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# **A REAL-TIME ANALYSIS METHOD OF STUDENTS' BEHAVIOR FOR A SUPPORTING SYSTEM OF A DISTANCE LECTURE**

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## **ABSTRACT**

Distance Education Course (DEC) has been becoming more and more popular in many universities with the fast development of the Internet technology. The communication between the teacher and the students in DEC environment, however, is a more difficult problem than that of conventional courses. This paper proposes a real-time evaluation method to enhance the communications between the teacher and students. This method analyzes the distribution of the reference of students and informs the teacher the learning state immediately. Experimental results have illustrated the feasibility of this method.

## **KEYWORDS**

Distant lecture, Real-time analysis of student's behavior, Supporting tool, Communication between classrooms

## **1. INTRODUCTION**

The growth of a communication network technology enables people to take part in a distant lecture. There are mainly two kinds of method to hold such a lecture. One is a web-based method; the other is a method of sending video and audio of lecture scene. We are studying some supporting systems for a distant lecture. In the web-based method, we have designed and developed a supporting system: a Computer Aided Cooperative Classroom Environment (CACCE) [Suganuma-2000]. On the other hand, we are developing a camera control system for the distant lecture held with the method sending a lecture scene. We call it "ACE": Automatic Camera control system for Education [Suganuma-Nishigori-2002].

In a distant lecture, a teacher cannot watch his students in the remote classroom or he can watch them only by the medium of a monitor. In this situation, he cannot judge their state as well as he judges the state of students in the local classroom. Some student portfolios assessments and behavior analysis methods are studied to solve this problem [Liu-1999]. They support, however, the lecture that the students learn the HTML courseware by themselves, and cannot synchronously correspond to the progress of the lecture in the local classroom. We designed a function to inform a teacher of the state of his students in the remote classroom with cooperation between ACE and CACCE. In this paper, we describe the real-time analyzing method of student's behavior.

## **2. SYSTEM COMBINED ACE AND CACCE**

We envisage a distant lecture as transmitting a scene captured by a video camera in a lecture delivered in a normal classroom. We are developing a camera control system named ACE (Automatic Camera control system for Education). ACE captures a suitable scene for students following their teacher's explanation. A teacher commonly writes and explains something on a blackboard. Students take part in the lecture watching objects (words, sentences, formulas, figures and so on) written by the teacher. We consequently made ACE keep capturing the latest object written by the teacher because the latest object is often explained by the

teacher and so it is important for many students. ACE focuses on the latest object for a while whenever ACE detects the latest object. After a-few-second zooming, ACE takes a scene including the latest object and the region near it in a discernible size. The scene captured by ACE is transmitted to the remote classroom with teacher's voice. Students in the remote classroom take part in the lecture by watching the transmitted scene, which is reflected on a screen.

## **2.1 Function showing the object written before**

Indeed ACE captures the latest object as something explained by a teacher, but some students probably want to watch another point. ACE has a function recording the scene captured before as not a video but still images. Objects on the blackboard don't change after a teacher writes or erases them. If any objects are updated, ACE detects them as the latest objects again. And the volume of still images is less than that of a video. These are reasons why a still image is good enough for information to show the object written before.

We made ACE select a frame in the scene which included the latest object and the region around the latest object as a candidate of stored still image because a teacher often wrote relational objects in a cluster. ACE stores the selected frame with the time when ACE captured it if a teacher does not occlude something written on the blackboard. The link to the stored image is automatically made in the web page which we prepared. If each student is assigned a PC connected to the Internet, students can refer the still image whenever they would like to watch contents of the previous scene.

## **2.2 Spying students in the remote classroom**

In a remote lecture, a teacher cannot comprehend the state of his students in a remote classroom as well as ones in a local classroom. It is a useful function to inform the teacher of the state of his students. ACE supplies students the feature that they can refer a scene captured before with a browser on their own pace. We guessed that their operation to their browser probably denote the state of students. If the browser used by the student can inform a program running on the teacher's PC of the URL of the displayed page, the transmitted information probably helps the teacher to adjust the progress of his lecture.

On the other hand, CACCE consists of two types of browser: a teacher's browser and student's browsers. These browsers are connected by a socket connection and communicate each other. We have combined ACE and CACCE. The student's browser usually kept displaying the latest page stored by ACE by sending an URL of the page displayed by the teacher's browser. The student's browser reports to teacher's browser about a URL of the displayed page and the time of beginning of displaying whenever the student browsed another page.

## **3. MODEL OF STUDENT'S BEHAVIOR**

When students refer previous information of the lecture, their reference seems to be classified into the following five types: (1) the reference under the teacher's direction, (2) the reference because of the narrow image projected on the screen, (3) the reference because of the difficult contents, (4) the reference because of the fast progress, and (5) the reference because of confirmation of contents of the lecture.

The references of type (1) occur when a teacher directs his students to look at a particular page. In this case, almost all students begin to refer the page within a short time, so that the synchronism of the references often appears. The references of type (2) are caused by the difference between the screen size and the blackboard size. The screen in the remote classroom is often narrower than the blackboard in the local classroom. All contents on the blackboard, therefore, are hardly included in one image projected on the screen. Many students have to refer the previous page, when they want to watch the previous contents. The synchronism of this reference appears, but it is weaker than that of type (1) reference.

Many students individually refer the previous contents when they cannot understand the contents of the lecture. The references of type (3) occur in this case. The synchronism of references of this type hardly seems to appear because the students have an individual achievement level. Furthermore, students sometimes refer the page immediately before the page which the teacher is explaining because they followed the teacher's explanation with difficulty. This is a reference of type (4). Finally, the references of type (5)

occur when the students forgot the contents explained before, and/or when they wanted to inspect the related contents by themselves. The references of this type are usually a short time reference.

It is important for a teacher to be informed the information whether his students understand his explanation. What his students do not understand is also important. Furthermore, information about the progress of the lecture helps the teacher. We would consequently like to detect the reference of type (3) and (4). It is so difficult to detect directly these references because there isn't a clear difference between these types of reference and the others. Our method detects them by eliminating the other type of reference from all references. In the first phase, our method eliminates the reference to the page out of the still image of the lecture and the reference to the latest page of the lecture. In the second phase, it eliminates the reference of type (5) by using the feature of a short time reference. It can eliminate, furthermore, the reference of type (1) and (2) of reference because these references have the synchronism among almost all students. Finally, our method classifies the remains into type (3) or (4).

### 3.1 Extracting the synchronous references

We defined the synchronous reference as the reference that many students begin to refer the same page within a short time. Type (1) and (2) of reference is a synchronous reference. The beginning time, the time length and the page of the reference are so important to detect the synchronous reference. The system combined ACE and CACCE detects the beginning time, the ending time and the referred page from the student's operation. The system comprehends the page which the teacher because the page is explaining is the latest page generated by ACE.

Let us consider reference  $r_{i,j,k}$  that student  $k$  refers page  $j$  when the teacher explains page  $i$ .  $R_{i,j}$  is defined as set of references  $r_{i,j,k}$  that page  $i$  and page  $j$  are constant. Our system can extract references  $r_{i,j,k}$  belonging to  $R_{i,j}$  by using the beginning time, the referred page and the latest page. Figure 1 illustrates a sample data of  $R_{i,j}$ . The horizontal axis denotes the beginning time of reference and the vertical axis denotes the time length of reference. References  $r_{i,j,k}$  are plotted as points. Our system searches the region in which many references  $r_{i,j,k}$  cluster. Our system makes a  $T \times L$  window and counts points in the window. If a ratio of the number of points to the number of students is greater than the threshold we predefined, the system determines that the synchronous reference of page  $j$  occurs at time  $T_{i,j}$  for about  $(L_i \pm L/2)$  sec, where point  $(T_{i,j}, L_{i,j})$  is the center of the window.

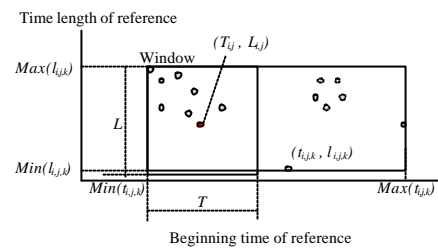


Figure 1. Extracting the synchronous reference

### 3.2 Extracting type (3) and type (4) references

When a student refers a previous page because he did not understand contents of the lecture, the beginning time and/or the time length of the reference seems to disperse. The synchronism of this reference then hardly appears. This type of references do not, consequently, eliminate by the method described in the previous section.

The more difficult the contents of the lecture are, the longer the time length of the reference seems to be. If more students refer the page, the page seems to be more difficult. Therefore, our method estimates difficulty of the page by the time length of reference and number of students who refer that page. Our indicator ( $d_i$ ) that denotes difficulty of page  $i$  is defined by the following formula :

$$d_i = \frac{a}{N} \sum_{k=1}^5 k q_k$$

where  $N$  is number of all students in the remote classroom, and  $q_k$  is number of students whose reference belongs lank  $k$  in table 1. The constant  $a$  is for normalization. We assumed that difficulty of a page was 1 when a half of students kept referring the page for the time length of the lank-5 reference. So we assigned 2/5 to  $a$ .

Table 1. Classification of the time length of a reference

Lank ( $k$ )	Time length ( $t$ )
1	$t < 30$
2	$30 < t < 60$
3	$60 < t < 120$
4	$120 < t < 180$
5	$180 < t$

Many students perhaps refer the page immediately before the page which a teacher is explaining when the teacher progressed to another page without student's understanding. The more growing the number of the students who referred the page immediately before is, the more quickly the lecture is. We consequently defined the index of the progress of the lecture as the following formula:  $2(bq/N - g)$ , where  $q$  is the number of students who referred page  $(i - 1)$  when the teacher explained contents of page  $i$ . The parameter  $b$  and  $g$  were assigned 1 and 0.2 respectively because we made our method reckon that the lecture is not so fast even if 20% of students refer the page immediately before the page the teacher explains and that it is so fast if 70% of students refer the page.

#### 4. EXPERIMENT

We have implemented a prototype of our classifying method and applied it to the four presentations of our seminar and to one traditional lecture on mathematics. We selected the presentation with PowerPoint application because the presentation more clearly divided by page than the traditional lecture. We generated and stored a still image every slide of PowerPoint presentation. There were about 5 students in the local classroom and about 10 students in the remote classroom. After each lecture, we asked all students in the remote classroom about reason of his references. The reasons they answered were classified into above five types described in section 3. We consequently made sure our classification was good enough to estimate student's behavior.

Table 2. Results of the questionnaire about progress of the lecture

	#1	#2	#3	#4	Lecture
Students who guessed the lecture is so fast	80%	60%	20%	40%	20%
Students who referred the page immediately before	100%	60%	40%	40%	30%
Number of pages that the teacher explained when our method detected the fast progress / Total pages	7 / 38	4 / 31	2 / 27	5 / 41	5 / 38

In our experiment, all students can refer the indicated page whenever the teacher directs his students to look at a particular page. The system combined ACE and CACCE works well. Furthermore, our method accurately extracted these synchronous references and never extracted other references as the synchronous reference. We confirmed that our method is good enough to extract the synchronous reference. Next, all pages whose difficulty was informed us at our questionnaire were extracted as the difficult page by our method. We also confirmed that our method is effective to detect difficult pages. Table 2 shows the results of our questionnaire about progress of the lecture. It says the students who referred the page immediately before the explained page increase when the students who guessed the lecture was so fast increase.

#### 5. CONCLUSION

We designed the real-time analyzing method of student's behavior and developed a prototype system of our method. Experimental results have illustrated that our method is effective to inform the teacher of his students' state. Our experiment was done in the case of a small number of students. We will make certain that the method is effective in the case of a large number of students.

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