A Multifactor Student Attendance Management System Using Fingerprint Biometrics and RFID Techniques

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Abstract—**Attendance is an important factor for measuring eligibility, commitment and record keeping for assessment of students and employees. Several automated attendance systems have been developed. These systems are mostly based on single factor template based, which pose a security fault line. This paper presents the development of a multifactor attendance system that employs the flexibility of RFID technology and the security of fingerprint biometrics to manage students' attendance record. Performance evaluation in terms of response time and event using 10 students shows that average execution time of approximately 4.61 seconds could be achieved. Likewise, the system recorded zero percent (0%) of false reject, which tries the system reliability and integrity of the result.**

Keywords- RFID; Fingerprint Biometric; Cryptography; Authentication; Security.

I. INTRODUCTION

In schools and various institutions or organizations, attendance is used for several purposes which include assessment of students' eligibility for term or promotional exams, assessment of staffs' commitment toward their job, and record keeping for employees. Attendance can be defined as being available either at a meeting or a particular place at a given time. It can as well be seen as the recurrence with which a person is available or the numbers of individuals present [1]. This concept can be applied and adopted for recording attendance in companies, industries, schools and so on where people are involved.

Radio Frequency Identification (RFID) is a fast and reliable means of identifying objects whereby identification data are saved in an electronic device known as RFID tags, also called transponders, and the data is retrieved by RFID readers, also called Interrogators, through radio waves. RFID tags are classified into two, namely: Active RFID labels and Passive RFID labels. Active labels have a battery incorporated with the label and transmits signal periodically to the reader. Whereas a passive label is cheaper, smaller, and makes use of radio energy that is transmitted by the reader because it is not self-powered by a battery. This project used passive RFID tags since they are less expensive, flexible, light, and last longer than active tags.

Biometrics means "Life Measurement", but the term is linked up with the function of measurable unique physiological and biological characteristics to identify an individual. Biometric characteristics are considered to be unique to a particular individual. Therefore, use of biometrics in this system provides a good approach against impersonation. This ensures users to verify a person's identity based on "who is he/she?", rather than verifying by what he/she possesses (Example, an ID card), or by "what he/she remembers" example, a password [2]. Selected biometric feature for Human Recognition System includes – DNA, Retina, Voice, fingerprint, iris, facial, and hand.

This paper presents the development of a multifactor authentication system (RFID and Finger Print Biometrics) for students' attendance management system.

The rest of the paper is structured as follows. Section 2 presents some of the related literatures in the field of study. While, Sections 3 presents the system design and implementation. Section 4 presents the system evaluation, while conclusion and recommendation for future work is presented lastly in section 6.

II. RELATED WORKS

A number of related works exist in the application of different methods and principles to effectively monitor the attendance of students. In [2], an attendance management system using Biometrics was developed. The system took attendance of students via a fingerprint module and the records were stored in a database. There was no false identification of students as success rate was over 90%. However, there were no security measures adopted in the database to protect students' data.

Also, [3] implemented a Wireless, Fingerprint Attendance Marking System, which presented a framework using which attendance management can be made automated and on-line. But the system lacks security measures to protect students' data.

In the same vain, [4] implemented a Zigbee Based Student Attendance System Using Local Area Network (LAN) Networking. In this system, students could report their attendance via biometric system and notification of attendance is passed to the administrative

office through a Zigbee Module. However, the device can get damaged and the students' data will be exposed.

A solution based on Template-Free Biometric-Key Generation by Means of Fuzzy Genetic Clustering which requires the storage of neither biometric templates nor encryption keys, but by directly generating the keys from statistical features of biometric data was proposed in [5]. This solution was proposed but not implemented.

Furthermore, [6] designed and developed a Portable Class- room Attendance System Based on Arduino and Fingerprint Biometric. However, the system is prone to attack by an intruder, especially through the web since the web application share the same database with the desktop application and no security measures were taken to protect information in the database.

Similarly, an embedded computer-based lecture attendance management system where a single-chip computer based sub- systems (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 (ID-Name, Matriculation Number and five pins encrypted code) was proposed in [7]. The system, though provided a simplified, low cost embedded computer based system solution to the management of lecture attendance problem in developing countries but does not eliminate the risk of impersonation.

RFID [8] and Biometrics technologies have both been individually used to solve the problem of attendance in modern times. RFID has a major security and integrity problem called "buddy punching" which is when a user swipes a card on behalf of another without the presence of that user [2]. The system developed in this paper combines the flexibility of RFID technology and the security of fingerprint biometrics to track student's attendance record.

III. SYSTEM DESIGN

In the attendance system, RFID labels having unique characters are linked with student names. This implies every student is given RFID labels exclusive to him/her. Passive RFID labels were picked in light of the fact that they needn't bother with a power source to function. However, they get powered through the electromagnetic field made by the RFID transceiver. At the point when a student swipes his/her RFID label near the RFID transceiver in the hardware module, the number connected to the tag is caught by the transceiver and sent to the processor which further shows the students' details on a Liquid Crystal Display (LCD) screen. The system will furthermore need to scan the students fingerprint for authentication and then record the time of attendance in the SD Card Memory.

The attendance system consists of two phases: The Registration unit and the Authentication unit. Figure 1 shows the block diagram of the system. The hardware unit is powered by 3.3V DC power source.

A. Registration Unit

Student's registration is in two (2) phases: firstly, registration with the Attendance Management System Desktop Application Software in the Administrator's

personal computer which shall take the record of each student's Name, Matriculation Number, RFID tag number, and the session. This will enable report generation and proper record management. Secondly, students will be required to place their fingerprints on a scanner for biometric capture in order to link to the student's RFID information already entered in the microcontroller's database.
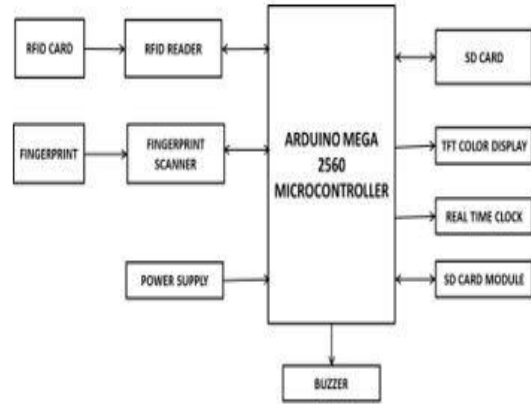

Figure 1. Block Diagram of Attendance System Hardware

B. Authentication/Verification unit

During authentication, the students will be required to pass their RFID tag close to the hardware module carrying the RFID transceiver; the number associated with the tag is taken by the RFID Reader and sent to the processor which further displays the students' details on the screen. The system will furthermore proceed to scan the students fingerprint for authentication and then record the time of attendance in the SD Card Memory.

The flowchart of the system is shown in Figure 2.

C. System software Design Considerations

The developed Software consists of a Database (Back end) and also an application program (Front end). The database stores the fingerprint record of the Students, Courses offered, Lecturers data. It as well serves for report generation as specified by the administrator and was implemented using Microsoft SQL Server. SQL Server incorporates numerous elements that make it an effective database administration framework: It has support for multiple platforms/operating system, easy integration with Microsoft .NET environment, scalable meaning can grow with database needs of a firm and reliable meaning c an detect incomplete transaction in a database and prevents it from being corrupted after power failure. The application program was developed using Microsoft Visual Basic.Net language in visual studio environment. The .Net gives simplicity of creating projects for cross-platform compatibility. The significant parts of the .Net consist of the Visual Studio Integrated Development Environment (IDE) responsible for developing the programs and the Microsoft .Net Framework, which is responsible for running programs. VB.Net is a very user-friendly and an object-oriented programming language. Block diagram and use case diagram of the software application is shown in Figures 3 and 4 respectively.
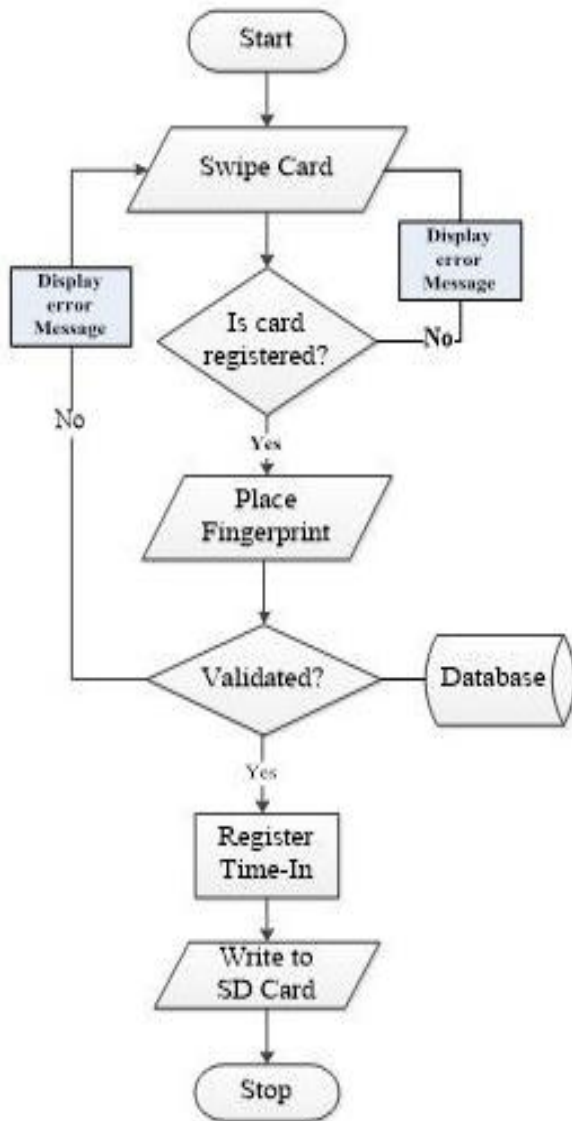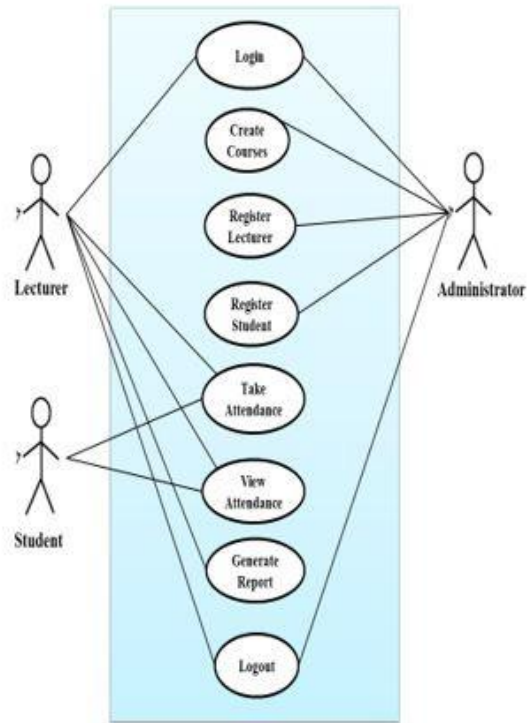
Figure 2. System Flowchart

Figure 4. Use Case Diagram

D. System Implementation

The hardware authentication unit as shown in Figures 5 is a combination of the RFID reader (125 KHz 10 cm range RFID reader), fingerprint sensor (Optical Fingerprint Sensor Module – FPM10A with TTL/UART interface), TFT LCD display, Real Time Clock, Buzzer, Arduino Mega 2560 board, and an SD card reader. This unit is independent of the computer system to carry out its operation. For attendance, Students get to swipe their tags and place their fingerprints on this module at every lecture. Attendance record of each student is taken and stored in the SD card. At the end of the day, the administrator takes the SD card to the computer system to download attendance record into the Student Attendance Management System Software (SAMS).
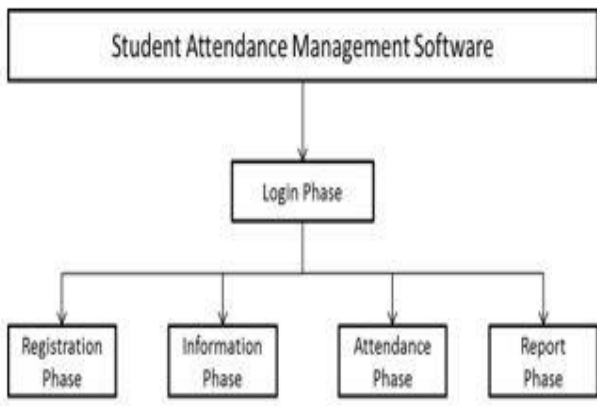
Figure 3. Block diagram of the Attendance Management System Software

Figure 5. Stand-alone Hardware Unit

The RFID Tag is shown in Figure 6.

Figure 6.   RFID Tag

E.   Software Modules

1) Login Form: This is the first interface displayed when the SAMS application is launched after it must have been installed by the user. It enables the administrator to gain access to the attendance management system after entering valid login credentials in the Username and Password fields respectively. The login form is shown in Figure 7.

2) Registration Forms: This consists of two forms: the Course registration form for the registration of courses offered in the department and the Student registration form through which students details are saved in the database of the system.

3) Record Forms: This likewise consists of the two forms as shown in Figure 8, bearing information of every registered course and student in the department. The administrator gets to view, search, delete, and edit student or course information saved in the database.

Figure 7.   Login Form Interface

Figure 8.   Course Information Form

4) Attendance Form: Through this form as shown in Figure 9, attendance details of students saved on the SD card from the hardware device after attendance of the day must have been completed are uploaded to the software's database.
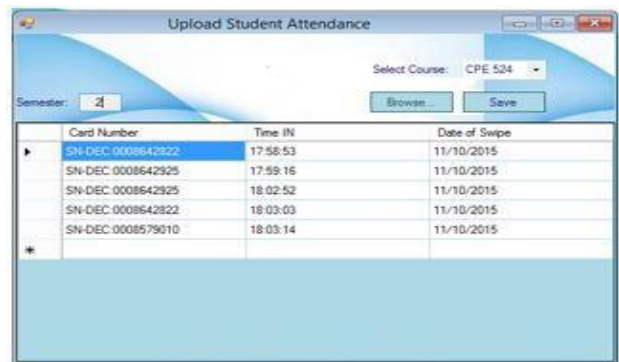

Figure 9.   Attendance Form Interface

5) Student Record Form: As shown if Figure 10, this form displays the record of individual attendance for each lecture. The administrator can view and show students their individual attendance records for the semester. The form also includes percentage attendance which shows the qualification of students for an examination.

6) Report Form: This is a report of the overall attendance of every registered student per course. Figure 11 shows the report form.

Figure 10. Student Record Form Interface

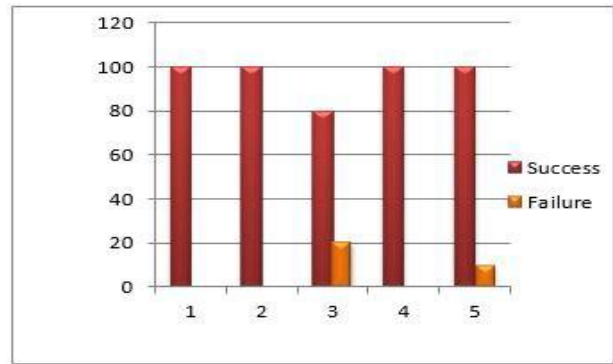Figure 11. Report Form Interface of Attendance System

Figure 12. Comparisons of Success and Failure Rate

TABLE II.   COMPARISON OF SUCCESS AND FAILURE RATE

Students	Biometric Attendance System (in seconds)	Rfid/Biometric Attendance System (in seconds)
1	3.81	4.06
2	3.43	4.30
3	4.12	4.90
4	3.63	5.17
5	2.53	4.79
6	2.49	4.66
7	2.72	4.70
8	3.35	3.95
9	4.01	5.24
10	4.21	4.31

IV.   PERFORMANCE EVALUATION

For performance evaluation, this work was compared with an existing biometric attendance system, developed by [7]. [7] developed an attendance management system using Biometrics. The system was tested and compared with the manual attendance system. The system was verified using fingerprints captured from Eighty (80) students of the department. The 80 students were separated into Eight (8) groups of 10 students each. A number of successes were obtained from the tests carried out.

The result of the tests carried out for the RFID and Biometric Attendance system are shown in Table and Figure 12. The test result shows that the system is effective and fast in response. There were no false accepts i.e. a person that was not preregistered was not falsely enrolled for attendance, and very minimal false rejects either due to incorrect placement of finger or the fingerprint contains dirt or moisture. The system was tested using 10 RFID tags and 10 fingerprints of students in the department of Computer Engineering, Federal University of Technology Minna, Niger State.

Results obtained in the system under research shows a higher precision in measurement than the attendance system by [1]. Testing of the same set of students was carried out 5 times with very high success rate. It can be shown in Figure 13 that the attendance management system under research has fast response time with an average execution time of 4.61 seconds.

TABLE I.   COMPARISON OF SUCCESS AND FAILURE RATE

No. of Tests	1	2	3	4	5
Success (%)	100	100	100	100	100
Failure (%)	0	0	20	10	0

Comparison of the Execution time of Biometric Attendance and Attendance System Using RFID and Biometrics is shown in Table 2.

The RFID and fingerprint Biometric Attendance Management System's average execution time for Ten (10) students is approximately 4.61 seconds as against 3.43 seconds for the Biometric attendance management system using fingerprint identification developed by authors in [7], a difference of 1.18 seconds which is a negligible difference due to the fact that the system under research adopts two (2) authentication techniques. Reports generated for the attendance system in [7] took approximately 30s, whereas that of the system under research takes approximately 7 seconds.
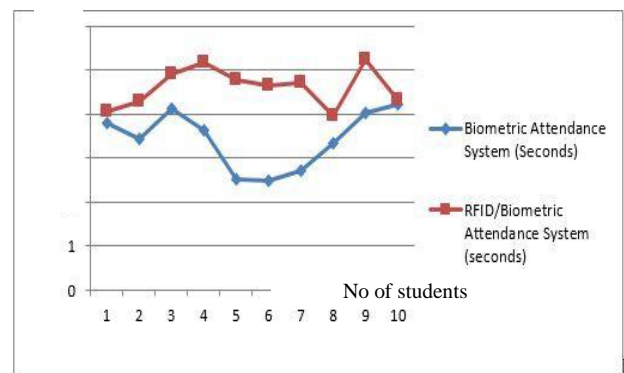

Figure 13. Comparison of Biometric Attendance System with RFID and Biometrics Attendance Management System

The system successfully registered and validated every registered student during attendance. This system is likewise an easy-to-understand system as information control and recovery can be possible by means of the user-friendly interface. In the course of the attendance, there were no cases of False Acceptance and thus the False Acceptance Rate (FAR) is 0.

V. CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

A multifactor authentication system has been designed and implemented for a functional automatic Student Attendance Management System. The prototype successfully reads RFID cards, captured and stored new fingerprints of students, scanned fingerprints placed on the fingerprint device and compared them with those saved in the database. The Problem of size of biometric data and theft was resolved by implementing SHA 256 hash function to optimize and protect the data. From the performance analysis of the system, the system proved to be efficient and fast because of its short execution time, minimal False Rejections, percentage attendance of each student and report generation. Subsequently, we are looking at addressing the following issues.

- The system can be further implemented using a wireless network for transmitting the student record directly to the database of the application software rather than SD card.
- A battery indicator can be interfaced with the hard- ware unit to indicate battery level as to when to replace or recharge battery.
- A sign-out interface can be created to ensure duration of time spent by every student at every lecture.
- Usage of High Frequency active RFID tags as against passive Low frequency RFID tags for better performance can be implemented.

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