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Design and Implementation of a Fingerprint-Based Attendance Management System

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Abstract

This paper presents a design and implementation of a fingerprint-based class attendance management system for convenient, efficient and effective record keeping of lectures. The class attendance management system was designed using Java, MySQL, for the backend and HTML, CSS, for the frontend through various platforms such as android studio. The system was carried out to meet both functional and non-functional requirements of the educational system as well as achieving a stable, maintainable, secure and reliable system. Testing was carried out to ensure the system requirements were met.

1. Introduction

In many institutions, and academic organizations, attendance is a very important criteria which is used for various purposes. These purposes include record keeping, assessment of students, and promotion of optimal and consistent attendance in class. In developing countries, a minimum percentage of class attendance is required in most institutions and this policy has not been adhered to, because of the various challenges the present method of taking attendance presents. This traditional method involves the use of sheets of paper or books in taking student attendance. This method could easily allow for impersonation and the attendance sheet could be stolen or lost. Also, taking of attendance is time consuming and it is difficult to ascertain the number of students that have made the minimum percentage and thus eligible for exam. Thus, there is a need for a system that would eliminate all of these trouble spots. An automatic attendance management system using biometrics would provide the needed solution. [1]

A class attendance management system is a software developed for monitoring and keeping record of daily student attendance in schools and institutions. It facilitates access to the attendance of a particular student in a particular class.
Biometrics is the measurement and statistical analysis of people's unique physical and behavioral characteristics. The technology is mainly used for identification and access control, or for

identifying individuals who are under surveillance. The basic promise of biometric authentication is that every person can be accurately identified by his or her intrinsic physical or behavioral traits. Fingerprint are a form of biometric identification which is unique and does not change in one's lifetime.

A biometric system can be either an 'identification' system or a 'verification' (authentication) system. Automated fingerprint identification is the process of automatically matching one or many unknown fingerprints against a database of known and unknown prints. Automated fingerprint verification is a closely related technique used in applications such as attendance and access control systems. On a technical level, verification systems verify a claimed identity (a user might claim to be John by presenting his PIN or ID card and verify his identity using his fingerprint), whereas identification systems determine identity based solely on fingerprints [2].

This paper focuses on authentication. As mentioned earlier, biometrics allows a person to be identified and authenticated based on a set of recognizable and verifiable data, which are unique and specific to them.

2. Review of Related Works

There are many of previous researchers who have worked on students' attendance system using various biometric technologies such as fingerprint, face and eyes recognition. However, all these studies are limited to attendance issue and neglect other benefits such as impersonation, cost, or ease of mobility. Kadry and Smaili in 2010 carried out a wireless attendance management system based on iris recognition using Daugman's algorithm. The system uses an off-line iris recognition management system that can finish all the process including capturing the image of iris recognition, extracting minutiae, storing and matching. Their drawback was that it was difficult to lay the transmission lines where topography is bad [3]. Shoewu, Makanjuola and Olatinwo in 2013 carried out a fingerprint-based attendance system, using a fingerprint scanner. Although it was relatively cheap and effective, their main drawback was that they did not consider the error that might arise in manual calculation. They did not provide a platform to calculate the overall attendance of the students at the end of a session [4]. Kennedy et al., in 2017 carried out an iris biometric recognition system. The designed graphical user interphase was used to obtain the students particulars and get the iris image captured by the scanner. But they failed to consider the cost effectiveness and ease of mobility, assuming the students were already seated in the lecture hall [5]. Wati et al in 2018 proposed a real-time internet-based attendance system using face recognition. However it requires top quality cameras and advanced software to ensure accuracy and speed. Hence, the overall cost was too high [6].

3. Methodology

The fingerprint is captured using a fingerprint device and then stored into a previously enrolled database. For attendance, the student places his/ her finger over the fingerprint device and the student's matriculation number is sent to the database as having attended that particular lecture. At the end of the semester, reports are generated to specify the students that are eligible for exams and percentage of times the student attended lecture. It consists of two process namely; enrollment and authentication. During enrollment, the fingerprint of the user is captured and its unique features extracted and stored in a database along with the users identity as a template for the subject. During authentication, the fingerprint of the user is captured again and the extracted features compared with the template in the database to determine a match before attendance is made. The fingerprint-based

management system is implemented with Java on Netbeans and a Java development kit as the backend.

3.1. System Architecture

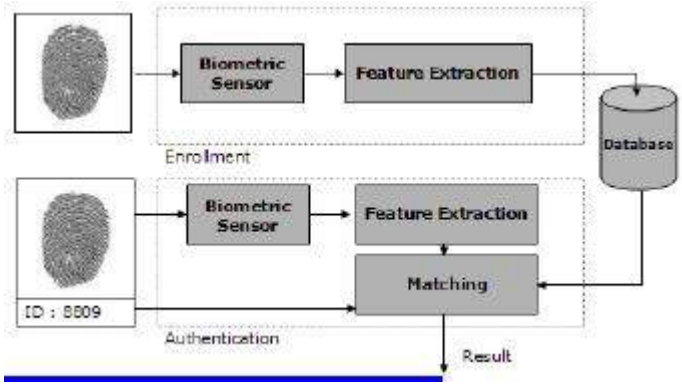

Figure 1: Block diagram of overall system

The attendance management system uses fingerprint authentication. In authentication, the system recognizes an individual by comparing his/her biometrics with his/her previous record in the database to certify if the individual is who he claims to be. In general, biometric authentication consist of two stages:

a. Enrollment: Unlike the identification method, this entails registering the student's bio data in a database so his/her fingerprint can be recognized and verified.
b. Authentication: Once verified, the fingerprint is compared to the already registered and accepted fingerprint and authenticated.

The identification accuracy of a biometrics system is measured with the false (impostor) acceptance rate (FAR) and the false (genuine individual) reject rate (FRR). The FAR/FRR ratios depend, among other factors, on the type of difficulty of the algorithms used in the fingerprint extraction. Usually, algorithms with high-medium complexity lead to acceptable low FRR/FAR. However, as it becomes more complex, the computational cost increases which leads to undesirable high processing times. Thus, the overall performance of the authentication system is evaluated in terms of FAR/FRR, computational cost and other factors such as security, size and cost. A brief flowchart is shown in Figure 2.

3.2 Implementation

The implementation of the application involves the fingerprint reader and the PC/mobile device. The fingerprint reader acquires the fingerprint and the PC consists of the window forms that simulate the attendance application. The functionality of the attendance management system was broken down into the following blocks. These are: (a). Administrative interface (b). Attendance system (c). Reports generation

3.3 Form

The form in the program include: Attendance portal, courses, department, student, lecturers

reports. Note: the courses, student, exams and lecturers form are administrative forms that can only be accessed by the administrator. All the forms are connected to the database and all transactions carried out on the form are stored in the database.

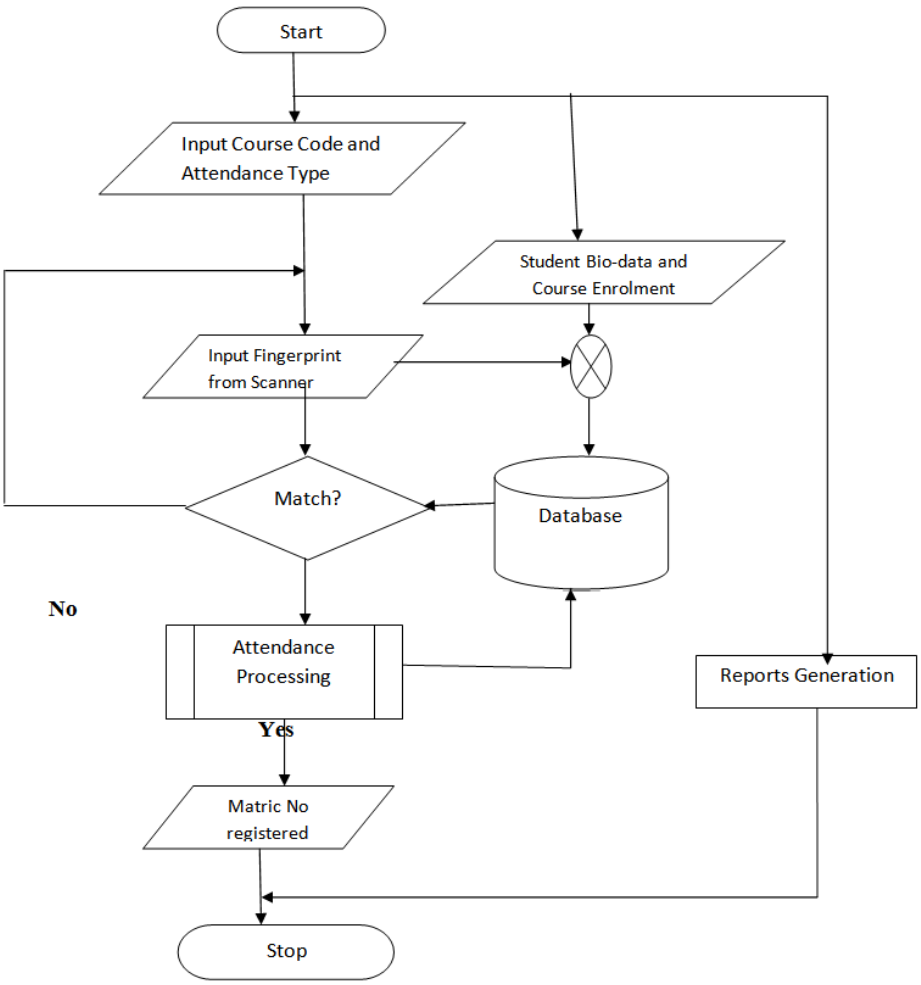

Figure 2: Flowchart for attendance management system

3.3.1 Attendance Portal

This form is used by the students to verify attendance in lectures. This is shown in Figure 3.

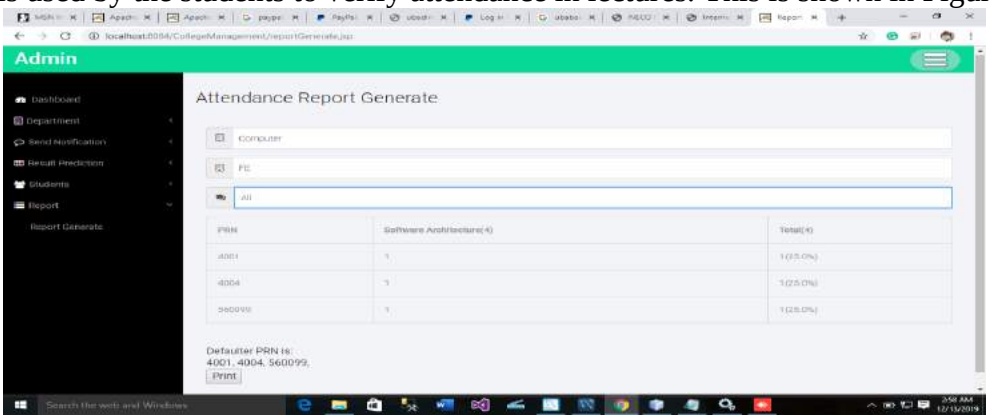

Figure 3: Pictorial view of attendance portal

3.3.2 Courses: This form is a platform to create, edit and delete courses as shown in Figure 4.

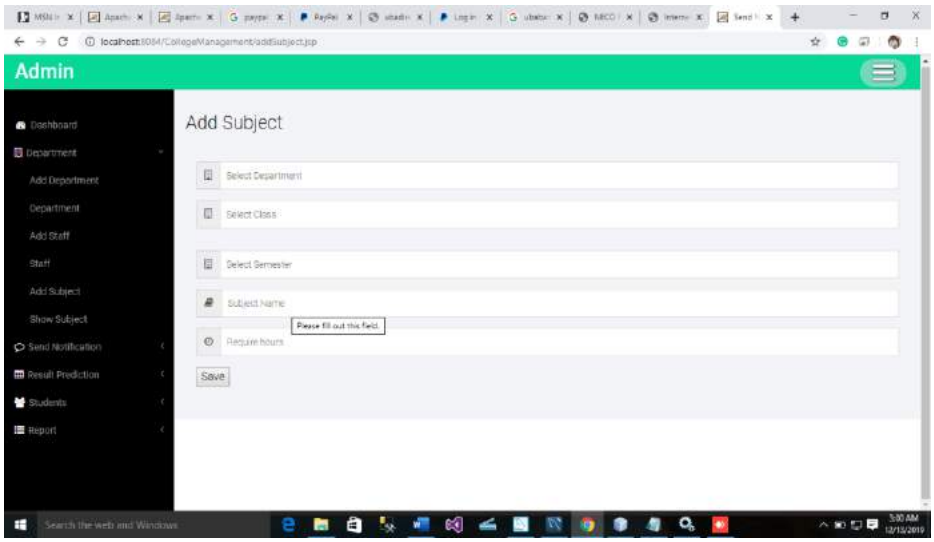

Figure 4: Pictorial view of courses

3.3.3 Department: It shows the department of the students, making it feasible for a lecture hall comprising of different departments. This is shown in Figure 5.

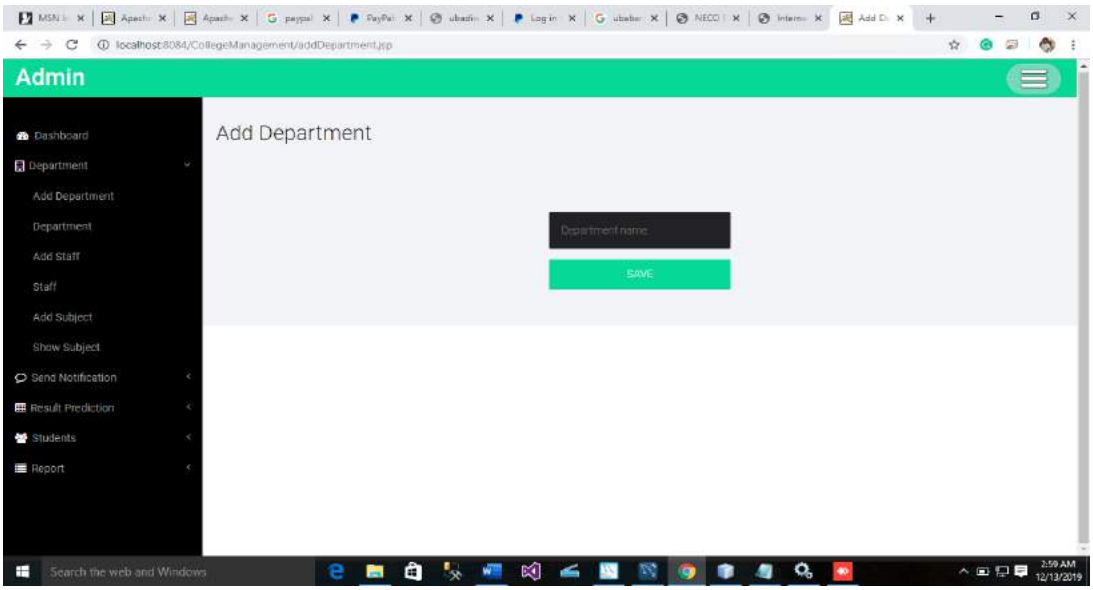

Figure 5: Pictorial view of department

3.3.4 Students: This form is used to enroll students and also to capture the fingerprint for each student into the database. This is shown in Figure 6.

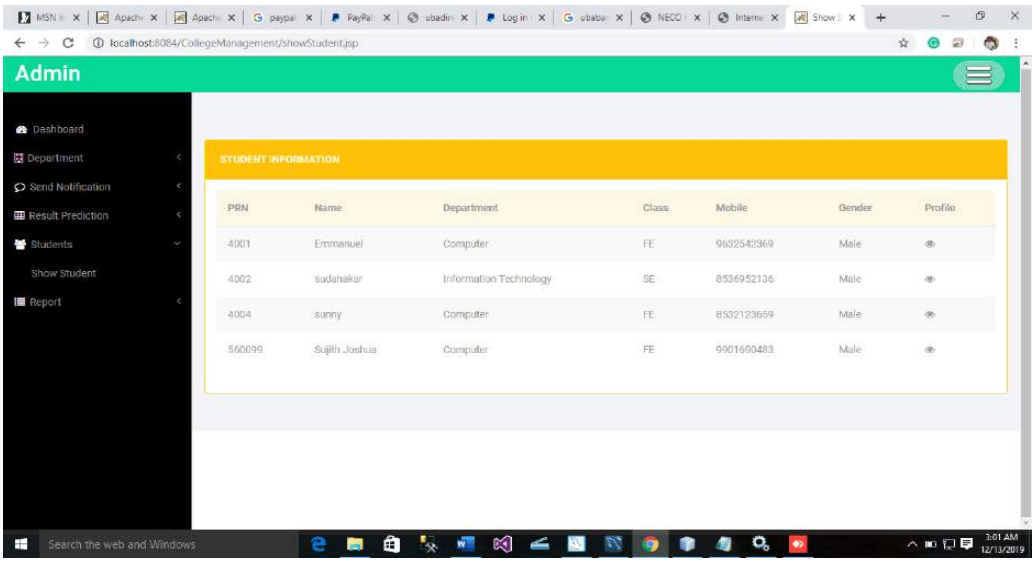

Figure 6: Pictorial view of students

3.3.5 Lecturers: This form provides the functionality to create, edit and delete lecturers. This is shown in Figure 7.

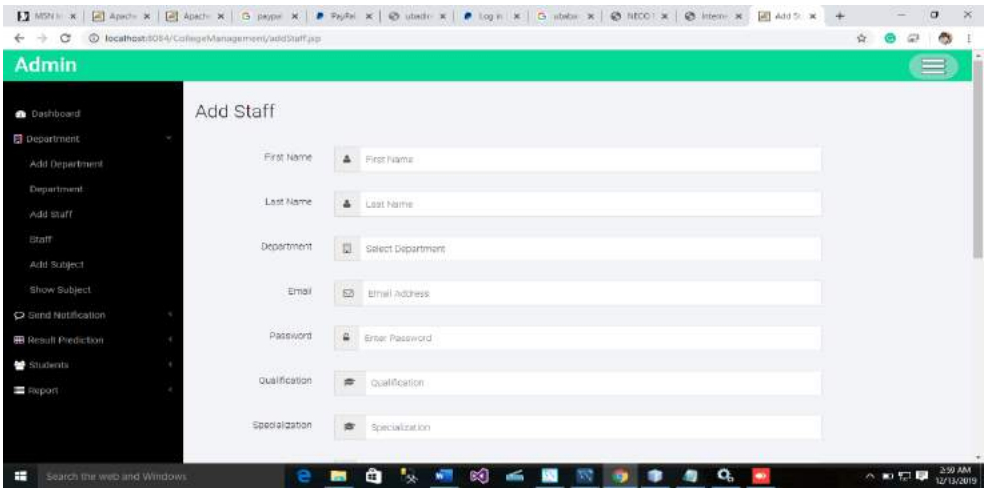

Figure 7: Pictorial view of staff

3.3.6 Report: This platform generates the report. The mathematics involved in generating the overall percentage of students that attended the class is computed, recorded and stored here.

4. System Testing and Result

4.1 Test Result

Figure 8 shows a pictorial view of the test result. It consists of the following for better sorting and an overall arranged system:

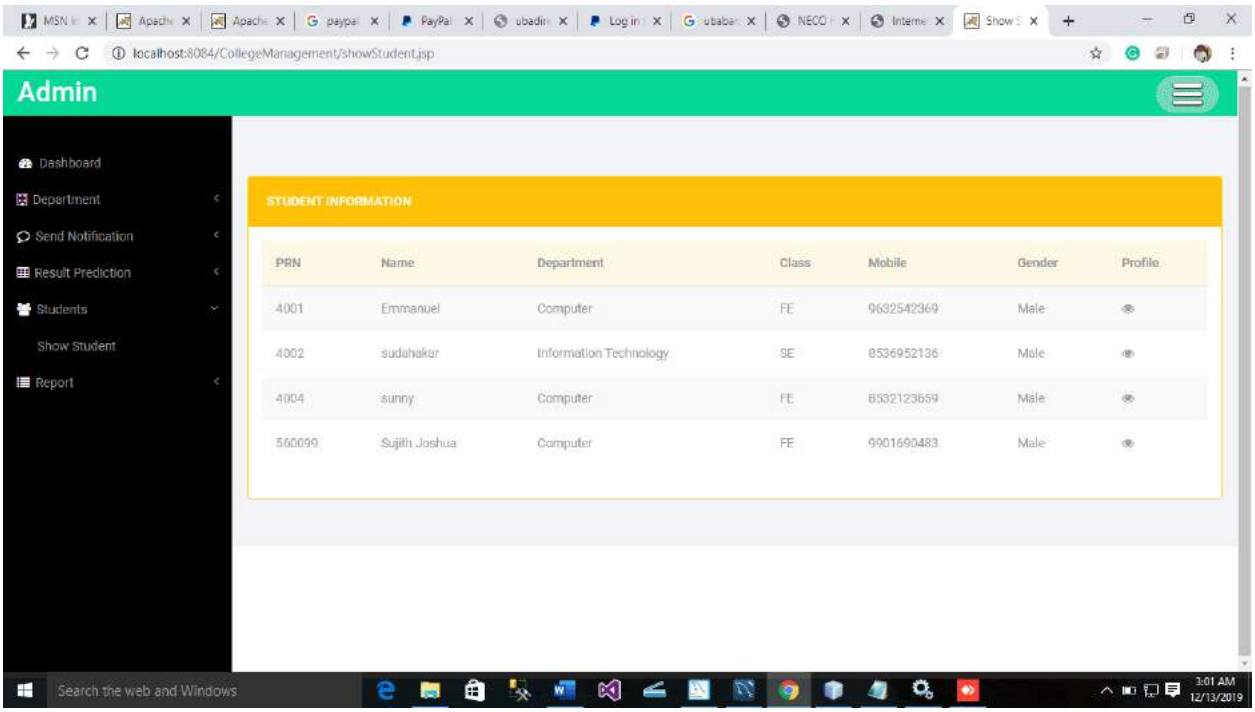

Figure 8: Pictorial view of test result

4.1.1 Enrollment and Registration Phase: The enrollment and registration phase is an administrative phase in which the administrator needs to log in. The courses and lecturers are also registered at this phase. All data and information required for the proper recording of attendance is enrolled here.

4.1.2 Attendance Usage: The lecturer selects the course code and the attendance type, then the student places his/her fingerprint on the fingerprint reader; the finger recognition unit compares the fingerprint features with those stored in the database. The possible cases are: (a) Match (of fingerprint): Captured user fingerprint features are matched with stored fingerprint templates. The user is automatically recorded for that lecture. A message box pops up for a short interval to show that the user has been recorded for the attendance. (b) Non-match (of fingerprint): The user is not accepted for attendance and a message is shown in the textbox that fingerprint is not found.

4.2 Execution Time

The total period to register a new user i.e. sensing the fingerprint and inputting the bio-data is at most, 1minute 20seconds. For the actual attendance collection process, the total time taken to sense the fingerprint, identify the user and record the attendance for that particular course is less than 10 seconds.

4.3 Comments

This system can also be adapted for other institutions as well as for exam validation. After the overall attendance is taken, it will also show if the student is valid or not, based on the percentage generated from the attendance system. That is, the system is flexible.

4.4 Summary

This project requires a fingerprint reader for finger detection. Every lecturer can login to the system through finger detection. The fingerprint of the student is compared with the one stored in the database and if it matches, attendance is marked for that particular student. The system also generates a brief report of attendance from the database according to subject-wise or date-wise as required. A defaulter list can be generated through the system. Admin has the option to take a print of the reports and defaulter list thus generated.

5. Conclusion

This work focused on the design and implementation of a fingerprint-based class attendance management system to provide a convenient and efficient means of conducting class attendance and documenting the process.

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