Attendance Management System using a Mobile Device and a Web Application

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***Abstract*—There have been many proposals to optimize the students' attendance management in higher educations. However, each method has pros-and-cons, we have not yet found the ultimate solution. In this study, a novel framework for the attendance management is proposed, which consists of a mobile device and a web application. While the lecture goes on, students participating in the lecture can register their attendance into the mobile device with their selfie or their signature. After the lecture finished, the registration data are sent to the database, and they will be referred in the 'RollSheet.' This paper reports an overview of the system and the results of evaluation after a trial period, which were conducted in the second semester of the fiscal year 2015.**

I. Introduction

There is a compelling need for a well-designed attendance management system so that the records of their participation are efficiently managed, especially in the case of the lecture has large numbers of participants. Therefore, many systems to optimize the students' attendance management so far have been proposed.

As a typical example, there is a case of the complementary use of a student identification card. In such case, IC chip or magnetic record installed in the card is used as a key for registration. Figure 1 shows the card readers placed at the entrance of classrooms, where the students touch their identification cards on the reader, in order to register their attendance information.

Furthermore, there are several methods to improve the attendance management proposed by many researcher and system vendors. However, each method has pros-and-cons, and we still have not yet found the ultimate solution.

In this paper, a novel framework for the attendance management is proposed, which consists of a mobile device and a web application. Comparison between proposed system and existing systems is discussed in the next section. Section three describes the proposed system in details. Section four illustrates the evaluation conducted in the second semester of the fiscal year 2015. After the trial period, students responded to a questionnaire. The results of the questionnaire is also explained in the section four. And section five concludes the paper.

Fig. 1. Card readers implemented the wall of classroom.

II. Problems in the Existing Systems

As already mentioned, there are several types of attendance management systems, and they are classified into following categories and their combination:

- student identification card and card reader system,
- near field communication (NFC) based system,
- barcode and similar coding based system,
- biometrics system, and
- one time password system.

The case example in the category of the identification card and its reader system is a typical case, as shown in the section one. There are not only research examples, but also many products are delivered in the market.

Regarding these system, there are two major problems; one is a queue problem and another is a cost problem. At the beginning or at the end of the lecture, you can see that the students, who want to record their attendances, make a long queue in front of the card reader, if the number of attendees are too much. That is the queue problem. In addition, we have to pay much expense for replacing the whole of all identification cards if the cards do not have any function of keeping information.

NFC-based systems, which utilize RFID [1]–[3], BLE Beacon [4], [5], and WiFi, are also familiar with researchers and developers in this field. These systems require special devices, such as, RFID reader, the beacon transmitter, and

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so on. It results in the cost problem similar to replacing the identification cards. The same problem comes up with some biometrics-based system [6].

Barcode or some two dimensional coding system, such as QR-code or similar code, is easy to implement and does not require any special devices. That means we can build such system in a cost-competitive manner. Also, password based system is relatively easy to be constructed. However, the capability to check validity of attendance for individuals is weak. For instance, if the password is reported to someone outside of the classroom via some way, person who knows the password can easily pretend participating in the lecture.

YuXiang *et* al. [7] compared the capability of attendance check methods, from the aspect of following six properties: OAAS[1] availability, check method, extra equipment, concurrent check, proxy attendance, and prevention of movement.

III. Proposed System

In this section, an overview of our attendance management framework and its system architecture is illustrated.

A. An Overview

In order to solve the problems previously mentioned, we adopted the combination of an mobile device and web services.

While the lecture is going on, a mobile device running the application which has been developed in this study for registration of students is passed around among participants, one by one. When the participant of lecture get the device, he or she find his/her ID and name from the screen of the device (see Figure 2, (1)).

By clicking the item which is found by the user, a screen for each person is appeared (Figure 2, (2)). At first, the user have to confirm it is unmistakably the registration screen for oneself. Also, the screen allows users to select one from two options, registration by selfie or registration by signature.

If the user choose an option of registration by selfie, a photo taken by the user is stored into the device and it is used for the registration. On the one hand, if the user choose an option of registration by signature, the user signs his/her signature on the screen by the finger and the record of attendance is stored into the device with identification by the signature (Figure 2, (3a) and (3b)). After the registration, the ID and name which have been already registered are removed from the list of participants (Figure 2, (4)). The device can be passed around to the student sitting next to the person who has been already registered.

The function that the registered attendees are removed from the list shown in the main screen of the mobile device is considered unique and useful. It means the items of absent person remain after all participants finished their registration. Therefore, the lecturer can instantly catch the information on absent participants.

The evidence of participation for the lecture can be confirmed by facial image on the participants' selfies or images of their signatures, registered by each student (Figure 3, (1)).

[1]OAAS stands for One-stop Attendance and Absent System.

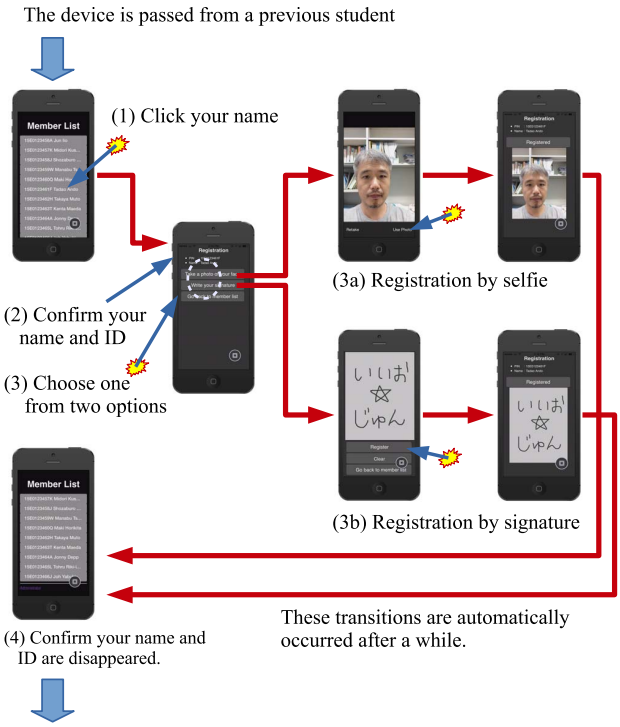


Fig. 2. An overview of using registration application running on a mobile device.

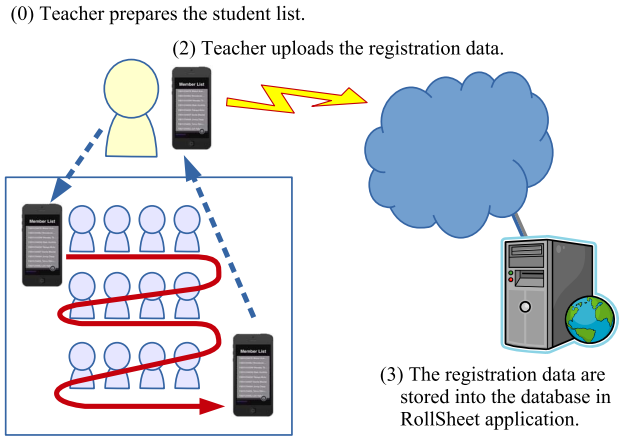


Fig. 3. A use case of collecting attendance information and uploading the registration data into the database.

The image of photo and hand-written signature are stored into the 'RollSheet' database (Figure 4) after the lecture by clicking 'send to the server' button in the administration mode of the device (Figure 3, (2), (3)).

Fig. 4. A screenshot of "Roll Sheet," which is partially masked, considering privacy protection in relation to personal data.

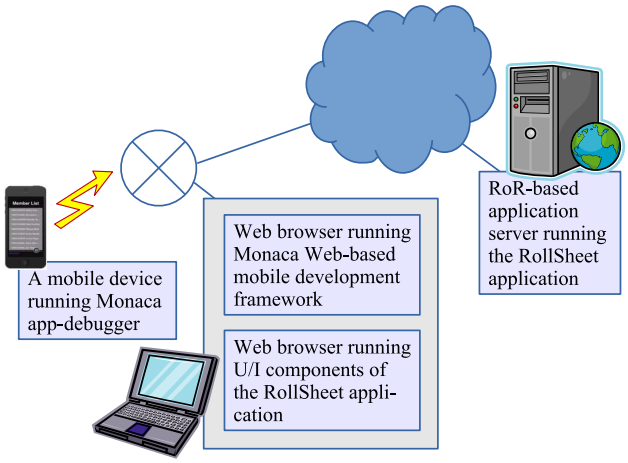


Fig. 5. System architecture of the mobile application and the 'RollSheet' application.

B. System Architecture

A figure illustrating the system components is shown as the Figure 5. An application running on the mobile device is implemented as a Monaca-application. Monaca[2] is a web

[2]http://monaca.io/

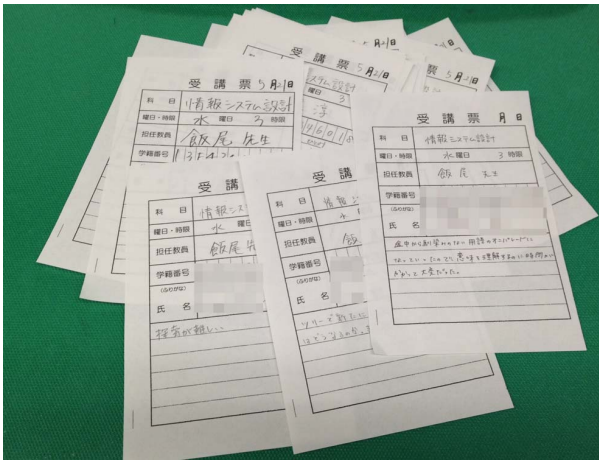


Fig. 6. Examples of form paper submitted by some students, in which some fields are partially masked considering privacy protection in relation to personal data.

service for mobile application development platform, which is based on PhoneGap technology, and it enables us for providing mobile application written in JavaScript and HTML5 without any registration schema, such as, AppStore for iOS and Google Play for Android.

In the left-hand of Figure 5, we can see the mobile device and a PC running an application of development platform, which are connected into the same network segment, by the restriction of Monaca development framework. In addition to that, the server running 'RollSheet' application, which is provided as a Ruby-on-Rails application, is connected into the Internet.

IV. Evaluation

The proposed system has been evaluated by a trial experiment in one lecture course and by subjective evaluation with a questionnaire paper.

A. Evaluation by Trial Experiment

In the second semester of fiscal year 2015, a trial was conducted for the lecture 'Library Service and Information Technology.' The number of participants in the lecture was approximately sixty. Since no students are familiar with this system and with similar registration devices, the lecturer had to explain the operation of the registration application installed in the mobile device.

As previously explained, students can choose the way of registration, by taking their selfie or by writing their signature. However, almost of all students chose the latter way. Only at the first time, the lecturer asked students for choosing the registration by selfie. That is why the selfie image are shown only in the first column in the Figure 4.

Although the participants were explained that the proposed system was mainly used for the attendance management, paper forms are concomitantly used, in the trial period. Some

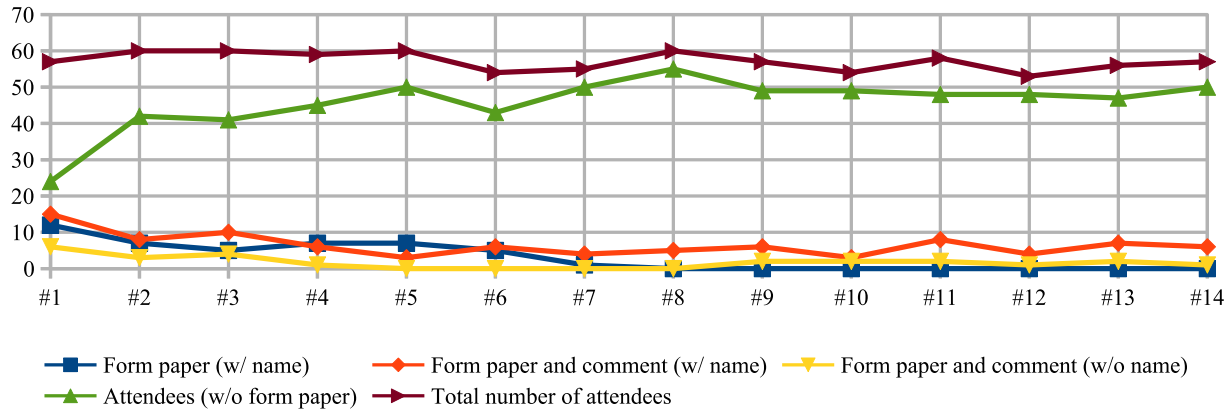


Fig. 7. This graph shows 1. the number of submissions of form paper with name (blue line), 2. that of form paper with comment and name (red line), 3. that of form paper with anonymous comment (yellow line), 4. the number of attendees without form paper submission (green line), and 5. the total number of attendees (brown line)

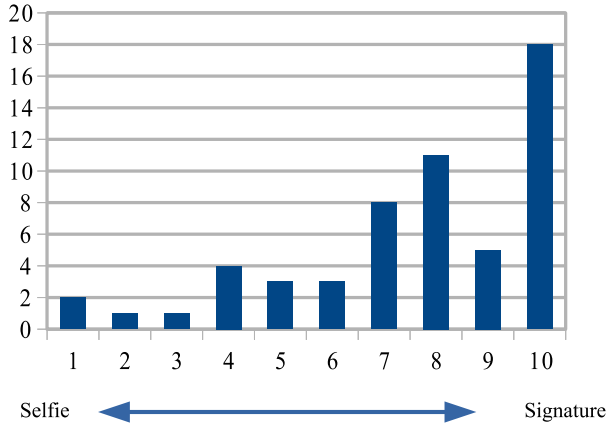


Fig. 8. The answers of question about registration method; which is preferable, selfie or signature?

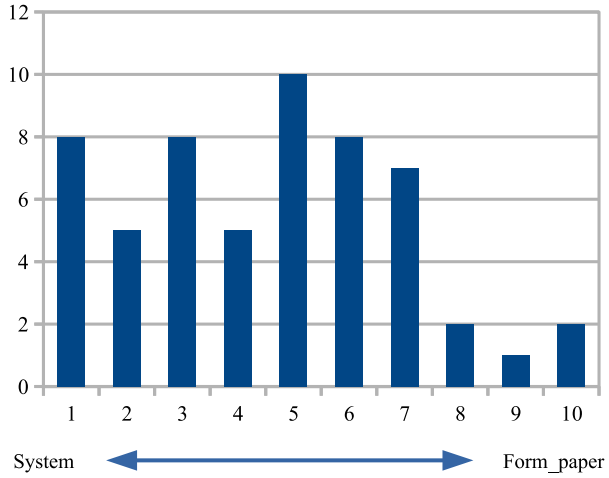


Fig. 9. The answers of question about registration method; which is preferable, system or form paper?

students like to write comments and questions for the lecture (Figure 6). However, the system has no function for conveying feedback from students to the lecturer. Therefore, the form papers were also prepared for students who want to write their comments or questions so that their feedback would be written in the paper.

Figure 7 is the graph showing the transition of numbers; brown line shows the total number of attendees, green line shows the number of attendees without form paper submission, yellow line shows the number of submissions of form paper with anonymous comment, red line shows the number of submissions of form paper with comment and name, and blue line shows the number of submissions of form paper.

We can confirm that the proposed system was gradually believed by the students. The number of attendees without paper form submission gradually increased especially at the first couple of lectures.

B. Subjective Evaluation

At the last lecture on the course, we asked students for answering questionnaire in order to evaluate the usability of the proposed system.

Figure 8 illustrates the tendency of preferences between selfie and signature. Relatively many students prefer the registration by signature instead of that by selfie.

Figure 9 also shows the tendency of preferences between system and form paper. In this question, answers are dispersed. At least, it would be confirmed that the students recognized the form paper was old-fashioned.

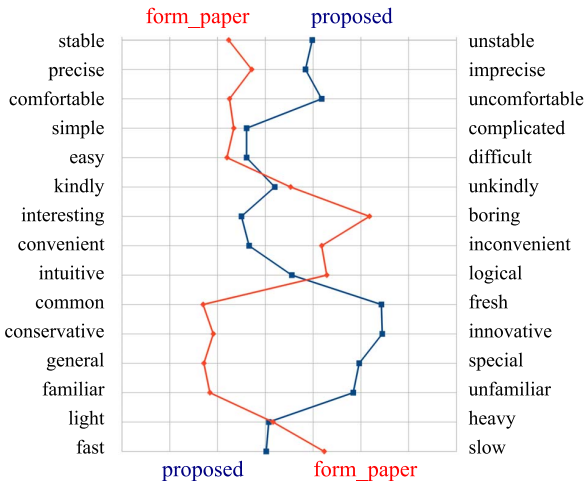


Fig. 10. The results of profile analysis using semantic-differential method.

Impressions against the proposed system were measured by profile analysis using semantic-differential method (Figure 10). Respondent of the questionnaire was requested to represent his/her impression by pair of adjectives. For example, in the case of 'stable – unstable' pair, the impression is judged by these seven options: strongly stable, stable, weakly stable, neutral, weakly unstable, unstable, and strongly unstable.

Red and blue lines in Figure 10 indicate the average points of evaluation on the form paper and the proposed system, respectively. The differences between red and blue lines imply some superior features of the proposed system. The proposed system are considered more interesting, convenient, fresh, innovative, and special, as compared with the form paper. On the other hand, the old-fashioned form paper is preferred in terms of stability, preciseness, comfortableness, and familiarity.

V. Conclusions and Future Work

This study has proposed a novel attendance management system using one mobile device and web application. The mobile device collects attendance information of participants in the lecture and the web application manages attendance data.

A trial experiment was conducted in the second semester last year. The result indicated that the proposed system was efficient for managing attendance records and its usability was welcomed by the students.

Meanwhile, the trial made clear that the use of this system encumbered the submission of feedback comments. In a typical lectures, the number of feedback comments written in form papers tends to increase, because answers to comments and/or questions are explained in the next time of the lecture. That motivates the students to write feedback comments. Thus, it enables interactive classes, so that the lecture helps students' understanding. In contrast, according to the result of the trial experiment, there are no increase of the feedback comments. This is considered as one of disadvantage of the proposed system.

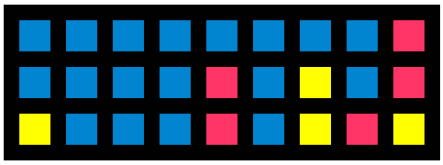
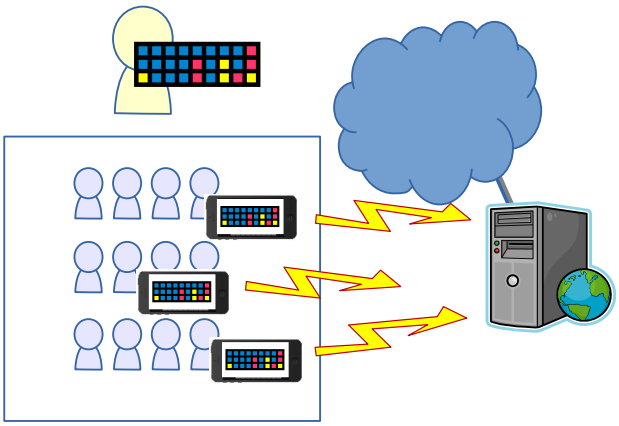


Fig. 11. An example of the chameleon code.

Fig. 12. A screenshot of a test application for the chameleon code, which recognizes the code shown in the screen located at the front of the classroom.

(1) Teacher prepares the chameleon code and show it on the screen.



(2) Students take a photo of chameleon code and send the attendance data into the server.

Fig. 13. An overview of the new version of the attendance management system, which uses the chameleon code as the one time authentication code.

To solve this problem, a new version of the attendance management system are currently being designed. The new system adopts an one time authentication code shown in Figure 11, named "chameleon code."[3] The code is displayed at one time in the lecture and it is used as the evidence of attendance.

Figure 12 is a screenshot of a test application for the chameleon code. The application software takes realtime video image and it can recognize the position of the code in the

[3]http://www.shift-2005.co.jp/chameleoncode_english.php

video. New version of attendance management system hires the architecture shown in Figure 13. It is similar to the system that uses QR-code. However, the capability of code recognition of chameleon code is better than that of QR-code.

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