Student Attendance System using QR Codes
(Case Study: Institut Teknologi Telkom Surabaya)

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Abstract. Student attendance system is needed to measure student participation in a classroom, especially in Institut Teknologi Telkom Surabaya. Several attendance systems have been proposed based on manual presence. This is a highly important problem. The administration requires careful follow-up, taking care of it and not being lenient. The previous systems are inefficient in term of processing time and low in accuracy. This paper aims to propose student attendance system using QR code based on mobile application. To ensure the student attends in the classroom, QR code contained the time information was generated and displayed at lecturer presentation. The student only needed to scan the displayed QR code using his/her android or IOS smartphone. The code was then sent to the server for attendance process. The proposed work was designed and implemented using Android Studio, Objective C, and UML (Unified Modelling Language). The experimental result shows that the proposed attendance system only needed 0.000030s to recognize a QR Codes in the server.

Keywords: Course attendance system, QR Codes, Android based, IOS based, Smartphone

1   Introduction

It is a well-known fact that virtually all organizations whether educational or commercial need to properly record the attendance of its students or employees for effective planning, management and functioning of the organization. In most universities in the developing countries, student's attendance is usually taken by old file system approach by calling students name and using paper sheets, this approach is being used for a long time [1, 2]. According to [3] It becomes difficult for the administration at the universities to regularly update the attendance record and manually calculate the percentage of classes absented and attended for the purpose of subsequent results processing and examinations. Keeping these issues in mind, this work designed and implemented a system to overcome the problems associated with attendance recording.

In [4] claimed that many universities are beginning to update their standards by issuing students with identification cards that are equipped with ID chips, radio frequency identification (RFID) tags and barcodes, and this opens up the way to design and implement a barcode-based student attendance system as a management system in the classrooms in order to solve many problems faced by lecturers and students such as recoding security and inefficiency of traditional methods of attendance record keeping.

The technological revolution influenced everything, even the methods of marketing, business and educational applications for the real world business issues. Today, the use of Artificial Intelligence (AI) algorithms is expansive, particularly in providing solution to challenging problems including image segmentation, analysis of medical image, nurse rostering problem, healthcare monitoring system, patterns recognition and retrieval of information, learning management system, as well as prediction of river flow. Accordingly, utilizing the AI algorithms and web technology, countless scholars have created as well as implemented a smart attendance system to solve the student's attendance problems [5-6].

A Smart attendance system based on face recognition [5], the proposed system can be used to take attendance of the students sitting in a classroom all at once. The proposed system involves four steps. Firstly, face detection. Secondly, face alignment. Thirdly, face encoding. Each face is encoded with unique128 values. Finally, SVM classifier is trained with these 128 dimension values for each face. The system also makes a report of attendance with the date and then it is automatically mailed to the faculty.

Based on [7] design of student attendance system can efficiently manage students attendance of the Computer Science and Engineering department at Jatiya Kabi Kazi Nazrul Islam University. Fingerprint features are considered to be the best and fastest method for biometric identification. In their work, attendance is marked after the student's biometric identification. For student identification, a fingerprint recognition based identification system was used. The proposed system based on fingerprint recognition was tested on a class of student fingerprint databases and achieved significant results.

In [6], the proposed system are utilization and plan of face detection and recognition framework to consequently recognize students. This proposed facial biometric framework will contain an enrollment procedure in which the remarkable features of people's face will be put away in a database and after that the procedures of distinguishing proof and verification.

The rest of the paper is organized as follows; problem statement and methodology of the proposed work will be illustrated in section 2. Database construction, Interface

design, and results will be discussed in section 3. Finally, the conclusion is presented in section 4.

2   Systems and Methods

2.1   Design Attendance System

The most important factor for students in schools and universities is regular attendance. Students who are absent from lectures will experience issues obtaining additional instruction and information from their teachers. As a result of significant absenteeism, students may more likely to be unemployed, homeless, or involved in the justice system. Students with high rates of absenteeism can affect other students who have regular attendance in the same class. High rates of absenteeism may cause students to fail in a specific class and they may have to enroll at another school or university. Therefore, universities should provide a system that helps s tudents to improve attendance [8].

Attendance systems are used in many universities. At the University of Sulaimaniyah, an attendance system is widely used by both colleges and departments. Typically, the attendance system is managed by each teacher. Teachers record a list of students that are absent from class or lectures.

Moreover, some teachers at the University of Sulaimaniyah make attendance a part of a student's grade; therefore to obtain the best grades possible, students must attend classes. However, some students are not aware of how many classes they have missed because this information can be difficult to obtain. Therefore, students with a high rate of absenteeism may receive low grades or may fail a class. For example, the College of Science has mandated that all students attend all lectures.

2.2   QR-Code

A Quick Response code (QR- code) is a two-dimensional bar code designed by Denso Wave in 1994 in Japan. A QR code is arranged in rows and columns of black and white and has been designed to be read by smartphone [9].

A QR code can hide a large amount of data, numeric and alphanumeric. Thus, they have become popular all over the world. Moreover, QR codes are widely used in telecommunication due to the increased popularity of smartphones, which typically contain software that can read QR-code images [10].

Fig. 1. QR Codes

A QR-code image comprises a functional pattern and an encoding region as can be seen in Fig. 1. The patterns included in a QR-code image are the finder, alignment, timing, and separator patterns. Each of these patterns has its own functionality [11]. These are as follows:

1. **Finder pattern**: This pattern can be found at the edges of a QR code image. The finder pattern is a square block that contains that contains a black square. There are three finder patterns on every QR code image; at the top left, top right, and bottom left. There is no finder pattern at the bottom right. The primary function of the finder pattern is to tell a scanner or decoder that the image that has been encoded as a QR-code image. No data is stored in the finder pattern.

2. **Alignment pattern**: Similar to the finder, there is no data stored in the alignment pattern; however, it provides information scanner devices to correctly position the data stored in the encoded data region. The alignment pattern is positioned between encoded data and is usually in the center of the image. The structure of this pattern consists of a small square with a tiny dot inside. In addition, the number of alignment patterns can differ for different QR codes.

3. **Timing pattern**: This pattern lies between two finder patterns. Timing patterns are arranged both vertically and horizontally. There is a black dot inside each timing pattern. The main purpose of the timing pattern is to correct the central coordinate for each data cell when any distortion occurs during decoding of symbols or when an error is found in any cell pitch in the QR code. No data is stored in the timing pattern.

4. **Encoded data**: This pattern is located at the center of the image. Data is stored within this pattern. In addition, when data is inserted, it is converted to binary data. This binary data is converted back to the normal text when the image is decoded by a scanner [12].

2.3   Mobile Application

The implementation of the mobile and backend system is important for the proper functioning of the app. Let us have a look at the tools and environment we have used

to build the system. Implementing the application (Mobile system) refers to coding in Java. So, to build the system we will opt for Android IDE because it already consists of predefined plugins which will be useful for us since we will have the necessary tools in that platform itself. Both the Mobile and the Backend System comprises of different components and in order to create a relationship and link those tables, we will use the SQL Server database. For our system, the admin (backend system) needs to obtain information about students, timetables, or lecturers and for this to be possible, we have chosen to use IIS web server which will fetch data from SQL Server database and will then display those data to the admin [13].

The Mobile App is made up of different. These are as follows:

- **Modules for scanning the QR-Codes**: When a student clicks on the "Login" button, then the app will check the QR-Codes that show in the display. If the app finds that the student is within the Student ID and Password matches the one in the database then the app will insert the student has been present in the class. The app will check for the student's location several times during that lecture and will subsequently mark the student as present or absent.
- **View Students' Attendance**: Students can input the ID to verify their attendance.

2.4   Secure Authentication System

Once the requirements to implement this prototype have been described, we need to explain how the actual authentication will take place. For this, we need to understand first how the registration process would work. Then, the authentication method will be described.

- **Registration**: This part is not implemented as the paper is only intended to present an authentication method. The following steps are a suggestion on how to complete the registration process:
    o   The user would go into the registration section in the mobile application and would submit her username, password and QR-Codes number of the phones he intends to use to authenticate.
    o   After validating the data entered (correct password complex enough), the server would store this information on the database.
    o   Next, the server would generate a private and public pair of keys unique to the user, that would be stored on the server.
    o   After this, the user would proceed to download and install the application on her phone.
    o   The first time the mobile application is run, the user will need to enter her username and password (the QR-Codes can be verified by the mobile application) and the credentials (user/password) would be validated against the database through an https request to the application server.
    o   If successful, three files would be imported and stored in the user's phone internal storage: the server's public key, the user's private key, and a user

data file containing the user's encrypted credentials. The server's public key will be used to decrypt the credentials file. The user's private key will be used to authenticate in the server.

- **Authentication:** Due to the need to store transactions and users information, we will have the following two tables in the database as shown in Table 1 and Table 2.

Table 1. Table Server

Column	Type	Modifiers	
qr-codes	bigint		User's QR-Codes
timestamp	integer	not null	Time stamp

Table 2. Table Users

Column	Type	Modifiers	
username	character varying (20)	not null	Username
password	character varying (20)	not null	Password

When the authentication page in the web application is opened, a QR code containing a random number rn between 1 and 999999999 is shown. In the background, a row is created in the transactions table, containing the current timestamp ts and the random number rn.

When the user opens the mobile application, she will need to input the password first. It will be verified against the user's encrypted file containing the credentials and if successful, the scanning application will run. The user can now proceed to scan the code from the web application screen.

The contents of the QR code will be captured and sent back to our mobile application. Our mobile application will then generate a string containing the captured random number and the IMEI of the phone, that will be encrypted using our private key. Next, the mobile application will check the state of the phone and decide whether we are going to authenticate in online or offline mode. For the case online mode authentication, if the phone detects an active Internet connection, the steps below are followed (refer to Fig. 2):

- The encrypted string plus the username are sent to the web server via POST through a secured channel (https). This means that the QR-Codes and random number are encrypted twice, and the username once.
- The server decrypts the string using the user public key and verifies that a row exists in the transactions table with our random number, updating the row with the QR-Codes of the user.

- The server checks then that the QR-Codes is correct and assigned to a user as per the users table.
- In case of success, the transaction row will be deleted and the user authenticated.
- A PHP session is created for the user, being destroyed when the user logs off or when the browser is closed
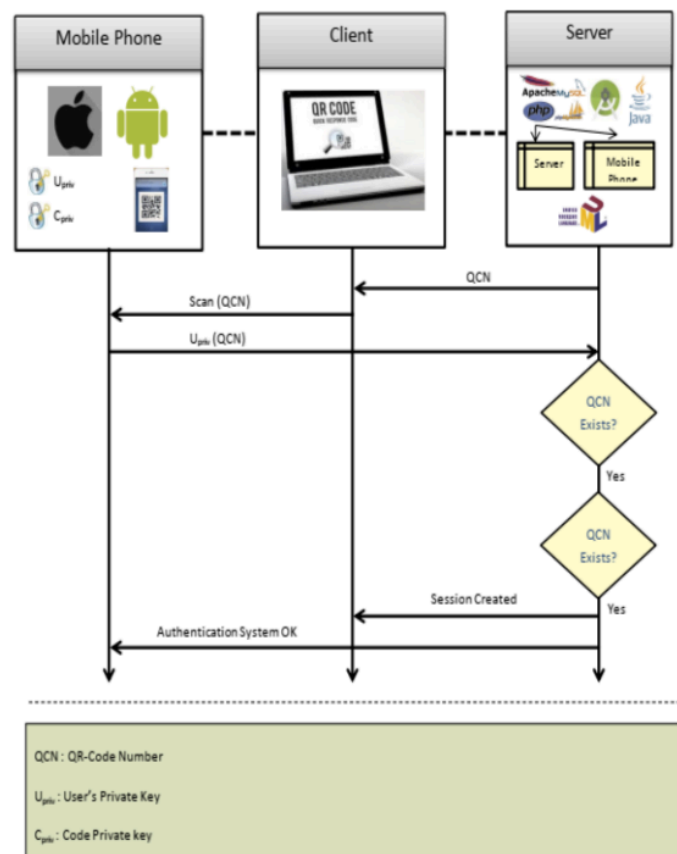

Fig. 2. Online Authentication System

3 Results and Discussion

3.1 Implementations

Use Case Diagram. A use case diagram is a graphic depiction of the interactions among the elements of a system. A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. In this context, the term "system" refers to something being developed or operated, such as a mail-order product

sales and service website. Use case diagrams are employed in UML (Unified Model-ing Language), standard notation for the modeling of real- world objects and systems. In this case, the actors are the Admin, Teacher, and Student. Fig. 3 shows the use case diagram for the proposed system:
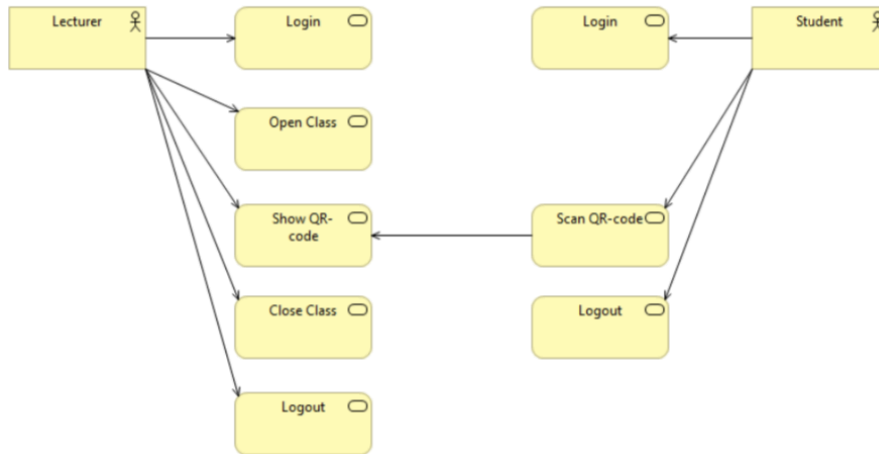
Fig. 3. Use Case Diagram

Interface Designs. The programming languages utilized in this work are the PHP programming language. The programming language is chosen to rely on the lan-guage's features which make them more suitable for this work. In the proposed sys-tem, the user starts with the login interface and the user has to enter the information required as shown in figure 3. If the information is found correct by the system search in the database, it displays to the user the system homepage and allows the user to make use of the proposed system. However, if it's not valid, the user will be redi-rected to the login page. The main interface for the teacher and the excuses verifica-tion interface are represented in Fig. 3(a), Fig. 3(b), Fig. 3(c), Fig. 3(d).

Fig. 3. (a) Login Interface. (b) Login successful interface (c) QR-Code Scanner (d) Web main interface

3.2 Analysis

This stage highlights the usability of the proposed system. During this stage, the system is evaluated while user satisfaction is ensured. The test was executed on the proposed system by running it on Mozilla Firefox and Internet Explorer using the localhost server. For evaluation purpose, 20 students from College of Faculty of Information and Industry at Institut Teknologi Telkom Surabaya were invited to use the prototype. The students were first briefed on the prototype's usage and the user interface. Then, the students tested the system and answered a survey questionnaire consisting of 7 items formulated to gauge the level of user satisfaction. The usability of the proposed system was also determined. The result, as well as the level of usability of the system according to the feedback provided by 20 students, can be referred to Table 3. As can be construed by the result, a significant amount of users agrees that the system is practical, useful and fulfills the project's primary objective.

Table 3. Collected data results from the 20 students

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Strongly Agree	10	7	8	5	7	9	13
Agree	7	6	9	11	10	7	3
Neutral	3	7	3	3	3	3	4
Disagree						1	
Strongly Disagree				1			

4 Conclusion

Computerizing classroom attendance tracking has many advantages over the old system. Data from classrooms can easily be transformed into databases for possible later

analysis or usages. This work designed and implemented a barcode-based student attendance system that can be easily accessed by the lecturers, help the lecturers to avoid maintaining the registry book, providing valuable information about the students and the reports can be generated using real-time processing. The proposed system was designed and implemented using the Android Studio, Objective C, and UML (Unified Modelling Language). The proposed system will also help in generating the defaulter's list on its own and send emails to those students whose attendance is below the required amount.

Acknowledgements

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