacher. Therefore, in the lesson of programming practice, the teacher answers each question respectively in the queue of students' raised hand, as well as provides common suggestions to all students simultaneously. Even if there are some teaching assistants in the lesson, sometimes many students are waiting for the assistance for a long time. On the other hand, the simultaneous suggestion bothers students who have no problem. It is difficult to balance these assistances corresponding to the situation of the classroom. This is an important issue to be solved in the WBT lessons.

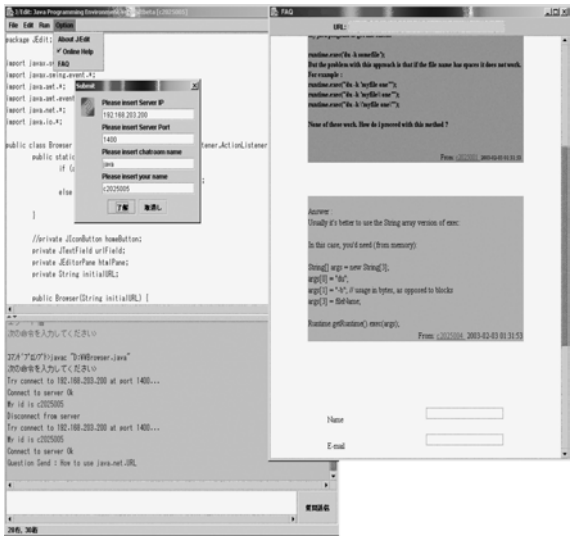

Fig. 1 J/Edit program and its components

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3. Collaborative Question-Answering System

Collaborative Question-Answer System refers to an agent supported e-Learning system that allows agents to communicate and negotiate for provide the best result to students. Collaborative Question-Answering System was developed base on previous research "Open Collaborative Agent (OCA)" [Wongvibulsin02] that allows agents cooperate or communicate together with common agent communication language and protocol. The task of Collaborative Question-Answer System is to support question-answering in collaborative. The system provides facility that student can learn with other student in classroom. Students or members of this system interact together in form of question-answer. The system receives questions from users and then gathers the answers from the other users. This answer is cooperated in form of answerer and checker negotiates together. In this section, we describe overview architecture and communication model that using in our system.

The system provides three main parts that are question, answer, and checker. Every message that output from each part is managed but centralization. Therefore, Collaborative Question-Answering System is composes of four type of agent as shown in Table 1. The question agent, answer agent, and checker agent are client agent for supporting user. The management agent is centralizing agent that address in server. The answer agent and checker agent can negotiate together for provide the best result for question agent's request. The management agent's role is managing message that flow in the system. To make these agents communicate, it requires knowledge of agent communication language (ACL), interaction protocol, and a transfer protocol [Finin95]. The agents communicate with others by using agent communication language (ACL) over communication protocol. Communication protocol is combined with interaction protocol and transport protocol. Interaction protocol is a high-level framework for interaction. Transport protocol is the actual transport mechanism used for the communication (e.g. TCP/IP).

Agent	Description
Question Agent	Its role is sending the question to management agent
Answer Agent	Its role is sending the answer to management agent
Checker Agent	Its role is checking the answer and reply to management agent
Management Agent	Its role are manage in coming message, check alive of client, and checking message time out.

Table 1 Agents in Collaborative Question-Answering System

In Collaborative Question-Answering system, it is also provided interactive protocol as shown in Table 2. The agents in this system communicate by using ACL that written in XML format over these protocols to finish its tasks. In the next section, we show how Collaborative Question-Answering system processes messages by using these protocols.

Protocol	Description
Request	This protocol use for send question
Reply	This protocol use for send answer
Check request	This protocol use for request checking the answer
Check reply	This protocol use for reply the checked answer
Answer acceptant	This protocol use when the answer was accepted

Table 2 Collaborative Question-Answering Interaction protocol

4. Collaborative Question-Answering process

Collaborative Question-Answering System is implemented in the J/Edit program that is a general Java editor used in Nippon Institute of Technology. The reason for using this program is to avoid the trouble of using other tools. In this section, we describe Collaborative Question-Answering process. To support collaborative learning, the phases of question-answer are following:

(1) Question phase

This phase is initial phase of Collaborative Question-Answer system. The question agent sends the user's question to the management agent by using Request protocol (1-RQ in Fig. 2)

(2) Answer phase

When the management agent receives a request from the question agent, first it will create message log and store it to its database. Then it will find an answer agent by selecting from users currently using this system. Finally, it will forward the request to the selected answer agent (2-RQ). The answer agent will display the question on the display of the selected user, and waiting for the answer from the user and then reply it by using Reply protocol (3-RP). If the user can answer the question, it will go to next phase but if not the management agent will find a new answer agent. In case, that no one can answer or no other user in the system, the management agent will wait for new one login until message dead (message time out). Then the management agent will acknowledge for waiting to the question agent.

(3) Check phase

When the management agent receives an answer from the answer agent, it will do same process as in the answer phase that it will select a checker agent and send an answer message to it by using Check request protocol (4-CRQ). The checker agent will send the acceptance by using Check reply protocol (5-CRP). If the checker agent accepts the answer, then it will go to the next phase but if not the management agent will send the message to the answer agent for answer again with checker's comment. The answer agent will answer again until the checker agent accepts. This means the answer agent has to negotiate with the checker agent. Although the checker agent is able to accept or reject the answer, the answer agent has priority to choose a new checker agent.

(4) Accept phase

After the checker agent checks the answer and sends the acceptance to the management agent. The management agent will send the answer to the question agent by using Reply protocol (6-RP). The management agent will wait an acceptance from the question agent (7-AA) and then send it to DB agent for adding it to FAQ database (8-AA). This database can be used by other system such as BBS.

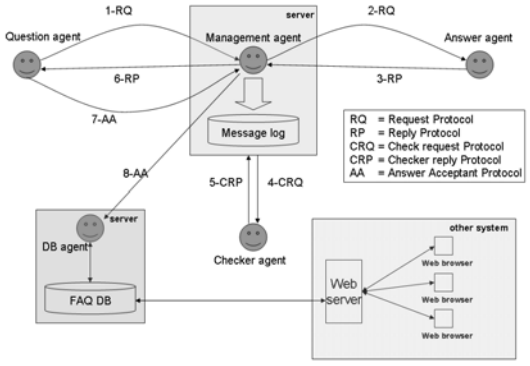

Fig. 2 Collaborative Question-Answering System

This system also has checking timeout of a message and alive of a client. The management agent checks every message flowing in this system and stores it in the message log DB. The algorithm of message timeout is shown in Fig. 3. The management agent program has the thread that always checks message timeout. The message will be dead (timeout) if only the client was dead. In case that message status is reply waiting and check waiting, the management agent will select a new client automatically. This is for making system to be real-time. However, in case that a message is accept waiting the management agent will wait until that the client logins again (in term of offline system).

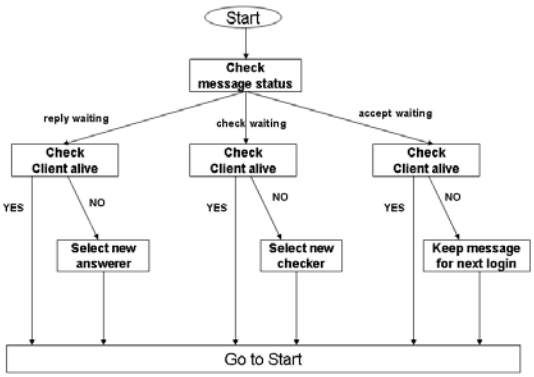

Fig. 3 Message timeout checking algorithm

5. Implementation

Collaborative Question-Answering System is implemented on Windows 9x/NT environment. All agents are developed in Java, which are base on Java RMI and DOM technology.

The system runs on two hosts. The first host is the system server. The management agent resides here and can access to the message log database. The message log database is used as a log for every message that passes via this server. The second host is the client system that integrates in the J/Edit program. The question agent, answer agent, and checker agent reside here. The message used to communicate in this system is represented by XML. The example of DTD describing this XML is shown in Fig. 4. When client receives message, it will interface to user by using popup windows as shown in Fig. 5.

```
<!ELEMENT  reply(sender,destination,content)>
<!ATTLIST  reply type (reply|request_new_checker|cannot)>
<!ELEMENT  sender(#PCDATA)>
<!ATTLIST  sender server NMTOKEN #REQUIRED>
<!ELEMENT  destination(#PCDATA)>
<!ATTLIST  destination server NMTOKEN #REQUIRED>
<!ELEMENT  content(requestor,replyer?,checker?,requestId,request_time,question,answer?)>
<!ELEMENT  requestor(#PCDATA)>
<!ATTLIST  requestor server NMTOKEN #REQUIRED>
<!ELEMENT  replyer(#PCDATA)>
<!ATTLIST  replyer server NMTOKEN #REQUIRED>
<!ELEMENT  checker(#PCDATA)>
<!ATTLIST  checker server NMTOKEN #REQUIRED>
<!ELEMENT  requestId(#PCDATA)>
<!ELEMENT  request_time(#PCDATA)>
<!ELEMENT  question(#PCDATA)>
<!ELEMENT  answer(#PCDATA)>
```

Fig. 4 Example of DTD for describing XML

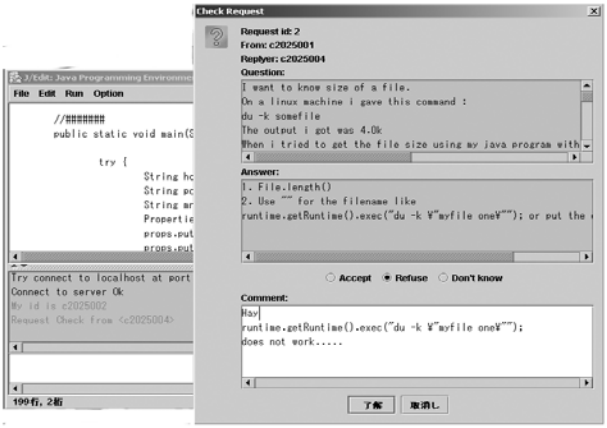

Fig. 5 J/Edit and message popup

6. Experimental Result and Evaluation

The latest phase of the work on Collaborative Question-Answering system consisted of performing tests for its functionality, usability and education efficiency.

Functionality tests were performed during the design and implementation of the modules of the system. We involved end users (students) in these phases and used feedback from them to fulfill and complete our functionality

Usability and education efficiency of the system was tested in order to show when and how Collaborative Question-Answer system should be used, using questionnaire technique.

We involved first year students from Java practice lesson in the analysis. In general, users are satisfied with our system

usability, although some of them still need to be assisted by the instructor. They found Collaborative Question-Answering system as a very convenient service when having a good management in the class. For example, we should manage third year student Java practice lesson at same time as first year student Java practice lesson. The reason is for making third year student and first year student use Collaborative Question-answering system at same time. This means third year student and first year student can collaborate and share their skill with others. Other result is teacher have more time to do another works. Some of user suggested that it could be provided more information from another source not only from other users. This is to reduce their time in finding more information from other resource (e.g. WBT [Ishikawa01, Ishikawa02]). We found that it is very good idea, and we will implement it in the next version of our system

This kind of feedback will continue to contribute to our system. More extensive research and evaluation of the impact of the system on the students' learning process will be performed during the following work on the system

7. Discussions

One feature of Collaborative Question-Answering System is real-time and offline system. Real time for this system means the system tries to find an answer from the online user. User receives message in the form of popup dialogue. This popup forces the user to response the request. Offline are divided into two parts. First, offline in process means when system finishes both answer and check phase but requestor was not online, the system will keep answer and provide to requestor for next time login. Second, offline after process means when system finishes every phases, system will send the result to DB agent to store into FAQ database. After this user can access this database via BBS and can add comment to each topic.

With this system, students can improve their skill and correct problem together with their friends without waiting help from instructor. Therefore, we decide to use this system to implement the agent supported collaborative learning in the computer programming practice and also use it to improve collaborative learning environment e.g., collaborative virtual environment [Bourns01] and demonstration tools [Wang02].

8. Conclusions and Future work

The paper describes the teaching assistant facility to activate question answering among students in the computer programming practice using Collaborative Question-Answering System. The facility is implemented in the system to provide agent supported collaborative learning. The system finds answer that is proved and discussed from another student without requesting user to specific "who is to do this work". In the future, we plan to develop it to work not only in a single university but also in everywhere and develop it to work with other agents such as agent in Community web Software [Ishikawa02].

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