A Fingerprint Based Attendance Monitoring System with SMS Alert

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ABSTRACT
Management of the attendance of students in an institution can be rigorous using the conventional method of paper sheets and the old file system method. The approach and accuracy of this attendance record are marred with various issues, such as the manipulation of the attendance record by fraudulent students, updating of the current attendance record to the already collated previous attendance records, and so on. Previous attendance management systems monitor attendance of the students without giving feedback such as sending Short Message Service (SMS). A fingerprint-based attendance management system with an SMS alert was developed to monitor the attendance of the student and inform them of their attendance status before the examination. The system utilizes a portable fingerprint scanner as the input to acquire fingerprint images and notebook personal computers as the mobile terminal for the processing of the images and to record attendance. The system consists of two modules, the enrolment and the authentication modules. The enrolment module takes the fingerprint of an individual, extract its unique features and stores it in a database while the authentication module takes a fingerprint, extract its features and compare it with the fingerprints stored in the database. A database was developed to store student's information, lecturer's information, and attendance records of the students. Java was used as the programming language, SQLite as the database, and eBulkSMS API as the means of SMS. The system was tested with ten courses and an accuracy of 90% was achieved.

Keyword: Attendance, fingerprint, Java, SQLite, eBulkSMS

1. INTRODUCTION

Biometric identification systems are widely used for the unique identification of humans mainly for verification and identification. Biometrics is used as a form of identity access management and access control. The use of biometrics in the student attendance management system is a secure approach. There are many types of biometric systems like fingerprint recognition, face recognition, voice recognition, iris recognition, palm recognition, and so on (Sridevi, 2014). Fingerprints are considered to be the best and fastest method for biometric identification. They are secured, unique for every person, and do not change in one's lifetime (Sridevi, 2014). Besides these, the implementation of the fingerprint recognition system is cheap, easy, and accurate. Fingerprint recognition has been widely used in both forensic and civilian applications. Attendance Management falls into two categories namely: Conventional and Automated methods (Ononiwu and Okafor, 2012). Conventional methods include timesheet, attendance register, and time clock. Timesheets are documents, electronic or otherwise that record what time was spent by the employee on what tasks. Attendance register is an official list of people who are present at an institution or organization. Time clock which is a mechanical (or electronic) timepiece used to assist in tracking the hour when a student arrives at the class if he or she meets the lecturer's lecturing time. Automated methods include the barcode attendance system, magnetic stripe attendance system, Radio Frequency Identification (RFID), and the biometric attendance system (Ononiwu and Okafor, 2012).

Issues in managing absenteeism, tardiness in school or class have always been at the expense of large numbers of students on a system that offers limited returns or even more, unfortunately, at the expense of the lecturer's considerable workload. Identity sharing or impersonation as an illegal means of clocking in study hours for course accreditation has also been highlighted as an inherent problem that has not been properly addressed (Supriyo, 2012).

Attendance management of students in an institution can be rigorous using the conventional method of paper sheets and the old file system method. The approach and accuracy of this attendance record are marred with various issues, such as the buddy-signing or manipulation of the attendance record by fraudulent students, updating of the current attendance record to the already collated previous attendance records, and so on (Shoewu *et al.*, 2014). According to Sridevi (2014) analyzing and tracking student performances based on attendance is tedious and may not be accurate most of the time. Therefore, there is a need for the development of a fingerprint-based attendance system with SMS alert to overcome the problems associated with the attendance system.

2. REVIEW OF RELATED WORKS

Recently, there has been so much research in the development of students absence and attendance system, some of which include Internet systems like web-based system, mobile-based attendance system, some of the others computerized attendance system with hardware technology like fingerprint based attendance system, iris-based attendance system, face recognition based attendance system, RFID (Radio Frequency Identification) based attendance system, and others need communication technology like Bluetooth mobile device.

Shoewu and Badejo (2006) designed and implemented a system that authenticates the user based on passwords. This system still could not eliminate impersonation since the password can be shared or tampered with. Passwords many times can be forgotten or the system hacked thereby preventing user's access to the system. Kadry and Smaili (2010) proposed 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 processes including capturing the image of iris recognition, extracting minutiae, storing and matching but it is difficult to lay the transmission lines where the topography is bad.

Shoewu *et al.* (2011) proposed an embedded computer-based lecture attendance management system where single-chip computer-based subsystems (an improvised electronic card and the card reader) were interfaced serially to the serial port of the digital computer. The electronic card is a model of a smart card containing the student identity (IDName, Matriculation Number, and five PIN encrypted code). The student ID is authenticated by the card reader which compares the entrance code with the encrypted code on the card swiped through the card reader. The student is granted and/or denies specific lecture attendance based on the result of the comparison by the backend software system running on the PC to which the card reader is serially interfaced. The system though provided a simplified, low cost embedded computer-based system solution to the management of lecture attendance problems in developing countries but does not eliminate the risk of impersonation. The system is device-based in which students have to carry RFID cards and also the RFID detectors are needed to be installed.

Shehu *et al.* (2011) proposed a real-time computer vision algorithm in automatic attendance management systems using Computer vision and face recognition algorithms and integrating both into the process of attendance management. The system eliminates classical student identification such as calling student names, or checking respective identification cards but cannot still identify each student present in class thereby providing a lower recognition rate because facial images are subject to change between the time of enrolment and time of verification and also poses a bigger financial burden during installation and do not offer any privacy protection. Meorsaid and Misran (2014) present a system of recording student attendance using fingerprint identification that allows students to monitor student attendance to class electronically. This attendance system displays attractive graphics and has the complete students' details using Microsoft Visual Basic Studio and an integrated fingerprint reader. The system still lacks in the aspect of security such as the student manipulating the record by creating an attendance form without the lecturer's consent.

Karwan *et al.* (2018) present a student attendance management system, the system is a web-based application developed for daily student attendance in departments within the institution. It facilitates access to the attendance of a particular student in a particular class. This system will also help in

generating reports and evaluating the attendance eligibility of a student. When students' absence arrives at their 5% rate for a specific course, a notification email was sent to them informing them about the risks of failing in that specific course. This work tends to improve the conventional attendance monitoring system which can calculate the percentage of attendance of students and also send the results to the students via SMS.

3. METHODOLOGY

The developed attendant management system is divided into the hardware section and the software section. The hardware is the fingerprint scanner that captures the fingerprint image and the computer system which runs the developed application and houses the database. The software section comprises the database creation software and the application program. The database software employed is an SQLite database while Java Programming Language was used for the application program. The software application consists of the enrolment module and the authentication module. The enrolment module captures the fingerprint images of the students and the lecturer then extract the features and stores the unique features in a database. In the authentication module, the lecturer who is also the admin will first authenticate himself to unlock the system before the students can be authenticated. In the authentication module, the fingerprint to be verified was captured by the fingerprint scanner and the unique features were extracted. The extracted features were compared with the features stored in the database, and when a match occurs, it authenticates the user and marks him or her as present. The result of the percentage attendance is stored in the database which can be queried by the admin when needed. The Griaule fingerprint software development kit was used for the enrolment and authentication process because it contains the API needed to access data from the fingerprint reader.

Griaule fingerprint SDK is a fingerprint recognition software development kit (SDK) which helps to integrate biometrics in different areas of applications such as authorization, transaction management, attendance system and so using the fingerprint. The SDK supports windows programming language such as DLL, Java, ActiveX or .NET. It also improves the template quality which helps to improve the recognition rate and also eliminates the need of using multiple samples of the same finger thereby reducing the size of the database and identification time. Griaule fingerprint SDK supports one-to-many fingerprint identification

The UML diagrams such as the use case diagram, activity diagram for the activities on the developed system, an entity-relationship diagram was also employed. The use case diagram has two actors namely, the student, lecturer, or administrator, and the diagram is presented in Figure 1. The activity diagrams for the registration of lecturer, management of student information, management of lecturer information, student attendance check-in is presented in Figure 2 (a - h). The actions performed by the actors ranging from registration, checking in, adding courses, deleting courses, and managing reports. The attendance management system has two main modules namely the admin or lecturer module and the student module. The Admin is a person who runs and manages the system, in this project the lecturer or director of the school has rights of the admin. The Admin creates the structure of a system for creating standards and classrooms. The admin manages student information, lecturer information, course information, assign lecturer to course, add attendance, validate attendance, manage report, and manage communication methods. From the student module, the student access to the system is limited only to check-in their attendance for an ongoing lecture using their fingerprint.

Fig 1: Use-Case Diagram

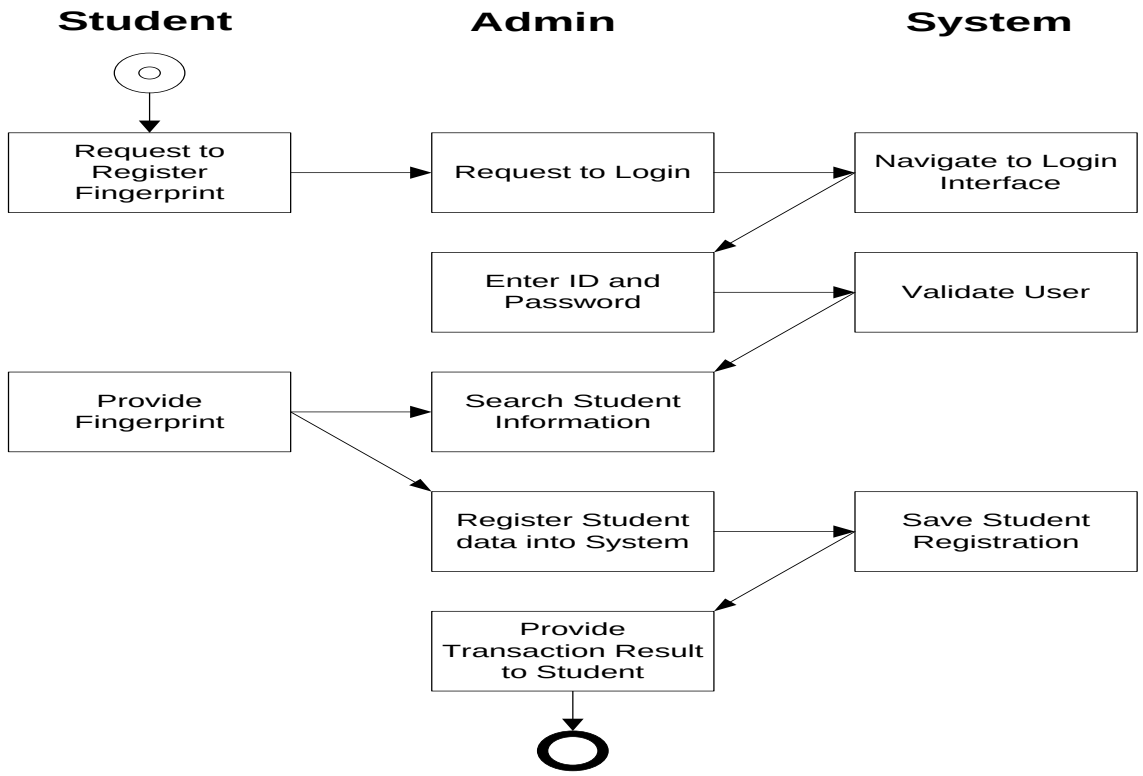

Fig 2a: Activity Diagram for Register Fingerprint (Student)

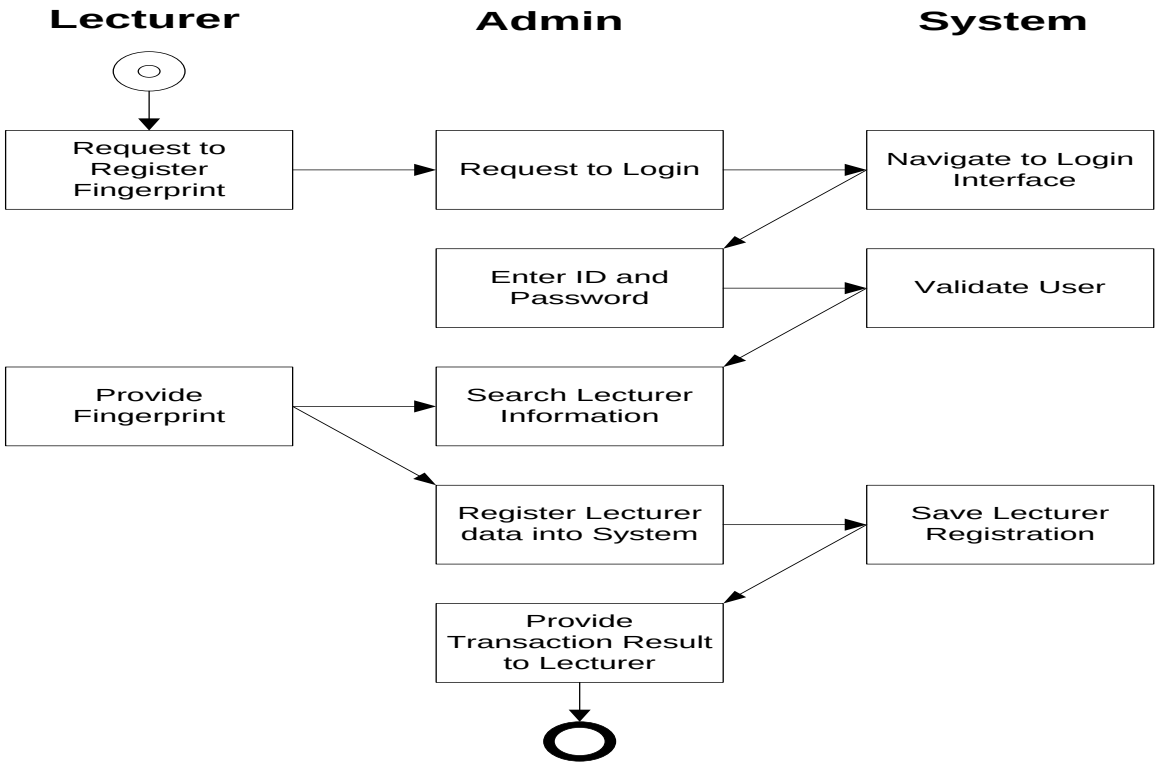

Fig 2b: Activity Diagram for Register Fingerprint (Lecturer)

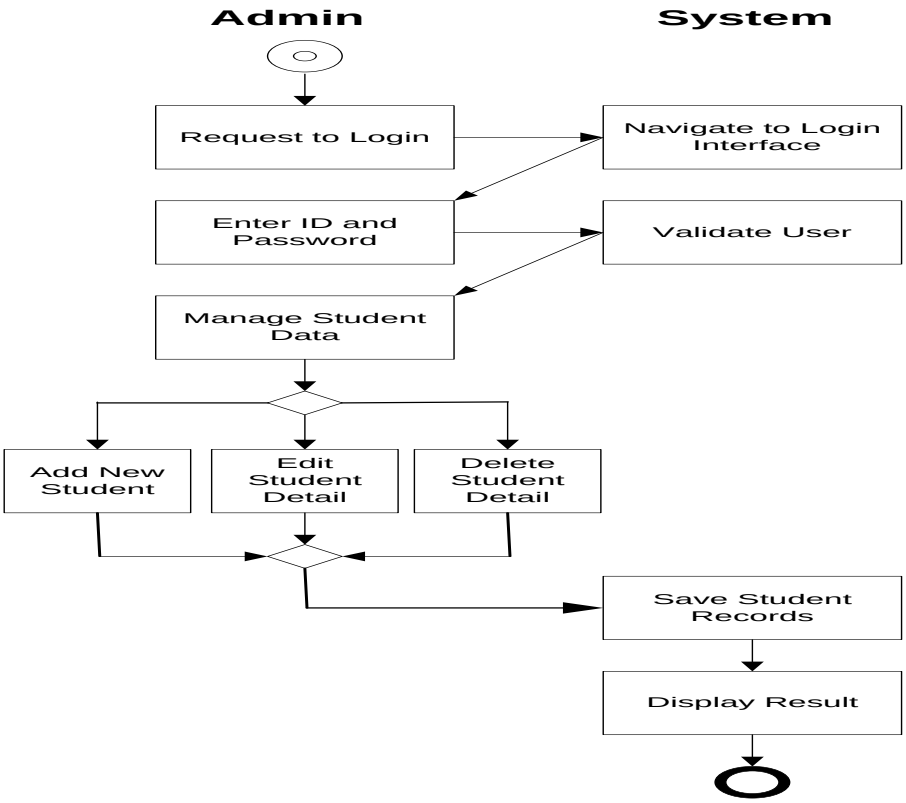

Fig 2c: Activity Diagram to manage Student Information

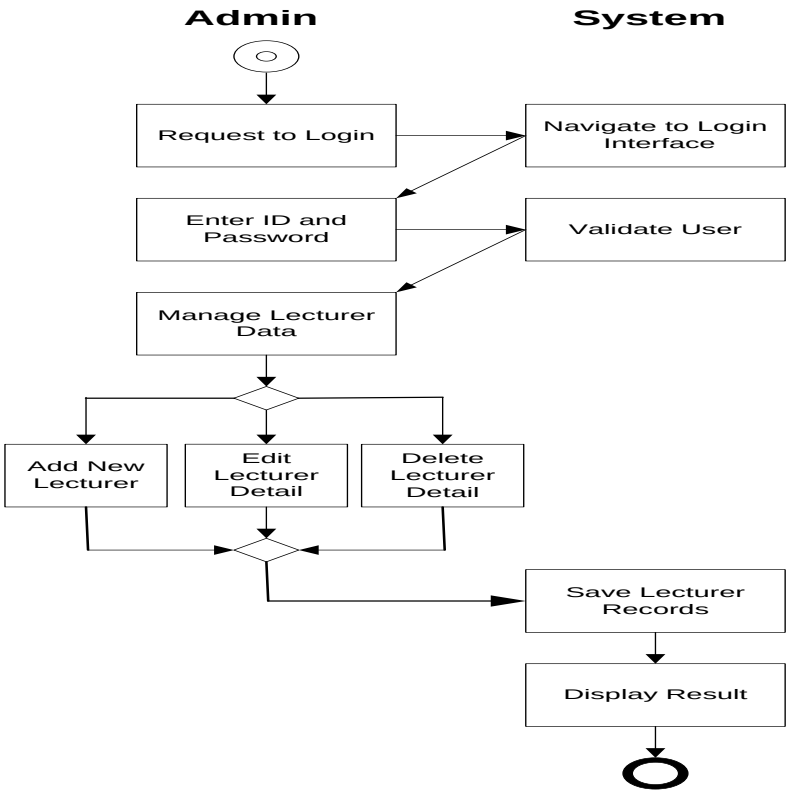

Fig 2d: Activity Diagram to manage Lecturer Information

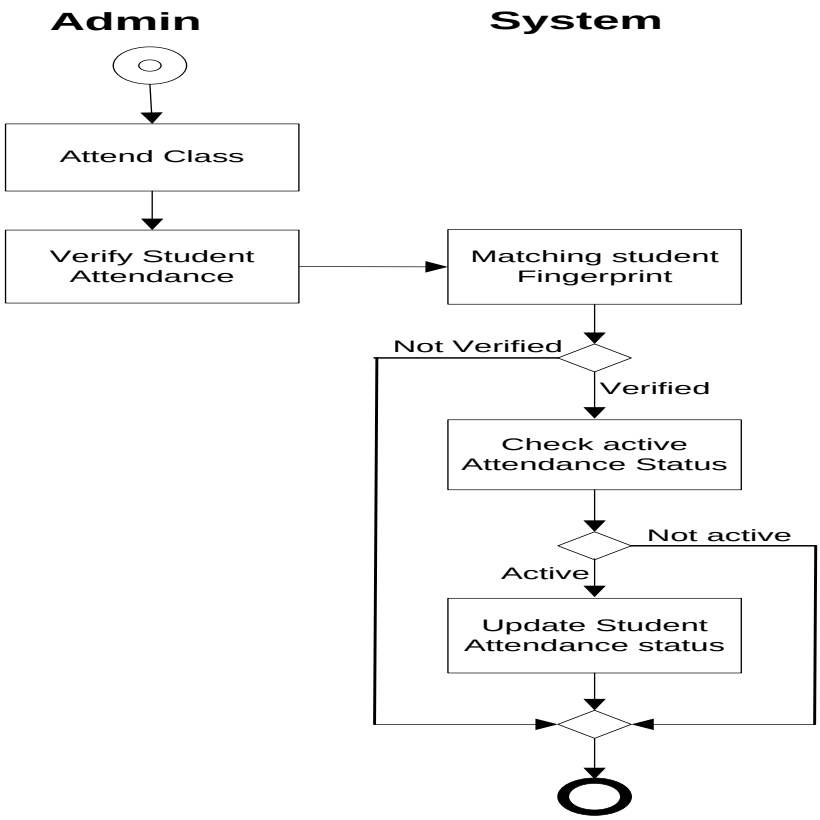

Fig 2e: Activity Diagram for Check-in Attendance (Student)

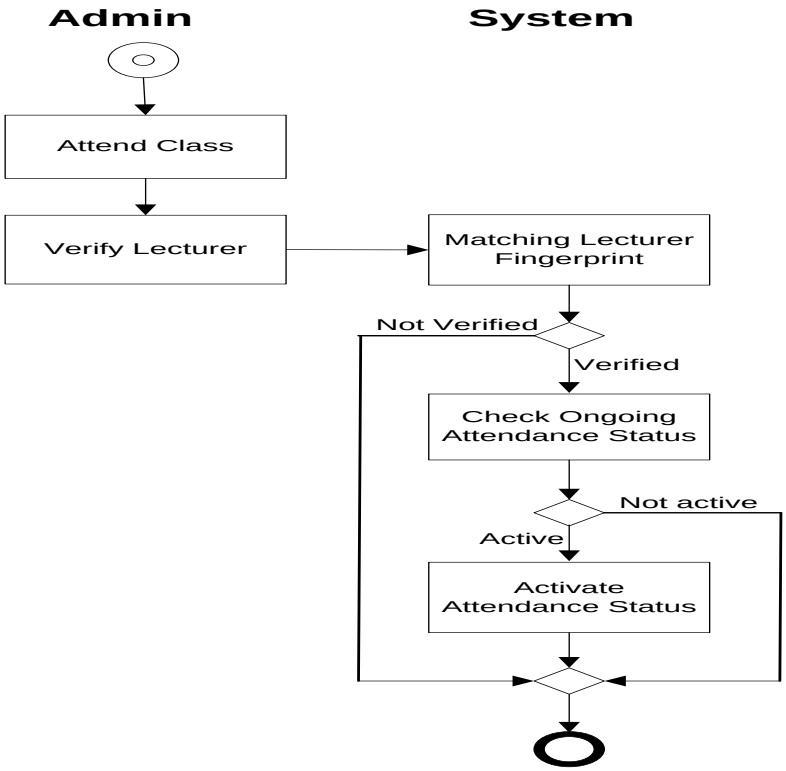

Fig 2f: Activity Diagram for Attendance Activation (Lecturer)

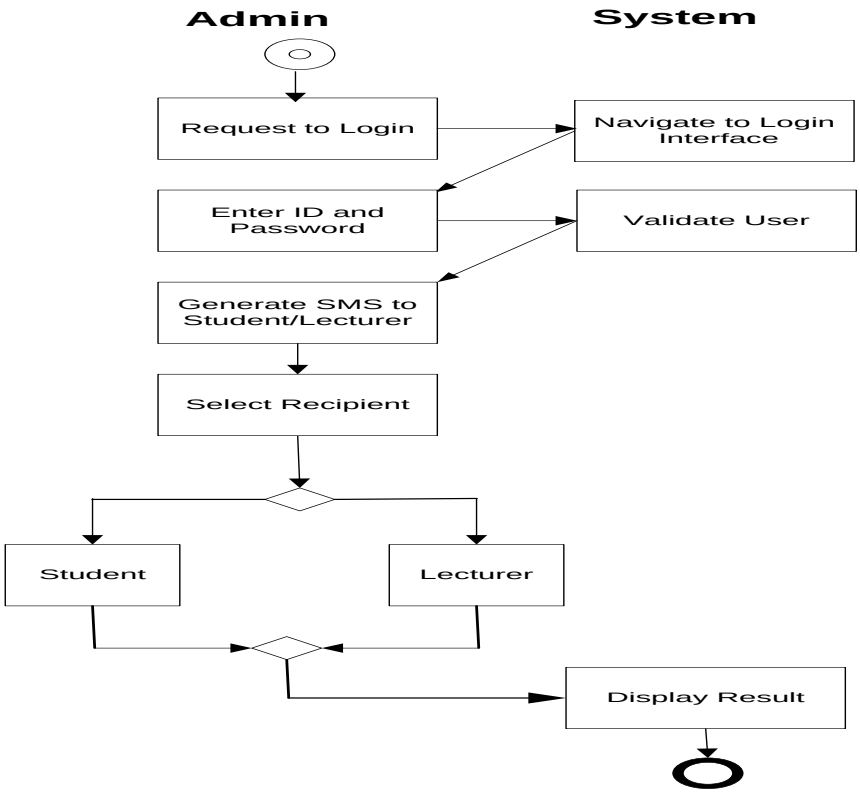

Fig 2g: Activity Diagram to Manage Communication Method (Admin)

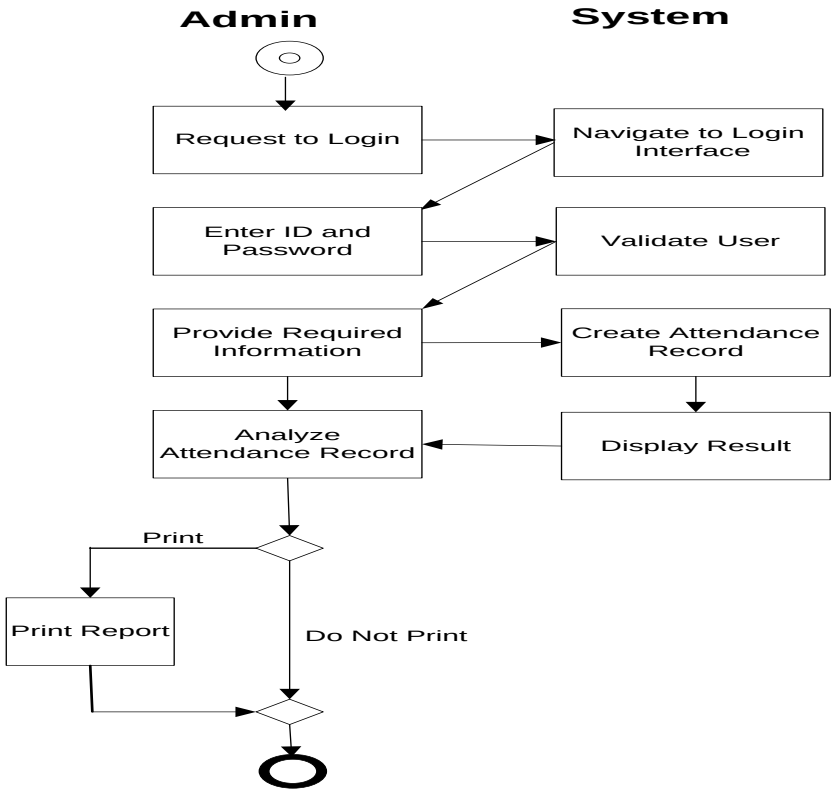

Fig 2h: Activity Diagram to Manage Report (Admin)

4. RESULTS AND DISCUSSION

Some of the results obtained from the implementation of the fingerprint-based attendance monitoring system are presented in Figure 3 (a - d). Figures 3a and 3b show that the personal details of both students and the lecturer successfully login. The Figures redirect users back to view personal details edit personal profile. It also displays a successful registration or record update. It stores the student's

or lecturer's fingerprint templates into a folder. The GUI for the authentication is shown in figure 3c which shows that the authentication was successful. Figure 3d shows the calculated attendance report of the students.

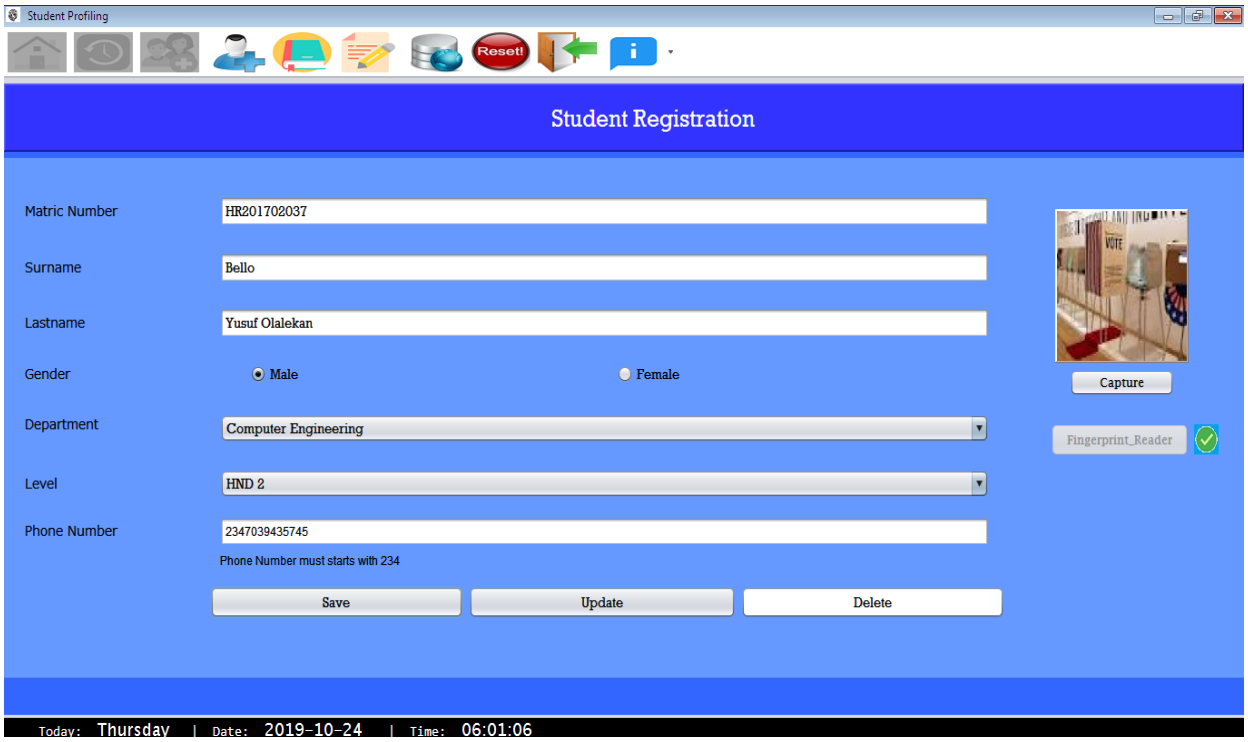

Fig 3a: GUI to Manage Student Information

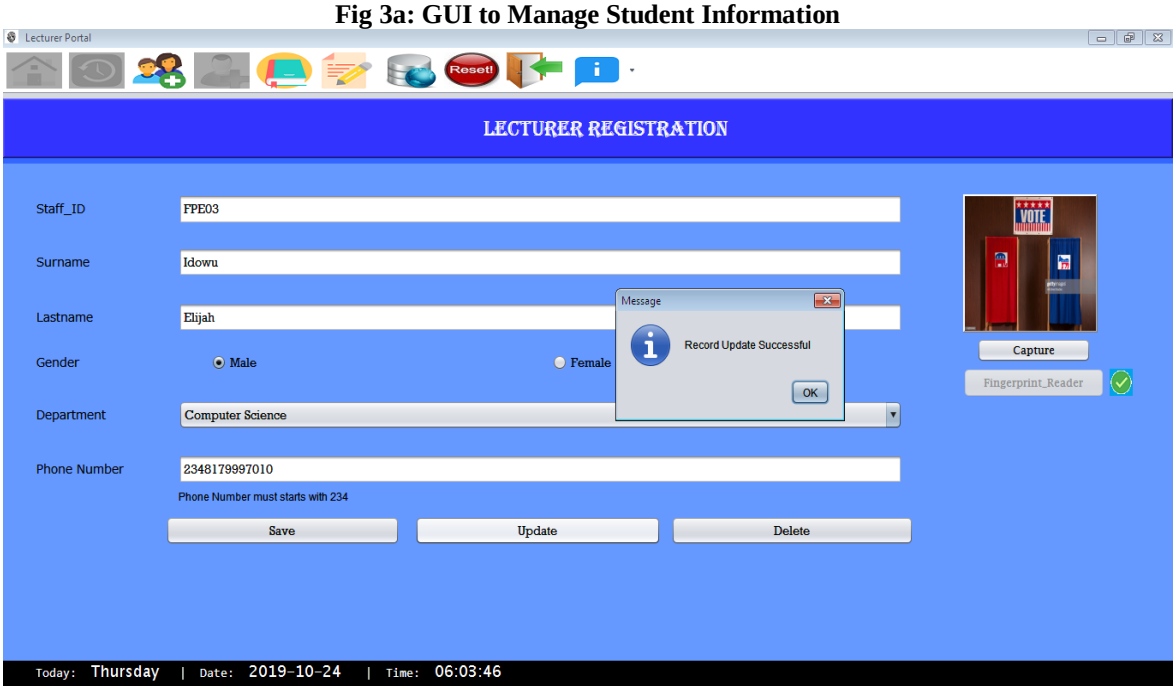

Fig 3b: GUI to Manage Lecturer Information

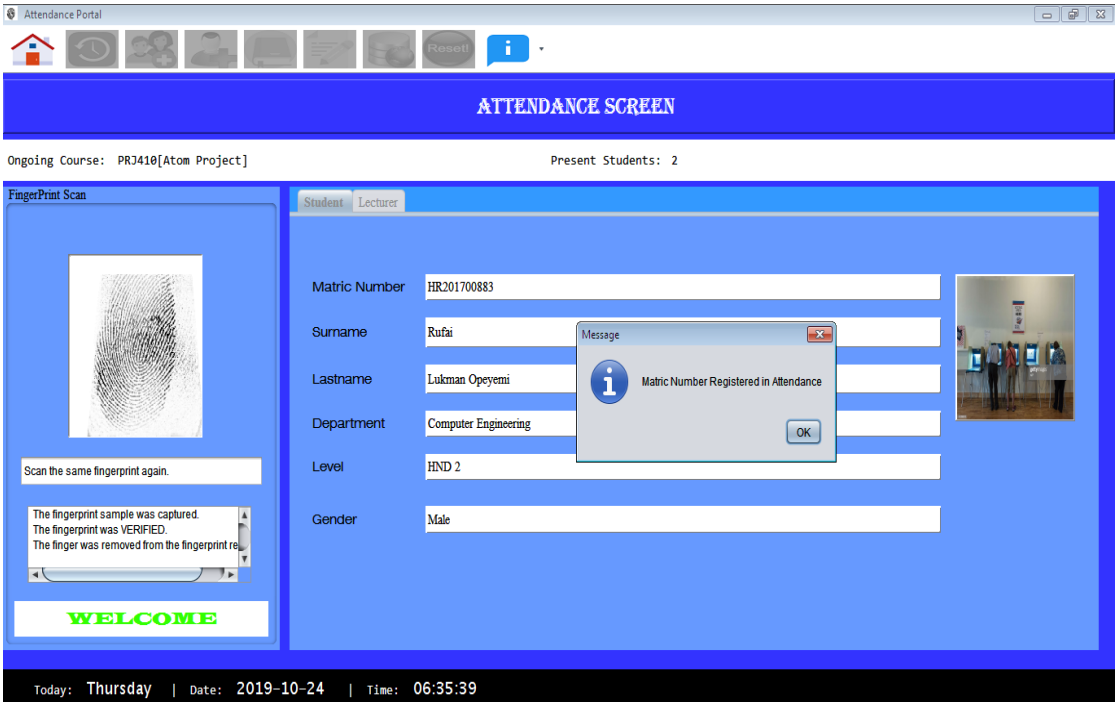

Fig 3c: GUI for Attendance Check-in

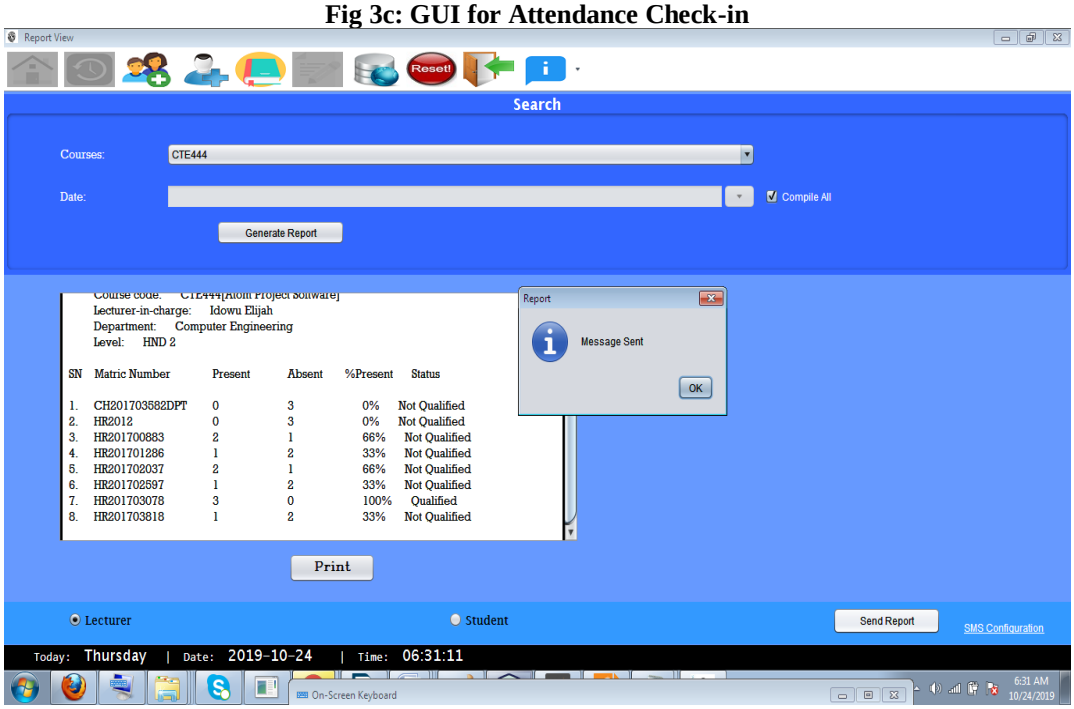

Fig 3d: Attendance Report

5. RESULTS EVALUATION

Higher National Diploma (HND II) Students were used to experiment with the developed system on different lecture occasions. The students performed normal automated attendance registration, verification, and check-in. At the end of the lecture, the system calculated the total number of students who attended the class for that particular period, and also, lecturers in charge of the course manually calculated the number of students who attended the lecture to evaluate the performance of the developed system. The results obtained are presented in Table 1.

Table 1. Experimental Result of the Developed System

S/N	Course Code	Number of Registered Students	Results from Manual Computation	Results from the Developed System	Remarks
1	CTE 421	47	45	45	Correct
2	CTE 431	47	43	43	Correct
3	CTE 433	47	47	47	Correct
4	CTE 434	45	46	46	Correct
5	CTE 435	47	45	45	Correct
6	CTE 436	47	46	46	Correct
7	EEC 433	43	38	39	Incorrect
8	EED 413	47	47	47	Correct
9	CTE 441	47	45	45	Correct
10	CTE 444	47	43	43	Correct

From Table 1, the results of the manual computation and the developed system vary by one that is 38 for manual and 39 for the developed system in EEC 433. It was shown that only one course out of ten was erroneously computed by the developed system. The performance of the system was determined using the metrics in equation (1).

$$Accuracy = \frac{Total\ Number\ of\ Correct\ observations}{Total\ Number\ of\ Experiment} \times 100 \quad (1)$$

$$Accuracy = \frac{9}{10} \times 100 = 90\%$$

From the performance, evaluation result obtained it can be deduced that the developed system is almost perfect.

6. CONCLUSION

The developed fingerprint-based attendance monitoring system was able to perform all the activities in terms of registration, validation, updating records, and monitoring students' attendance per course. The result of the developed system shows that the system will assist in eliminating stated problems such as buddy-signing, loss of attendance sheet, skip class issue, and hard in analyzing student attendance records from time-to-time.

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Author's Brief Profile

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