Lecture Support System
Using Face Recognition and Learning History on LMS

Tetsuo Shoji†, Yohei Kawaguchi††, Koh Kakusho†, Minoh Michihiko †
† Academic Center for Computing and Media Studies, Kyoto University
{shoji,kakusho,minoh}@media.kyoto-u.ac.jp
†† Department of Intelligence Science and Technology, Graduate School of Informatics, Kyoto University
kawaguch@mm.media.kyoto-u.ac.jp

Abstract

Today, various kinds of e-learning systems are applied in the field of education including synchronous, asynchronous and even blended learning. With the diversification of lecture styles and the evolution of information media, great effort has been invested into the development and research of e-learning systems. Our purpose is to construct seamless education environment for supporting human communication over the time and space barrier.

In this paper, we describe lecture support system using face recognition and learning history on Learning Management System (LMS). Our lecture support system has the feature that lecturers are able to grasp the state of student’s learning while going the rounds of student’s desks and seeing student’s face in face-to-face classrooms. Therefore, in cases where discussion period of face-to-face classrooms, this feature means that our system gives a lecturer a catalyst when he/she asks students questions. Our system is the following:

1. We acquire learner’s learning history using Sui² for a face-to-face classroom. Sui² is LMS to accommodate SCORM2004, and it is open source and developed by NTT in Japan. In our classroom, students are able to access from lecture archive video, lecture materials, and presentation materials on Sui². Students study these materials in their home or university. Student’s learning history are stored in the database on Sui².

2. Students register their face images and name in the classroom.

3. A lecturer wears a camera and a Head Mounted Display (HMD) on his head. Student’s face images are captured from the camera in the classroom. The HMD is used to display student’s learning history.

4. Our system recognizes student’s name using captured images, registered student’s face images and their name.

5. Our system acquires student’s learning history from the database on Sui² using recognized his/her name. Then, our system summarizes and visualizes acquired learning history. Furthermore, our system shows visualized learning history to the lecturer via HMD.

Finally, we verify practical effectiveness of our system for actual face-to-face classroom using above system.
1 Introduction

Recently, blended learning[1] has been becoming the trend of learning technology. Blended learning is learning which combines online and face-to-face approaches. Further, it contains a mix of different formats, and different types of learning environment (ex. synchronous and asynchronous learning, self-paced and instructor-led learning, and fixed and mobile learning). Because, e-learning can not only be supported by providing lecture contents online, e-learning tools also have to provide the opportunities for students and lecturers to communicate, discuss and collaborate online[2].

In blended learning, there are advantages of both face-to-face classroom instruction and online learning in the aspects of time, place, interaction, and pace. While learning online, students can learn at any place at a flexible time schedule, and also study lecture materials as many times as they like at their own pace. On another front, while learning in a face-to-face classroom, students can discuss lecture topics with a lecture or students.

In such education environment, it is necessary to support two targets generally. One is student, and the other is lecturer. In previous work, in order to support both of lecturer and students, LMS or CMS is used[3]. However, there is issue for such blended learning that uses LMS or CMS. It is difficult for lecturer to check student’s learning history quickly, when a lecturer discusses lecture topics with students in face-to-face classroom. Furthermore, in order to check student’s learning history, lecturers need to login to LMS or CMS, and to check their history by using student’s name. Therefore, it is necessary for lecturer to know student’s name. However, if a classroom consists of many students, many of lecturers are difficult to remember student’s name and face, and it takes a long time to check learning history on LMS or CMS.

In this paper, we describe lecture support system using technique of face recognition. Our goal is to show lecturers student’s learning history quickly. In fact, even if a lecturer doesn’t know student’s name, he/she can check student’s learning history quickly.

2 Lecture Support System

2.1 Learning History and Lecture Materials on LMS

In our classroom, we use Sui² that is open source learning management system as shown in Figure 1. Sui² can acquire various student’s learning history. For example, there are access time and total access count of lecture material, and login/logout time, and so on.

Lecture materials on Sui² are bulletin board system(BBS), presentation materials, web-based text books, practice materials and lecture archive videos. BBS works in conjunction with Sui² (see Figure 2(a)), and This BBS was developed by Nagaoka University of Technology. Presentation materials are

![Figure 1: Learning Management System developed by NTT (Sui²)](image-url)
slides that the lecturer explained in the classroom (see Figure 2(b)). Text books are detailed web-based text about contents of this lecture (see Figure 2(c)). Practice materials are practice subjects (see Figure 2(d)), and sample source code (see Figure 2(e)). Lecture archive videos are generated by using our archiving system, and our archiving system is described below.

In our archiving system, recorded objects are lecturer, slides, whiteboard and students. These objects are recorded by the following methods.

(1) **Lecturers**

A Lecturer wears positioning sensors, and the relation between cameras and the position data is known. Under such conditions, gestures and facial expression of lecturer are recorded automatically while cameras track lecturer using position information acquired from the sensor.

(2) **Slides**

Lecture slides are recorded with time stamps from electronic slides (ex. Microsoft PowerPoint) on a computer.

(3) **Whiteboard**

Contents written on whiteboard are recorded by using electronic whiteboard.

(4) **Students**

Students who are speaking are recorded automatically. The position where students are speaking are estimated by using Cross-power Spectrum Phase analysis(CSP) method[4].

These recorded multimedia data are managed by using time stamps. In addition, the retrieval function is necessary for archive videos. Because, an archive video is about 90 minutes in cases where general
lectures, and it is difficult for students to search any scenes in an archive video. Therefore, we realize the retrieval function in the following way.

1. Characters are extracted from lecture slides each page.
2. Keywords are extracted from these characters by using Japanese language morphological analysis[5].
3. List of extracted keywords are generated.

Students can retrieve lecture slides by selecting keyword from this list. As archive videos and lecture slides are managed by time stamp, students can retrieve archive videos by selecting retrieved lecture slide. Furthermore, in order to generate lecture material for web-based e-learning system, we should convert these data into SCORM2004 format. SCORM means Sharable Content Object Reference Model, and it is standard and specification for web-based e-learning. Our conversion way are described below.

1. Videos of lecturers and students are encoded on real media format.
2. Electronic slides are recorded as jpeg images each page.
3. Contents written on whiteboard are convert vector data into flash media
4. These multimedia data are synchronized using Synchronized Multimedia Integration Language(SMIL).
5. These data are converted into SCORM format using XcalatII Author. XcalatII Author is developed by NTT in Japan, and is able to generate lecture contents for SCORM2004. We post converted archive videos on Sui² (see Figure.3).

2.2 Outline of Lecture Support System

Outline of our lecture support system is shown in Figure.4, and the flow of our lecture support system is the followings:

1. Students register their face images and name in a face-to-face classroom.
2. Students study lecture materials using Sui² in their home or university. Student’s learning history are stored in the database on Sui².
3. Lecturer wears a camera and a Head Mounted Display(HMD) on his head. Student’s face images are captured from this camera in a face-to-face classroom. The HMD is used to display student’s learning history.
4. Our system recognizes student’s name by using captured images, registered student’s face images and their name.

5. Our system acquires student’s learning history from the database on Sui² by using recognized his/her name. Then, our system summarizes and visualizes acquired learning history. Furthermore, our system shows visualized learning history to lecturer via HMD.

2.3 Face Detection and Recognition

Our system requires to know student’s name in a classroom, and there are two methods of knowing their name. One is to recognize their face using image processing[6], and the other is to use sensors such as radio frequency identification(RFID) tag[7].

In cases where face recognition, accuracy of face recognition is lower. However, it is not necessary to distribute the tags to students. Furthermore, we can acquire student’s face images while communicating with a lecturer. We think that these images are useful in a field of Faculty Development(FD).

In cases where RFID tag, there are issues for using the tag in a classroom. Although we can know who there are in a classroom by using the RFID tag, we can’t know where there are in a classroom. In other words, we can’t know a position that students are sitting. Because, there are many students having the RFID tag in a classroom.

In our system, we recognize student’s face using image processing for the following reason. Our system gives a lecturer a catalyst when he/she asks a student questions. In other words, it is possible for a lecturer to ask students while going round their desks and checking their learning history on Sui². In order to carry out this, it is necessary to know student’s seat and name.

3 Experimental Result

3.1 Educational Environment

We use our lecture support system in an extension lecture of adult education. The number of students is eleven, this lecture is a small-scale classroom. This extension lecture divides into face-to-face classroom
and programming exercise. This face-to-face classroom is one hour, and this exercise is two hours. In this face-to-face classroom, the lecturer teaches students "Image Processing Theory" by using slides and whiteboard. In this programming exercise, students create programs written in C programming language. Figure 5 shows an appearance of this extension lecture.

### 3.2 System Environment

Our system consists of a web camera, Mitsubishi Head Mounted Display (HMD), and a portable PC with wireless LAN. The camera has the capacity to capture images at 640 x 480 pixels resolution, and lecturer wears this camera and HMD on his head, as shown in Figure 6(a). The camera is used to capture student’s face, and the HMD is used to display information that supports lecturer. Portable PC is used to detect and recognize student’s face using captured images from the camera. Then, it is used to summarize and visualize student’s learning history on the database via the network.

### 3.3 Students’ Face Registration and Recognition

In order to acquire student’s learning history, it is necessary to know student’s name. Our system can know student’s name from result of face recognition. In fact, student’s name is recognized by using images captured from the camera on lecturer’s head.

In such case, our system requires to know students’ faces images and name in advance. We register student’s face images and name in our system by student oneself. However, there is a issue when regis-
tering student’s face images and name in our system. If students register their face images and name at the same moment, their face become downward generally, while inputting their name by using keyboard. So, our system can’t detect student’s face due to this. To improve this issue, we register student’s face images and name in our system by using the registration display as shown in Figure7. This registration display can input student’s name by using software keyboard. In other words, students can input their name without using keyboard, when watching the PC monitor. Student’s images are captured from a web camera on PC, when students input their name by using software keyboard.

In our system, we have been using "OKAO Vision Library" for face detection/recognition. This face recognition library has been developed by the Japanese division of Omron an automation, sensing and control technology manufacturer, and this is the library of Microsoft Visual C++

3.4 Display of Lecture Support Information

Figure.8 shows an example of lecture support system. In this system, the lecturer can check login time, access count for lecture materials, total of access time per day, and student’s information including name, affiliation and e-mail address. Our system recognizes student’s face, and updates information to support the lecturer at intervals of a few seconds.

Our system is useful when there is question-and-answer period in face-to-face classrooms. Because, our system gives the lecturer a catalyst when he/she asks students questions. For example, if a student had never accessed Sui2, lecturer can ask this student directly, "Why did not you access Sui2?". If a student has studied a lecture material over and over again, lecturer can ask this student, "Where have you not understood in this lecture material?".

3.5 Evaluation of Lecture Materials and Our System

We did the three questions about lecture materials for students after the last lecture. In the first question, we asked students, "What were useful for the following lecture materials on Sui2?". In this question, students rank from 1st to 5th from the following lecture materials: (a)lecture archive videos, (b)BBS, (c)text books, (d)presentation materials in the lecture, (e)practice subjects, (f)presentation materials in the practice, (g)sample source code, (h)epexegesis(ex. how to use editor,compiler,etc). We shows a result of this question in Table.1. In this Table.1, the most useful lecture material is “presentation material in the lecture”. It is easy for us to guess this result. Because, this material is the one explaining text books of this lecture, so that it is easy for students to understand this lecture. Unfortunately,
however, “lecture archive videos” rank lower than “Epexegesis”. Because, an archive video is about 60 minutes, and students of this extension lecture are working people. So, we guess that they don’t have enough time to watch these videos.

In the second question, we asked students operationality of Sui². This question is on a 5-point scale with rating as follows: 1(Worse) and 5(Best). The mean of this question was 3.25. In the third question, we asked students the reasons that answered the above question. The style of this question is a free space, where the students are asked to write comments about Sui².

- Watching lecture archive videos on Sui² caused Internet Explorer Browser to fail.
- Presentation materials wanted to upload Microsoft PowerPoint(PPT) files to Sui², because of printing these.
- It was not easy to know display of link or tree on Sui².
- It took some time to get used to Sui², because of having never used LMS. If PDF or PPT files were uploaded to Sui², it was easy to use.

Finally, in order to verify practical effectiveness of our system, we interviewed the lecture who used our system. He said, “I could know student’s name and face, and I could check student’s learning history

Table 1: Ranking of Lecture Materials

<table>
<thead>
<tr>
<th>Rank</th>
<th>Lecture Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>(d) Presentation material in the lecture</td>
</tr>
<tr>
<td>2nd</td>
<td>(g) Sample Source Code</td>
</tr>
<tr>
<td>3rd</td>
<td>(c) Text books</td>
</tr>
<tr>
<td>4th</td>
<td>(f) Presentation material in the practice</td>
</tr>
<tr>
<td>5th</td>
<td>(h) Epexegesis</td>
</tr>
</tbody>
</table>
quickly. Then, it was easy to communicate with students, because of being provided student’s learning history and information from this system”. As this experimental result, we could show effectiveness of our system. However, He felt uncomfortable wearing the HMD and the camera.

4 Summary

In this paper, we described lecture support system using face recognition and student’s learning history on LMS. As our system is wearable, lecturers can go the round of student’s desks while using our system. In other words, it is possible for lecturers to ask students while going the rounds of their desks and checking student’s learning history on LMS. If lecturers use our system in face-to-face classrooms, we are expecting increase in students’ educational effect.

However, an issue emerged from the result that interviewed the lecturer. HMD gave lecturer uncomfortable feeling. In the future work, we should verify a method of displaying learning history. Furthermore, we should discuss what kinds of student’s learning history is useful, with lecturers.

Acknowledgments

The authors would like to thank OMRON Corporation for providing OKAO Vision library used in face detection and recognition in our system. This work was partly supported by Research Promotion Bureau Consignment Business from the Ministry of Education, Science, Sports and Culture in Japan.

References


