Smart monitoring system for teaching and learning process at the university

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Abstract. Teaching and learning activities in the classroom require data collection on student attendance. The process of data collection on student attendance during lecture hours at the Information Technology Department, Politeknik Negeri Malang, is the responsibility of the lecturer. The lecturer calls and records students one by one to be written in an attendance form, then the form will be recapitulated to the system by administrative staff. This causes frequent errors in the recapitulation of student attendance. Errors in the recapitulation of data and a large number of attendance data that must be recapitulated will certainly make the process ineffective and inefficient. This study uses a smart card to facilitate the process of identifying students during teaching and learning activities in the classroom. Students and lecturers use smart cards to record their attendance before and after lecture hours. Every card contains a serial number to be scanned on the Near Field Communication (NFC) Reader. The serial number of the card owned by the student or lecturer will be sent to the server to validate whether or not the data is in the database. The data used includes lecture schedules, courses, classes, lecturers, and students that are stored in the database. The result of a smart monitoring system is the ability to manage data on the system, as well as recording attendance data.

1. Introduction

Currently there are a lot of students doing their activities on campus. This is because the campus provides various facilities needed by students to support the teaching and learning process, such as laboratories, libraries, and other facilities. In addition, the presence of canteens on campus makes students more likely to spend more time on campus waiting for the next lecture hours or even to do assignments when there are no lecture hours.

Politeknik Negeri Malang, especially Department of Information Technology, has several facilities that can be used by students such as laboratories, reading rooms, classrooms, and canteens. With this many facilities, of course, a technology is needed to record student data when using these facilities. This aims to maintain campus security, for example preventing unauthorized people (other than students) to enter and use the facilities on campus.

The use of smart card technology can be used as a student identification card to access campus services and facilities. Smart cards are tech cards with a built-in chip that is used for data reading. Smart card is a device that can store data securely and ensure data security during transactions [1]. Smart cards are often used for electronic processes such as personal identification, access control, authentication, and financial transactions [2]. There are two types of smart cards, namely contact smart cards and contactless smart cards. Contact smart cards have an advantage over contactless based on its cost but

contactless are more efficient and convenient for the users [3]. The use of contactless cards is increasing because of its quick and easy operation. This is because users only need to wave their cards at close range to the reader [4].

In another study, an Integrated Electronic Health Record System was developed to record patient health data electronically using smart cards. This smart card is used to identify patient data and store general health information of the patient. Thus, health service providers such as health clinics and hospitals can use these smart cards to access data on patient cards [5].

University of Washington also issued a smart card that functions as a valuable card for vending machines, laundry, and other applications, and is used as an identity card for access to campus facilities and buildings [6]. With this smart card, students only need to have one multifunction card that can be used for library tickets, parking tickets, and electronic wallets.

Smart cards can be designed for universities to improve the registration process, reduce card expenses, providing accurate attendance records and student progress. This card can contain student data such as name, date of birth, signature, card expiration date and mobile number [7]. By storing student records, grades, costs, sports clubs, smart cards bring convenience and better service.

In this study, smart cards are used to monitor student activities in order to facilitate the process of identifying students during lecture hours so that lecturers no longer need to record student attendance in class and administrative staff also do not need to manually enter attendance recapitulation into the system. Thus, this system is expected to accelerate the process of student identification and registration during lecture hours at the Information Technology Department, as well as preventing errors in entering student attendance data.

2. Research methodology

In this study, each student and lecturer is given a contactless Near Field Communication (NFC) card that stores information about data from the student or lecturer. Students and lecturers scan their cards through a reader that will read the student or lecturer information and then send it to the database.

This study uses NFC technology because NFC has several advantages compared to other wireless technologies, NFC technology is easy to learn and use [8], it provides two-way communication to exchange information between the two devices, it also uses less power than Bluetooth when working in active mode [9], NFC is built with lower transfer speeds (106 kbps to 424 kbps) so that the batteries used are also less [10], and it is compatible with other contactless approaches [11].

Data stored in the system database is divided into student data and lecturer data at the Department of Information Technology, Politeknik Negeri Malang. Student data consists of student ID number, student name, recapitulation of student attendance in class, and student schedule. Lecturer data consists of lecture ID number, lecturer name, lecturer teaching schedule, and recapitulation of lecturer attendance in class. Meanwhile, the serial number stored on the smart card will later be used as user identification.

The design of a smart card monitoring system utilizes web service technology for system service integration, Raspberry Pi, and NFC technology. The system architecture used to design the system is shown in Figure 1.

In Figure 1, it is known that students and lecturers record their attendance using NFC technology in the form of smart cards. Every student and lecturer has a card that contains a serial number to be scanned on the NFC Reader. Furthermore, NFC Reader will send the serial number of the reading results to the Raspberry Pi. The serial number of the card owned by the student or lecturer will be sent to the server to validate whether or not the data is in the database. If the card is registered in the system database, the system will record the tapping time and inform that the process is successful. However, if the card used is not registered in the system, the system will give notification that the process failed.
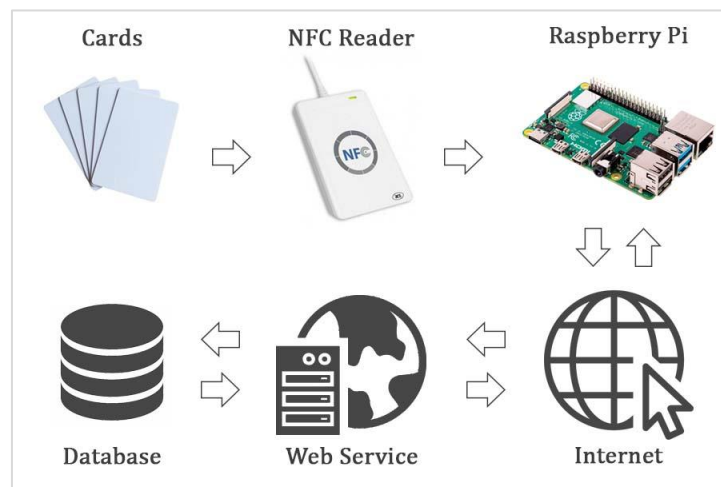
Figure 1. System architecture.

3. Results and discussion

The system implemented in this study uses web applications and mobile applications. Web applications are used by administrative staff to manage data on the system. While the mobile application is used by students and lecturers to record attendance in class according to the schedule.

In this study, several tests were conducted to measure the performance of the system, namely testing the distance needed by the reader to read the card and testing to read serial number of the card.

3.1. Testing of distance

This test is used to determine the distance needed by the reader to read the serial number of cards. In this test, experiments were carried out 8 times in each scenario using a distance of 2 cm to 5 cm. The test results are shown in Table 1.

Table 1. The testing results of distance.

Trial Number	Distance (cm)						
	5.0	**4.5**	**4.0**	**3.5**	**3.0**	**2.5**	**2.0**
1	✖	✖	✔	✔	✔	✔	✔
2	✖	✖	✔	✔	✔	✔	✔
3	✖	✖	✖	✔	✔	✔	✔
4	✖	✖	✖	✔	✔	✔	✔
5	✖	✖	✖	✔	✔	✔	✔
6	✖	✖	✔	✔	✔	✔	✔
7	✖	✖	✖	✔	✔	✔	✔
8	✖	✖	✔	✔	✔	✔	✔
9	✖	✖	✔	✔	✔	✔	✔
10	✖	✖	✖	✔	✔	✔	✔

Note: ✔ : successfully read the serial number
✖ : failed to read serial number

Based on the test results shown in Table 1, it can be seen that to read the serial number of the card properly, the required distance between the card and the reader is less than 4 cm. If the distance between the card and the reader is too wide, then the reader cannot detect and read the serial number properly.

The testing of distance is also carried out to determine the effect of tapping distance on the serial number read time. Figure 2 shows the testing results of correlation between distance and time.
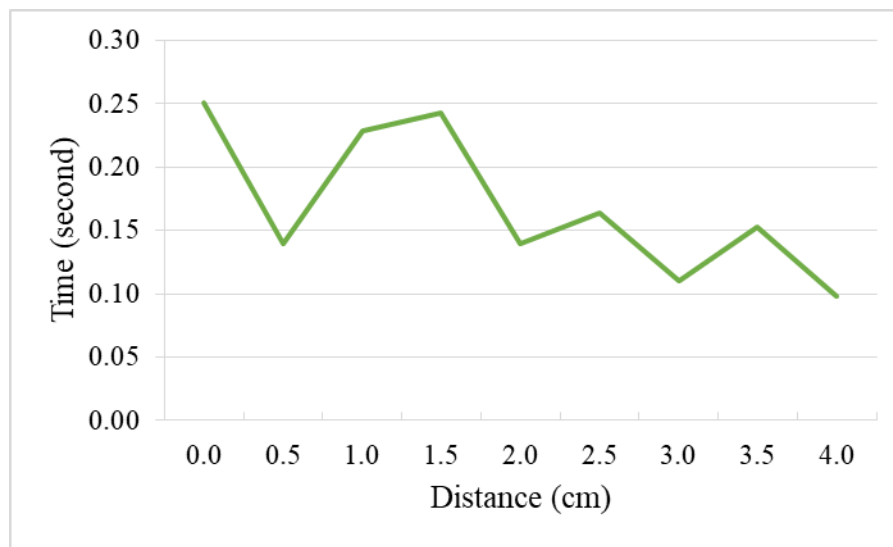
Figure 2. The testing results of correlation between distance and time.

Based on the graph in Figure 2, it can be seen that the tapping distance does not affect the time required for reading the serial number of cards. This is evidenced by the unstable time graph generated from the test results. The average time taken by the card to read the serial number is less than 0.2 seconds.

3.2. Testing of card reading
The testing of card reading is used to find out whether the serial number has been successfully read by the reader. This card reading is done 15 times trial. Table 2 shows the results of testing the serial number of the card.

Table 2. The testing results of card reading.

Trial Number	Status
1	Success
2	Success
3	Success
4	Success
5	Success
6	Success
7	Success
8	Success
9	Success
10	Success
11	Success
12	Success
13	Success
14	Success
15	Success

The test results show that the reader can read the serial number of the card properly. This is evidenced by the successful reading of the serial number 15 times. Thus, the percentage of successful reading the serial number of the card is 100%.

3.3. Testing of system functionality

The testing of system functionality is used to determine the success of the features on the system. The test results of system functionality are shown in Table 3.

Table 3. The testing results of system functionality.

Test Case	Input	Action	Result	Status
Login	Username and password	Enter valid username and password, then click login button	Login success	Pass
		Enter invalid username and password, then click Login button	Login failed	Pass
Insert Student	Student ID number and student name	Enter valid student name, then click Insert button	Data saved successfully	Pass
		Enter invalid student name, then click Insert button	Data not saved successfully	Pass
Update Student	Student ID number and student name	Modify valid student name, then click Update button	Data update successfully	Pass
		Modify invalid student name, then click Update button	Data not update successfully	Pass
Delete Student	Delete button clicked	OK button clicked	Data deleted successfully	Pass
		Cancel button clicked	Data not deleted successfully	Pass
Insert Lecturer	Lecturer ID number and lecturer name	Enter valid lecturer name, then click Insert button	Data saved successfully	Pass
		Enter invalid lecturer name, then click Insert button	Data not saved successfully	Pass
Update Lecturer	Lecturer ID number and lecturer name	Modify valid lecturer name, then click Update button	Data update successfully	Pass
		Modify invalid lecturer name, then click Update button	Data not update successfully	Pass
Delete Lecturer	Delete button clicked	OK button clicked	Data deleted successfully	Pass
		Cancel button clicked	Data not deleted successfully	Pass
Insert Course	Course ID number and lecturer name	Enter valid course name, then click Insert button	Data saved successfully	Pass
		Enter invalid course name, then click Insert button	Data not saved successfully	Pass
Update Course	Course ID number and lecturer name	Modify valid course name, then click Update button	Data update successfully	Pass
		Modify invalid course name, then click Update button	Data not update successfully	Pass
Delete Course	Delete button clicked	OK button clicked	Data deleted successfully	Pass
		Cancel button clicked	Data not deleted successfully	Pass

The test results of system functionalities in Table 3 show that the system can function properly and give results as expected. This is evidenced by the status of all the tests are 'Pass'.

4. Conclusion

The use of smart cards for monitoring the attendance of students and lecturers can be implemented successfully. The distance needed between the card and the reader to be able to read the serial number of the card properly is less than 4 cm. Reader successfully reads the serial number of cards with a percentage of 100%. The average time taken by the card to read the serial number is less than 0.2 seconds.

In further research, smart cards can be used for the process of identifying and registering students when using campus facilities, such as reading rooms, parking lots, and laboratories. In addition, smart cards can also be added e-money feature by working with certain bank.

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