Proposal of an Interactive Remote Lecturing System with Complementary Features of Nonverbal Information

Hisayoshi Kunimune[1] and Masaaki Niimura[2]

[1] Faculty of Engineering, Shinshu University, Wakasato 4-17-1, Nagano, Japan
[2] Division of Science and Technology, Shinshu University, Japan
kunimune@cs.shinshu-u.ac.jp

Abstract. This paper proposes an interactive remote lecturing system. The proposed system has some features to complement nonverbal information, which are lost in remote lectures. The remote learners can see entire picture of the lecture room including the teacher, the blackboard, lecture slides, and so on with low definition video. They also can clip a part of the picture and get high definition clipped picture. The proposed system provides the teacher and the students the video of others' faces depending on the situations of the lecture.

1 Introduction

Distance learning with the Internet has rapidly spread over the world. In the United States, over 6.1 million students enrolled on at least one online course during the fall semester in 2010 [2]. Many universities in other countries also offer online courses to their students [3, 4, 8, 10]. There are many inter-university consortia, and the participating universities of a consortium are sharing their lectures and learning resources each other [4, 5, 9]. Each participant, however, are often distant from the other participants; thus, they offer the other participants online lectures and learning resources.

Online courses are separated into two categories: asynchronous and synchronous. Asynchronous courses typically offer students a recorded lecture and slides or web-based learning materials stored on a learning management system. Synchronous courses representatively distribute a lecture video and slides from a lecture room to remote lecture rooms or students' computers. Previously, the lecture video was low definition, less than or equals to 640×480, and was not fit to take entire picture of a blackboard, a lecturer, and a projected slide to the video. Abler et al. pointed out as follows [1]:

> Common videoconference and distance learning systems provide students with a traditional television-like view of the instructor and/or the instructor's materials. This requires the instructor to use specially prepared materials to effectively reach the remote students.

Kunimune et al. prepared two types of high definition lecture videos, one of which takes entire picture of a blackboard and a lecturer and its camera angle is fixed, and the other takes limited scope and its camera angle moves to the place where teacher is explaining. They projected these videos on a screen in approximately real size, and students took lectures with these videos. According to the experimental result, the former one is better than the latter one about realistic sensation, concentration, note taking, and fatigue [7]. The characters on the blackboard written by the teacher are enough observable because the video was recorded in high definition and projected in approximately real size. Some of the students answered a questionnaire that the video in fixed camera angle is better because they can watch anywhere in the blackboard.

Lecture rooms designed for remote lectures offer students high definition video on large screens. Students can also participate in remote lectures with their computers anywhere. In the former case, they have to travel to the designated room. There also are some problems in the latter case: display size is too small to recognise the characters in a high definition lecture video, and network bandwidth is not enough to receive a high definition lecture video.

This paper proposes a remote lecturing system, which

(1) supports students to asynchronously participate remote lectures anywhere with their computers and narrow network,
(2) distributes lecture video in fixed camera angle to each student's computer,
(3) sends the student's video to the teacher and the other students,
(4) allows students to clip pictures from the video, and
(5) informs the teacher clipped regions by each student.

We assume that there is an actual face-to-face lecture at a university, and some remote students (less than face-to-face students) participate the lecture by using the proposed system.

2 Overview of Proposed System

This study proposes a remote lecturing system as mentioned in the previous section. Figure 1 shows the overview of the proposed system.

In the lecture room, the teacher, the blackboard, the slides, and so on are recorded with the video camera in fixed angle and high definition (1920×1080 pixels). The video encoder receives the video from the camera, and encodes the video into high definition and low definition (640×360 pixels or less) Flash videos. The encoder forwards the high definition video to the client software for the teacher and the picture clipping server, and low definition video to the streaming server. The streaming server distributes the low definition video to the client software for remote students.

Figure 2 shows three pictures clipped from actual lecture videos in different definitions. There are the large characters are on the left side of the blackboard, and the diagrams and the small characters are on the right side. In the video

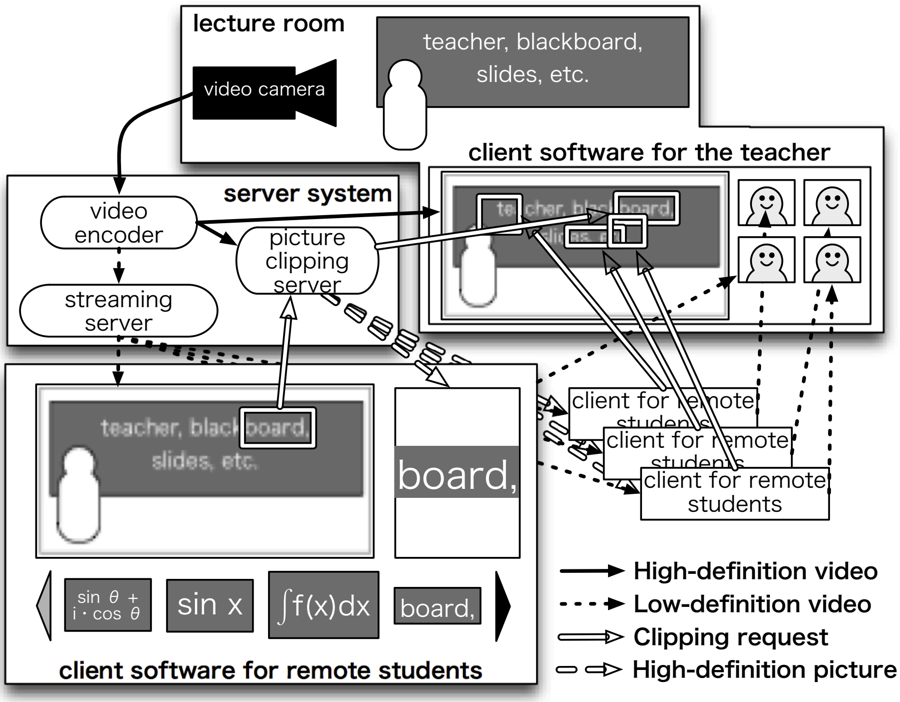


Fig. 1. The overview of the proposed system.

shown in Fig. 2(a), the some characters on the left side can be recognised; however some complicated characters (Japanese Kanji characters) on the left side and the diagrams and small characters on the right side are difficult to be read. In the video shown in Fig. 2(b), the diagrams and the small characters on the right side are also difficult to be recognised. In the high definition video shown in Fig. 2(c), almost all of characters and diagrams on the blackboard can be recognised with large displays; however, it is difficult to recognise the small characters in the diagrams when the video is played on small displays.

The client software for remote students is Flash-based software and works on general web browsers with Flash plug-ins. The students always can see entire picture of the teacher, the blackboard, slides, and so on with distributed video; however, they cannot clearly recognise the detail of the characters and diagrams on the blackboard and slides because the video is in low definition.

The client software allows the students to clip picture from the video by dragging a region on the video. The client software sends a clipping request, which includes the timestamp of the request and coordinate data of the dragged region, to the picture clipping server when the student drags a region. The clipping server generates a high definition picture by using the high definition video and the request from the client, and returns the picture to the client. The high definition picture shows the student the detail of the characters and diagrams on which he/she drags.

The client software for the teacher is also Flash-based software and shows the high definition video to the teacher. It also presents him/her the regions where each remote student recently clips. The client software for remote students sends a low definition video, which takes the student's face, to the client software for teacher.

3 Interactions in a Lecture

3.1 Situational Differences in Exchanging Information

We assume that there are two different situations in a lecture such as "lecturing" and "questions and answers" time, and consider the verbal and nonverbal information between a teacher and students in each situation. Some lectures include other situations such as "discussing with other students," "collaborating with others," and so on. However, we have not considered such situations, and treat only two above-mentioned situations in this paper as the first step of this work because these are the most basic form of lectures.

Table 1 shows the verbal and nonverbal information, which the teacher and the students receive from each other in lecturing time. In that situation, only the teacher talks to the students, and the students listen to the teacher's talk and watch the writing on blackboard and slides.

Table 2 shows the verbal and nonverbal information, which the teacher and the students receive from each other in questions and answers time. In that situation, the teacher and a student exchange their questions and answers. Thus,

(a) 480 × 272 pixels, 1Mbps.

(b) 640 × 360 pixels, 1.7Mbps.

(c) 1920 × 1080 pixels, 20Mbps.

Fig. 2. An example of differences among video definitions.

Table 1. Verbal and nonverbal information between the teacher and the students in lecturing time.

receiver	verbal	nonverbal
teacher	none	expressions and movements gaze on the blackboard/slides
students	utterances writing on the blackboard/slides	expressions and movements

Table 2. Verbal and nonverbal information among the teacher and the students in questions and answers time.

receiver	verbal	nonverbal
teacher	utterances of the questioner/answerer	expressions and movements of the questioner/answerer and the other students the questioner's/answerer's gaze
questioner/ answerer	utterances of the teacher writing on the blackboard/slides	expressions and movements of the teacher the teacher's gaze
other students	utterances of the teacher and questioner/answerer writing on the blackboard/slides	expressions and movements of the teacher and the questioner/answerer

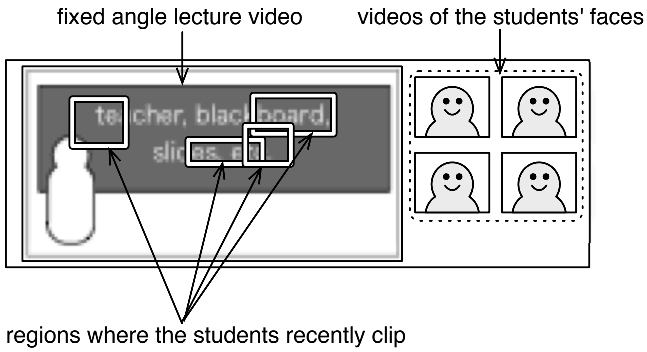
there are three types of person such as the teacher, a questioner/answerer (one of the students), and other students in the situation.

3.2 Lost Information and Its Complement

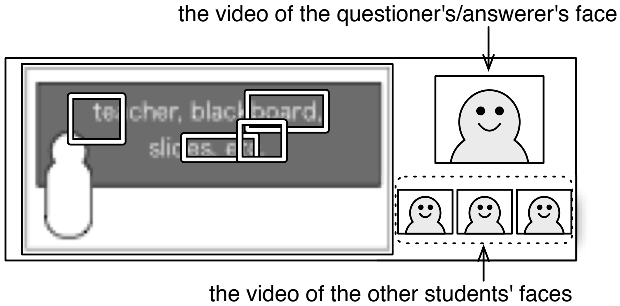
There are some kinds of verbal and nonverbal information between the teacher and the students in a lecture. Videoconference or remote lecture systems can transmit almost of all verbal information; however, it is difficult to transmit some kinds of nonverbal information. For example, the gaze directions of both the teacher and the students are lost by the "Mona Lisa effect." Hirata et al. explain the "Mona Lisa effect" as follows [6]:

> The Mona Lisa effect is a cognitive phenomenon as follows: when a viewer looks at a person displayed on a screen looking at the front, the viewer feels that the person always appears to follow the viewer with his/her gaze, wherever the viewer stands.

Figure 3 shows the information, which is provided by the client software for the teacher in the lecturing time and the questions and answers time. The



(a) In the lecturing time.



(b) In the questions and answers time.

Fig. 3. The client software for the teacher.

software always shows the teacher the regions where the students recently clip. The teacher senses the students' behavior and status, for instance, where they are interested in, and whether they follow the progress of the lecture, from the movement of the presented regions. This information complements the students' gaze on the blackboard or slides. The software also presents the teacher all students' faces in the lecturing time (Fig. 3(a)). This feature helps the teacher to grasp the students' expressions and movements. In the questions and answers time, the software emphasises the video of the questioner's/answerer's face (Fig. 3(b)). This feature helps the teacher to concentrate on his/her expressions and movements.

Figure 4 shows the information, which is provided by the client software for the students in the lecturing time and the questions and answers time. The software always shows the students the lecture video (fixed angle, low definition) and the history of clipped pictures. The software also shows the students high definition clipped picture in the lecturing time (Fig. 4(a)). In the questions and answers time, the software shows the questioner/answerer the video of the teacher's face instead of the clipped picture (Fig. 4(b)). This feature helps the questioner/answerer to feel that the teacher closely observes my behavior. On the other hand, the other students watch the video of the questioner's/answerer's face instead of the clipped picture at that time (Fig. 4(c)). This feature helps them to observe the expressions and movements of the questioner/answerer in addition to the verbal and nonverbal information from the teacher and verbal information from the questioner/answerer.

4 Considering Evaluation Items

We are developing a prototype of the proposed system, and have already confirmed that the system can distribute videos and high definition pictures from the lecture room at a university to several students at each home. However, we have to measure the detail of the system performance.

We also have to introduce the system into the actual lectures and evaluate the system from the viewpoints of the effects of the complementary information in addition to the system performance. Following items are the evaluation items of the system we considered.

- At the lecturing time, the proposed system transmits
  - the expressions and the movements of each student to the teacher, and
  - the expressions and the movements of the teacher to the students.
- At the questions and answers time, the proposed system transmits
  - the expressions and the movements of questioner/answerer to the teacher,
  - the expressions and the movements of the teacher to questioner/answerer, and
  - interactions between the teacher and the questioner/answerer to the other students.

5 Conclusion

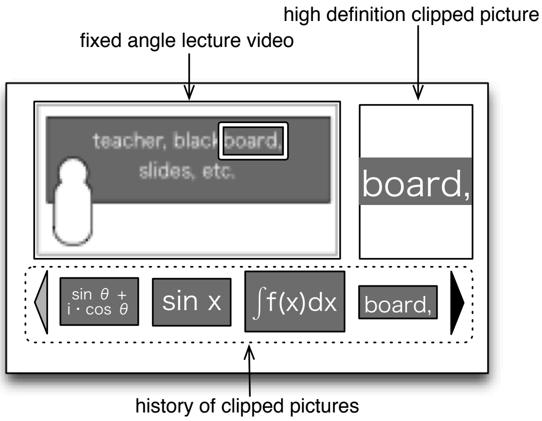
This paper proposes an interactive remote lecturing system with complementary features of nonverbal information. The proposed system has following features.

- The system works with narrow networks by distributing low definition videos.
- Remote students always can look at where they would like to look by clipping there.
- The system transmits complementary information depending on the situations of the lecture.

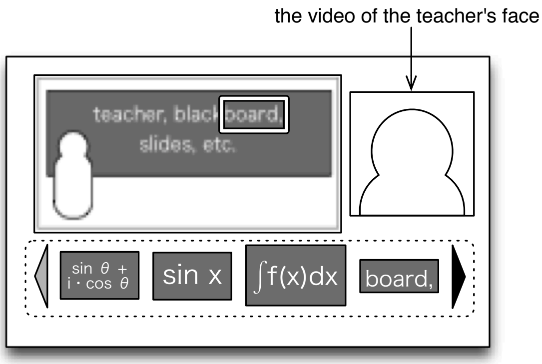
We also consider the items to evaluate the proposed system.

After we finish developing the prototype system, we will introduce the system into the actual lectures and evaluate the system.

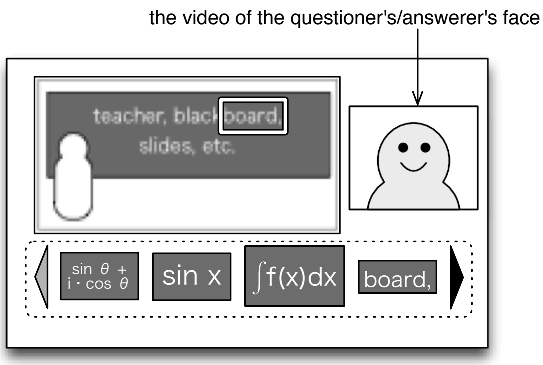
Moreover, there are lectures in different styles, for instance lectures including discussions, cooperative or collaborative activities, practices, and so on. We consider the availability to introduce the system to these types of lectures.



(a) In the lecturing time.



(b) In the questions and answers time (the questioner/answerer).



(c) In the questions and answers time (the other students).

Fig. 4. The client software for the students.

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