COMPUTER-MEDIATED EDUCATION SYSTEM USING DISCUSSION-EMBEDDED DIGITAL LECTURE VIDEO

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Abstract—*This paper proposes a computer-mediated education system using a discussion-embedded digital lecture video. Currently, digital video lecture and on-line discussion exist separately, and discussion topics are managed regardless of the lecture. However, when the discussion is based on the lecture, this separation makes it difficult for the participants to comprehend the discussion and contribute to it. In the proposed system, the comments contributed by the participants are embedded into the corresponding parts of the video automatically, and, thus, the participants can read related discussions while watching the lecture video, and can watch the corresponding part of the lecture video while reading the discussion. With this management of the discussion, the participants can clearly appreciate the relation between the discussion and the lecture, and deeply understand the content and background of the discussion. These advantages, enabled by relating discussion to lecture, facilitate further discussion by the participants, and, thus, a more effective distance-education environment can be achieved.*

Index terms—*Computer-mediated education system, knowledge worker, discussion-embedded lecture video, distance learning*

1. INTRODUCTION

Recently, with the frequent and continuous changes of industry and technology, progressive and continuous education for knowledge workers is increasingly important. However, most of the subjects that knowledge workers are required to learn have not been established as complete disciplines, partly because of the rapid progress of the changes [3][4]. Therefore, the learners must study from a lecturer who works in the forefront of the field. The lecturer is, of course, busy with his or her own work. The learners are busy themselves because they are normally studying part time alongside full time employment. That is, the participants, both teacher and student, do not have enough time for the necessary education.

We consider that network learning using digital video lecture and on-line discussion is particularly beneficial for assisting such busy participants, due to its asynchronous and flexible features. Furthermore, the asynchronous feature of network learning enables an education in which the concept of who is a lecturer and who is a learner becomes more fluid, and also forges global interaction among people in various fields [1]. These features are also suitable for the education of knowledge workers because important new knowledge is built through active discussion without borders.

However, in conventional systems, the digital video lecture and on-line discussion exist separately [2][5]. When the discussion is based on the lecture, this separation is inadequate for the participants to contribute comments, because it is difficult to clearly comprehend the relation between the lecture and the discussion. To manage the comments on the discussion, conventional on-line discussion systems such as BBS use a hierarchical tree structure to represent a message/reply structure, and sort the root comments of the tree, i.e. the topics, by date of speech. This is not enough to comprehend the background of each topic because the date of speech has little relation to the lecture.

We propose a computer-mediated education system using the discussion-embedded digital lecture video to manage the discussion appropriately. In this system, comments that are contributed by the participants based on the video lecture are embedded in the correspondent parts of the video automatically, and the reply comments by other participants are represented in the same way as a general BBS. In this system, the participants can read the comments on the related topic while watching the lecture video, and can also watch the corresponding part of the lecture video while reading the discussion.

With this management of the discussion, that is, discussion-embedded lecture video, the participants can clearly comprehend the relation between the discussion and the lecture, and, thus, can deeply understand the content and background of the discussion. Therefore, the participants can easily contribute comments to the discussion, and consequently, the proposed system achieves a more effective distance-education environment in which further discussion is promoted.

We have developed a prototype system that adopts the above-mentioned feature. This system proves that the proposed relation between the lecture and the discussion facilitates participant comprehension and promotes discussion effectively.

This paper is organized as follows. Section 2 describes the importance of the integration of the lecture and discussion. In section 3, the methodology of implementation

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is first described, and the fundamental function and evaluation of the prototype system using discussion-embedded digital lecture video is then presented. Section 4 contains our conclusions and plans for future work.

2. RELATION BETWEEN DISCUSSION AND LECTURE

2.1. Harmful effects of separation of lecture and discussion

When an on-line discussion is based on a digital video lecture, capturing the relation between the lecture and the discussion is important for the participants. A discussion based on a lecture means that the lecture is background knowledge for the discussion. In this case, each comment on the discussion often mentions one or more parts of the lecture. Therefore, capturing the relation is indispensable for a complete understanding of the contents of the discussion.

The separation of lecture and discussion in the conventional system causes two problems. The first is the comprehension difficulty of the discussion and lecture contents. If the participants who read the comments know the contents of the lecture completely, some effort to remember and re-watch the corresponding part of the lecture is required. If there is a discussion that delves into a lecture, the participants who watch the lecture cannot pick out the discussion appropriately. The second is the inability to contribute comments. Participants who contribute comments where lecture and discussion are separate must also clearly explain the relation of the comment to the lecture. This extra effort may obstruct frequent comment contribution. In consequence, these problems may prevent active discussion among participants.

2.2. Advantages of relating discussion with lecture

We propose to relate discussion with lecture as a solution to this problem. The term 'relate' means the discussion and the lecture can be easily referred to each other. In other words, the participants can read the comments on the related topic while watching the lecture video, and can also watch the corresponding part of the lecture video while reading the discussion.

This relating has two advantages. The first is that it makes it easier to understand the contents of both the discussion and lecture. Due to this relating, it is easy to know the part of the lecture that causes the discussion, and easy to read the related discussion that delves into the lecture. The second is to facilitate comment contribution. To easily contribute comments related to the proper lecture eases the mental burden on the contributor and promotes contribution. That is, active discussion can be promoted by relating the discussion to the lecture.

3. EDUCATION SYSTEM USING DISCUSSION-EMBEDDED DIGITAL LECTURE VIDEO

3.1. Discussion-embedded lecture video

We use the discussion-embedded digital lecture video in order to establish the appropriate relation between discussion and lecture. In the video, each comment is embedded in the corresponding point of the video. To be concrete, a method as shown in Figure 1 is used. This method uses an allocation table that relates each comment with the corresponding part of the video. The allocation table has sets of two pointers. One is to a comment and the other is to the lecture time when the comment was contributed. Each comment has pointers to reply comments and, thus, the message/reply structures are managed hierarchically. This helps the participants follow the thread of the topic in the same way as the conventional BBS.

Of course, general comments can have relations to more than one part of the video. However, only a one-to-one correspondence is used in the proposed system based on the assumption that the comment has only one main reference.

Moreover, it is important that contributors can easily relate the comment with the lecture, because this function eases the mental burden on the contributor and promotes contribution.

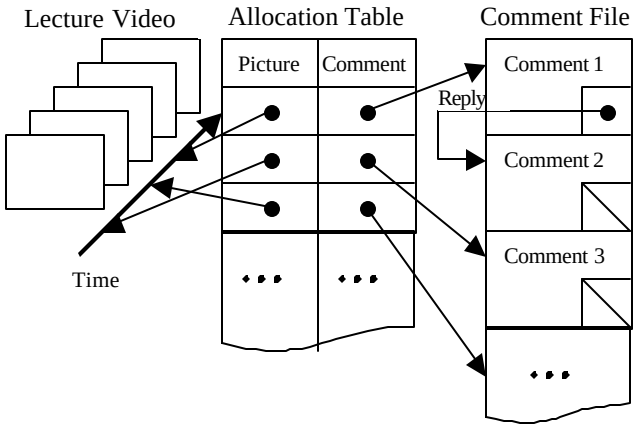

FIGURE. 1
IMPLEMENTATION METHOD FOR DISCUSSION-EMBEDDED LECTURE VIDEO.

3.2. Fundamental functions of prototype system

This section describes the fundamental functions of our prototype system. Figure 2 shows the general overview of the system. The digital lecture video can be played on the Lecture Video Form (Fig. 2 A) by using the play/stop button (Fig. 2 B [1]).

The fundamental functions of this system are as follows:

(1) **Comment contribution**: Participants can contribute a comment relating to the part of the video that they are watching. When they want to contribute to a part while watching the video, clicking the Comment Contribution Button (Fig. 2 B [2]) produces the Contribution Form on which they can write their comment. This comment is then added to the comment file and the relation between the comment and the video time of the part is added to the allocation table (Fig. 1) automatically.

Participants can not only provide a topic, but also reply to every comment. Clicking the Reply Button produces the Reply Form (Fig. 2 D [6]).

(2) **Discussion display**: The discussion is displayed in the Discussion Form, presenting the relations between each comment and its grounding part of the lecture (Fig. 2 C).

Although the look is similar to the general BBS, the most important difference is that all root comments are sorted by the time of the grounding part of the lecture, and not by the date of the speech. A colored line links each root comment and corresponding point on a slider bar that expresses the time of the lecture video. All comments on a topic are displayed together hierarchically at every topic in the same way as the general BBS. If a comment is selected, the title, author and date of speech of the comment is colored in blue, and the content is shown in the Content of Comment Form (Fig. 2 D).

(3) **Current video time display**: In order to capture the relation between the currently watched part of the video and the discussion, the location of the slider (Fig. 2 C [3]) indicates the current video time. Moreover, topics near the currently watched part are colored in red. Therefore, participants can easily find and read the comments related to the watched part.

(4) **Watching corresponding part of video**: This function enables participants to watch the part of the video that is corresponding to a comment that they are reading. The

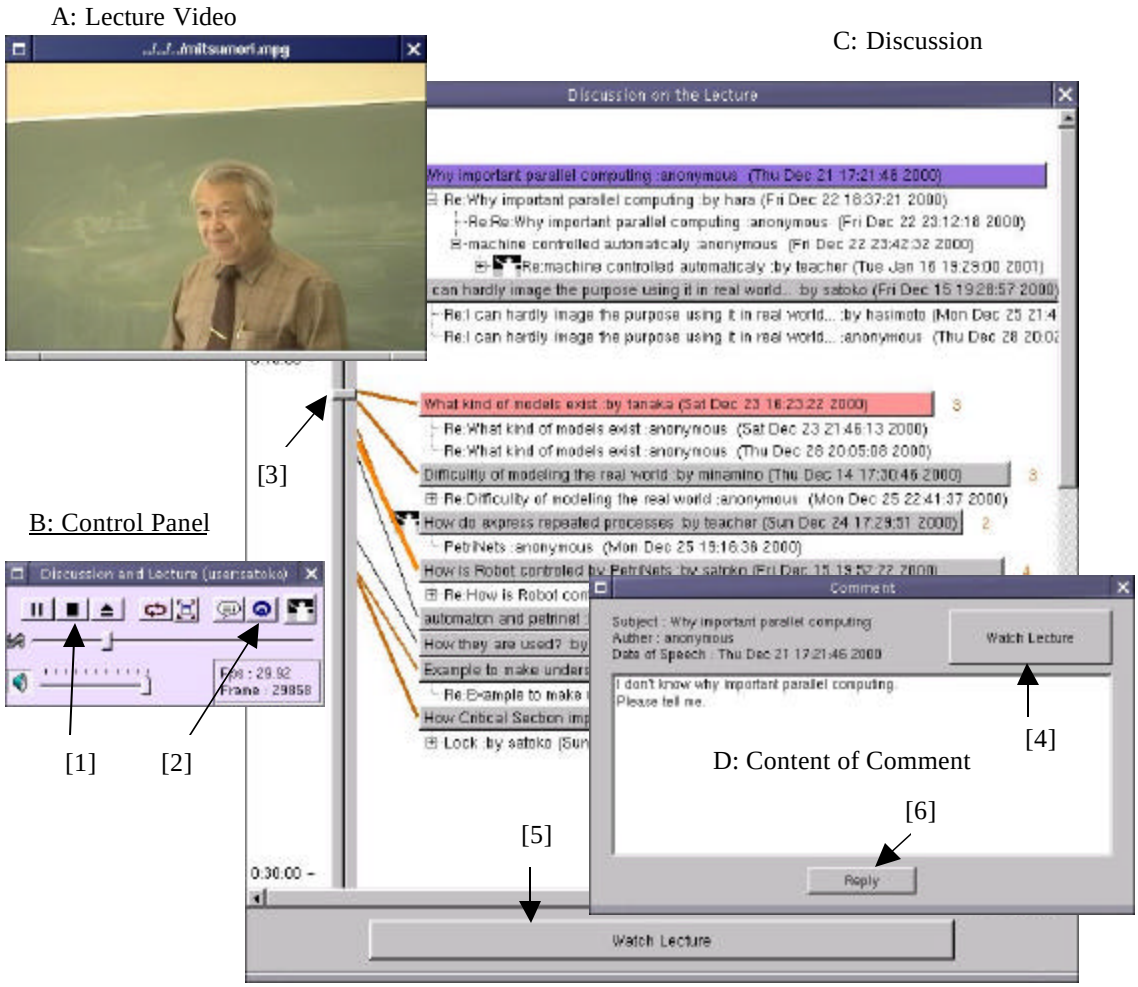

FIGURE. 2
GENERAL OVERVIEW OF PROTOTYPE SYSTEM.

part can be considered as the background knowledge of the comment; thus, they can understand the comment more deeply. Clicking the Watch Lecture Button (Fig. 2 C [5] or D [4]) plays the corresponding part of the selected (blue-colored) topic.

3.3. Evaluation of prototype system

(1) **Relation between discussion and lecture**: Figure 3 shows an example of the discussion-embedded lecture video of the prototype system. A part of the lecture video about "Petri Net" is being played (Fig. 3 A), and a discussion about an example of Petri Net grounded on the part (Fig. 3 B) is colored in red. Therefore, if participants want a deeper understanding of Petri Net, they can easily pick out the discussion. Of course, all comments about the example of Petri Net are managed hierarchically, thus, the thread of the discussion can be comprehended clearly. Conversely, if participants read this discussion before they watch the lecture and want to know the background of the discussion, the Watch Lecture Button provides the background (see Section 3.2 (4)).

Although this system uses the relation to a point of the lecture video, some comments are needed to relate with the interval of the video or with more than one point. Therefore, this relating method leaves much room for improvement.

(2) **Comment management**: In this system, participants can read the topics together that are grounded in a close part of the video. This function enables participants to pick out all comments on a topic appropriately, because topics grounded on the close part of the video can be considered to be close in respect to content as well (See Fig. 3). When a participant reads a topic about an example of Petri Net (Fig. 3 B), he or she can also read a topic about the disadvantages of Petri Net (Fig. 3 C). That is, all topics about Petri Net can be read simultaneously. In this way, participants can know various viewpoints of a topic and a deep discussion about a topic may be achieved.

With the conventional BBS, it is difficult to pick out comments about a topic together, as can be done with this system, because topics are managed by date of speech.

(3) **Determining center of participants' interests**: This system can also determine the center of participants' interests. The density of the lines that tie a topic to the

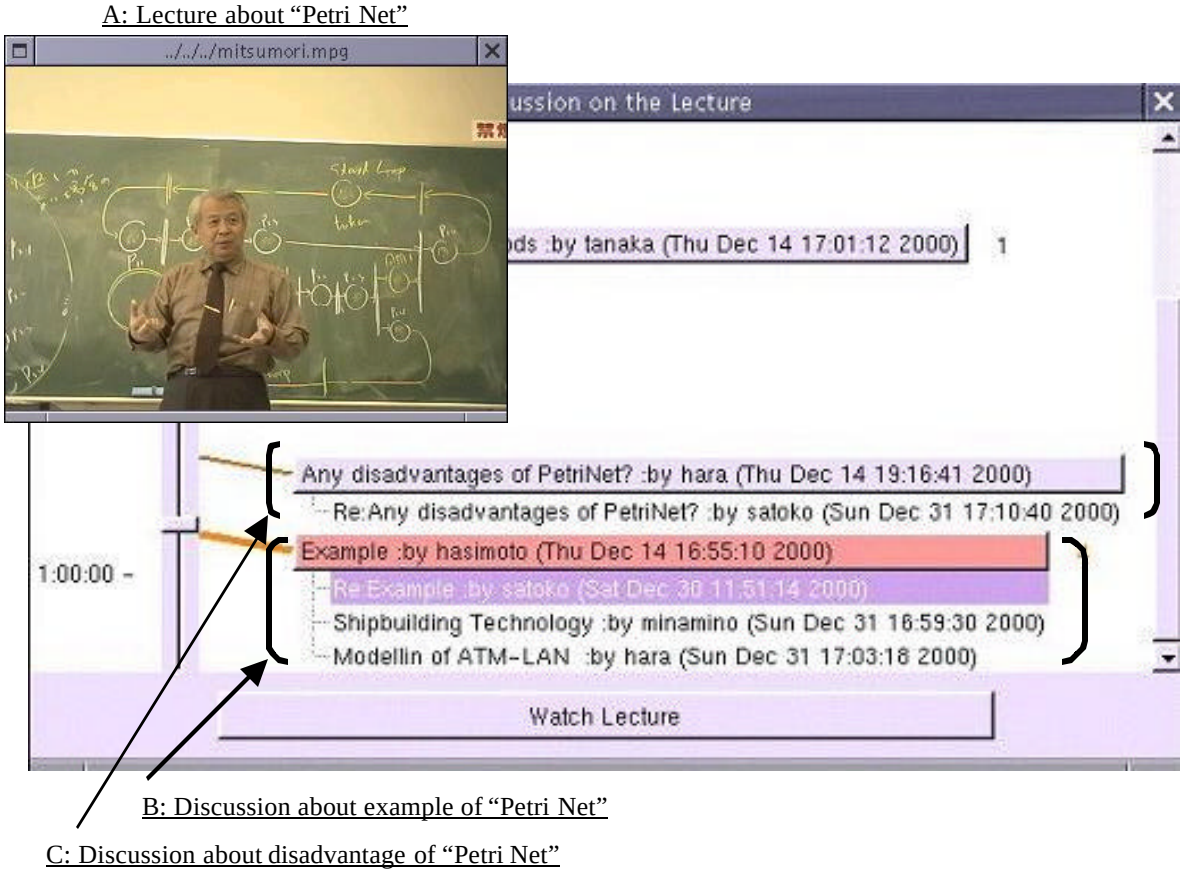

FIGURE. 3
ILLUSTRATION OF RELATION BETWEENDISCUSSION AND LECTURE

slider bar indicates the quantity of comments around the lecture time that corresponds to the location of the slider bar. Therefore, the center of interests can be easily determined (See Fig. 4). Understandably, participants' interests will be concentrated on the latter half of the form.

This facility is effective especially for lecturers, because they can capture the tendency of discussion and lead it in the proper direction.

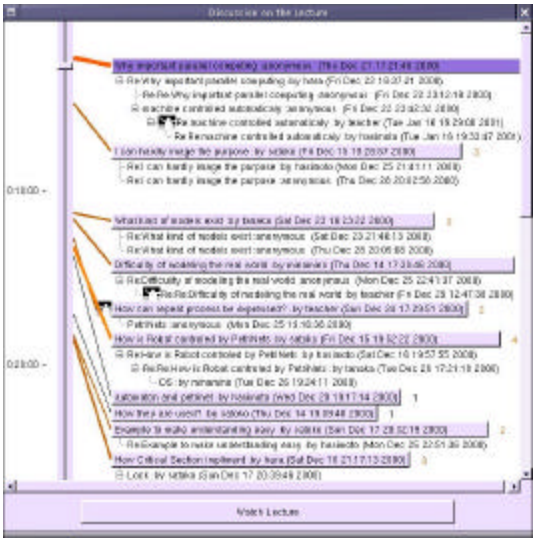

FIGURE. 4
CENTER OF PARTICIPANTS' INTERESTS

4. CONCLUSION AND FUTURE WORKS

We have proposed a computer-mediated education system using the discussion-embedded digital lecture video. This system manages comments by relating them to the time of the lecture video, not by date of speech. With this management, the participants can understand the content and background of the discussion deeply, can properly pick out comments that are relevant to each other and can easily determine the center of the participants' interests. These advantages facilitate further discussion by the participants, and, thus, a more effective distance-education environment can be achieved.

In future work, we will improve the relating method that relates a comment to a point in the video. To be concrete, being able to relate to an interval of the video or to more than one point is desirable. We should also generalize the methodology of text-data-embedded digital video and apply it to other fields for more effective text data management.

ACKNOWLEDGMENT

The authors received support from RCAST (Research Center of Advanced Science and Technology) at Doshisha University, based on a grant from the Japanese Ministry of Education. Haga received support from Grant-in-Aid for Scientific Research (C) (contract number: 11680373) from JSPS (Japan Society for Promotion of Science). We would like to express thanks to Sadamichi Mitsumori, Professor of the Department of KECS, for invaluable suggestions in the research direction; and Satoshi Hashimoto and Kenichiro Hara for helping development of prototype system.

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