
A Biometric Identity-Enabled Automated Attendance Monitoring System for Tracking Lecture Attendance and Performance

¹Egejuru Shama Chidi, ²Nosike Paul & ³Egejuru Ngozi Chidozie

^{1,2}Paul University, Awka, Anambra State, Nigeria

³Hallmark University, Ijebu-Itele, Ogun State, Nigeria

E-mails: shamaegejuru@yahoo.com, paul.nosike@pauluniversity.edu.ng, ngoegejuru@yahoo.com

ABSTRACT

Tracking student attendance in universities remains an essential but often inefficient task, especially in developing nations where records are still kept manually on paper. This work designs and evaluates a web-based Automated Attendance Monitoring System (AAMS) that integrates fingerprint biometrics with matriculation numbers for student identification. This work ensures that attendance records are accurate and reliable. Which will encourage students to attend lectures regularly, thereby leading to improvement in their academic performance. The AAMS replaces manual procedures with a transparent digital workflow, improving reliability and reducing administrative overhead. Unified Modeling Language (UML) diagrams guided the system design, while implementation was carried out using MySQL, PHP, HTML, JavaScript, and CSS. Manual method and biometric attendance approaches, when compared, showed that biometric authentication reduces impersonation and absenteeism, also improves student accountability. Overall, the findings suggest that a web-based Automated Attendance Monitoring System (AAMS) can help to improve students' academic performance and gives the institutions a reliable approach to monitor attendance and performance.

Keywords: Lecture Participation, Identity Number, Attendance, Biometric, Fingerprint Recognition, Performance, Automated Attendance

CISDI Journal Reference Format

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1. INTRODUCTION

Across the globe, institutions increasingly rely on Information Technology (IT) to optimize operations. The use of IT gadgets have enabled quicker task execution, improve communication, and offer affordable solutions for handling routine activities. The modern preference for completing tasks with minimal delay, reduced complexity, and lower financial cost has increased reliance on IT systems, which effectively support these expectations (Egejuru et al., 2022). The integration of Information Technology (IT) into academic institutions has become indispensable in supporting both administrative governance and the core teaching and learning processes (Alloso & Buenavides, 2025). Student attendance is a crucial factor in academic performance. The manual or traditional attendance practices most of the time are affected by errors and impersonation, which makes them inefficient.

Using fingerprint-based biometric authentication offers a more dependable and secure approach. This study was built on previous research in educational technology and created a strong framework for managing attendance (Alhassan et al., 2022; Bashir et al., 2023). Furthermore, the integration of SMS notifications and timetable synchronization enhances administrative oversight and intervention measures (Lee & Choi, 2022; Molina et al., 2022). Research showed that students who are constantly present in class are more likely to do well academically. The work will inspire institutions to assist students be more responsible and do better in their academic performance (Poh et al., 2023; Zhu et al., 2023).

Khan et al. (2022), and Tate and Fuller (2023), reported that students who attended classes regularly tend to participate more actively, and develop a deeper understanding of course material, and achieve better examination results, Therefore, by correlating attendance data with performance metrics, the management of the institution can identify students who may need additional support and those who are at risk of underperforming, due to low attendance. Notifying the parents or guardians, and administrator, can also assist in the improvement of student's performance.

Carrying out this automation using biometric (fingerprint) and identity number and sending messages to the parents and administrator become very necessary for attendance tracking. SMS notifications being sent on time, can ensure that attendance problems are identified and addressed promptly (Molina et al. 2022; Zhu et al., 2023). Fingerprint recognition is increasingly utilized in academic institutions owing to its distinctiveness, resistance to duplication, and cost efficiency compared to alternative biometric modalities (Aldabagh, 2024).

A fingerprint-based attendance system developed for universities demonstrated significant improvements in record-keeping accuracy and class monitoring while also reducing administrative workload (Gabuya Jr. et al., 2022). In a similar vein, research conducted within Nigerian higher education institutions found that fingerprint-based attendance systems significantly reduced impersonation and promoted fairness in attendance recording (Soyemi & Isinkaye, 2020). When fingerprint recognition was compared with facial recognition technologies, considering the lighting conditions and surrounding environmental factors, fingerprint verification is generally more stable and demands less computational power.

The integration of fingerprint with artificial intelligence presents new opportunities to improve system reliability and flexibility. The connection can make it possible to analyze data in real time, get predictions, and improve security systems. The application of machine learning techniques allows adaptation of user's behaviour over time, in so doing improving accuracy. The application makes fingerprint-based solutions not only secure but also easy to use, particularly in large classroom settings and institutions, with limited technological infrastructure (Necochea-Chamorro, 2024). With increasing emphasis on attendance, as a prerequisite for examination eligibility and a measure of student performance, these deficiencies underscore the inadequacy of manual or traditional systems. The combination of fingerprint authentication, identity numbers, and real-time SMS notifications, to develop an automated attendance monitoring system (AAMS), can encourage consistent participation and enhance overall student's performance.

2. LITERATURE REVIEW

Biometric-based systems are becoming more common in the education sector. Among the biometric-based systems reviewed, fingerprint recognition stands out as the most dependable on accuracy and security issues, due to its distinctiveness and ease to use. Alhassan et al. (2022), emphasized that biometric attendance systems improved accuracy, reduced impersonation, and streamlined administrative processes. Fingerprint-based attendance systems can confirm students' identities in real time, stop fake check-ins, and make ensures correct attendance records (Bashir et al., 2023). The integration of identity numbers (matriculation numbers) into biometric systems can provide an additional layer of security and identification. Molina et al. (2022) discuss how linking biometric authentication with student records enhances data integrity and prevents unauthorized access. In addition, sending real-time SMS notifications to parents and administrators enhances monitoring and enables timely interventions. Lee and Choi (2022) reported that immediate alerts about student attendance help improve engagement, as parents and school officials can act quickly to address absenteeism.

From the research carried out by Khan et al. (2022), it was suggested that effective attendance tracking has a positive influence on students' academic performance. The research found a notable association between frequent attendance and stronger academic outcomes. Automated attendance systems provide educators with valuable insights into student participation trends, enabling timely interventions for students at risk of poor performance (Tate & Fuller, 2023). Allosso and Buenavides (2025) created a student attendance management system that integrates data analytics and utilizes Near Field Communication (NFC) technology. It assessed manual and automated attendance systems regarding usability, dependability, and efficiency. This study employed a mixed-methods design, integrating developmental and descriptive-evaluative methodologies. The system was developed via Agile methodologies and evaluated by a survey aligned with the ISO 25010 Software Quality Model. Statistical study, encompassing mean, standard deviation, t-tests, and ANOVA, demonstrated that the automated approach surpassed the manual method, achieving a mean score enhancement of 2.05 points.. Results showed a significant difference between the two systems. Respondents rated the developed system as highly useful, reliable, and efficient. The system is limited to analysis of data.

Petil et al. (2024), developed an attendance system that was based on facial recognition, using the Haar Cascade Classifier. The system was designed to streamline attendance recording by automating identification and verification, which will reduce manual errors and save time. However, the approach faced notable challenges, which included accuracy issues that was caused by lighting conditions and variations in facial expressions, difficulties with system integration, data security concerns, and limitations in scalability. Eze and Uzoечи (2016) created a Biometric Attendance System with Online Monitoring for a university system. This system uses fingerprint authentication and online monitoring for both students and staff in higher education. The system was set up as a web-based platform that lets managers keep an eye on attendance in real time as users check in and leave. The work was driven by concerns over frequent absenteeism, which was identified as a contributing factor to declining graduate quality.

Alsmirat et al. (2019), noted that fingerprint samples captured with digital cameras frequently suffer from various forms of degradation caused by factors such as lighting conditions, background variation, low camera resolution, and image compression. To address these constraints, the researchers developed a high-quality fingerprint picture collection to investigate the impact of varying settings on recognition accuracy. The outcome showed how important it is to take pictures carefully and keep the quality of the images high in biometric authentication systems. The study, however, also indicated that exclusive reliance on fingerprint recognition might provide specific issues over time. From the existing literatures reviewed, there is support to combine the use of fingerprint recognition, matriculation numbers (identity numbers), and SMS notifications, to develop web-based automated attendance tracking, as an effective means of improving lecture participation and academic performance. These results helped to design and develop a dependable and effective Automated Attendance Monitoring System (AAMS).

3. METHODOLOGY

When handling an Automated Attendance Monitoring System (AAMS), the study focused on students' participation and performance in lectures using biometric features, identity numbers, and sending notifications to parents, and administrator. In analysis phase, the system requirements were gathered, and the problem domain is understood. The Unified Modeling Language (UML) was used to create a common way to show and see the design of the system. Use cases, scenarios, and sequence diagrams were developed to represent the structure and the architecture of system.

3.1 Data Collection:

To handle data collection, there was enrollment process, where students' fingerprint templates and unique identifying numbers were taken. The biometric data from students was kept safe in a centralised database, which protected the privacy and integrity of the data. During lectures, students are expected to confirm their attendance by scanning their fingerprints at designated scanners. The system then compared the scanned fingerprint with the stored templates to verify identity and record attendance in real time. Fingerprint information is stored securely using a hashing algorithm, and during authentication, the scanned data is matched against the saved templates. The student's matriculation number is also used to ensure accurate identification and record keeping. If a match is found, attendance is recorded; otherwise, the student is marked absent. After attendance is recorded considering the authentication, and the student was not in attendance, SMS notifications are sent to the student's parent or guardian and the administrator. The items needed to develop the AAMS, are the details of the students, courses, teachers/instructors/lecturers, and parents. This data items include student bio data (Student Enrolled), course enrollment details, details of the instructor, courses allocated to the instructor, and Administration Staff.

3.1.1 Student Biodata Data

The details of the student's biodata are the items needed to identify each individual. This include; the Name of the student (First name, Middle name and last name), gender, contact address, phone number, email address, matriculation number (this is a unique identification number given to students when they resume at a higher institution of learning, this is usually institution based as such there is no exact format), student department, faculty, student level, academic session of resumption, guardian information (name, contact address, email address). This data items are peculiar to each student.

Each student has his/her courses to be registered for the semester. Details of the courses that the students enrolled for will be recorded in this section. The details that would be captured here include the matric number, the student's name (first name, second name and Surname), the level of study, the course code, course title, the course unit, total units registered, the name of lecturer, the department of the instructor, faculty, instructor faculty, email address.

3.1.2. Instructor/Lecturer Table

The instructor/lecturer details are required. The instructor details include, the name of the administrator (First name, Middle name and last name), unique staff identity, department, faculty, gender, username and password, email, contact address, phone number and Course.

3.1.3. Administration Staff Table

The school administrator details are required. This is because any report sent to the parents will be communicated to the administrator for decision making and security purposes. Components of the administrator details include, the name of the administrator (First name, Middle name and last name), unique staff identity, department, faculty, gender, username and password, email, contact address and phone number. The system utilizes fingerprint scanners, which was linked to the database containing students' matriculation numbers. The bio-data of students with their fingerprints were stored in the database. Identity Number and Course code are also stored in the database. The details of the instructor and administrator were also stored in the database. The methodology involves data collection, system design and :

3.2. System Design

A web-based application facilitates data storage and processing, which allows remote access and management. The design of the architecture, involves system components, interface modules, and segments that manage how the system operates and interacts. The knowledge and information were modeled using Unified Modeling Language, enabling a structured representation governed by defined rules. Sequence Diagram for Attendance Management System, which is illustrated based on the key process of the system, was shown in Fig. 1. It is more effective and efficient to manage and monitor the attendance through the attendance management system.

Fig.1 represented the usecase diagram of AAMS. This diagram showed the attributes of the application modelled. As depicted in the diagram, there are two major users, the instructor and the students.

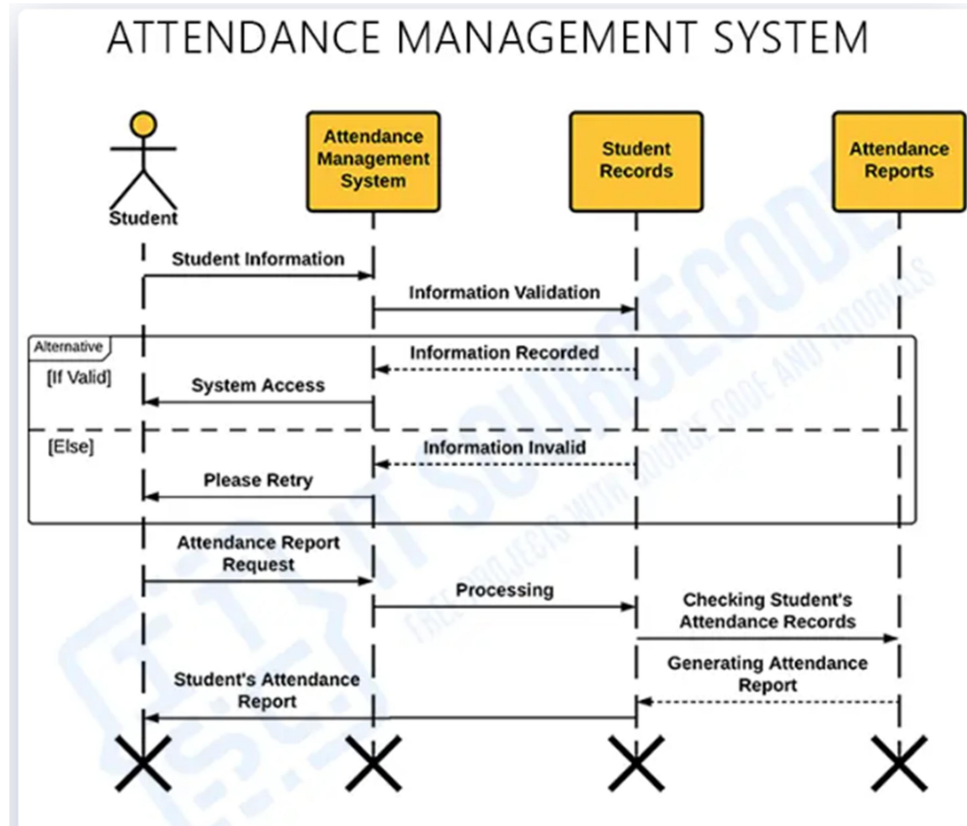


Fig. 1: Sequence Diagram for AAMS – Nym (2022)

Fig. 3 is the block representation of the whole system. The student will first of all register his/her courses on the system that will indicate the course lecturer. The student will select the registered course code to attend the class. Immediately the course code is input, the course title will be displayed and the username and password will be requested. This will help to confirm that the student registered for the class and supposed to attend the class. Immediately the student's fingerprint is confirmed, the time the student entered the class will be recorded as time-in. The student is admitted in the class. When the class closes, the student will log out from the system and the time of leaving class will also be recorded as time-out.

The instructor/lecturer is expected to put in remarks. The system will generate attendance report that will be sent to the parent/guardian and the administration of the school. Fig. 4 gives details of the biometric authentication of the system. When the course code is input, the system captures the fingerprint. The extracted features are being matched with the fingerprint captured during the first registration that is stored in the database. After class attendance, the system will generate report to the parents/guardian and also to the school administration.

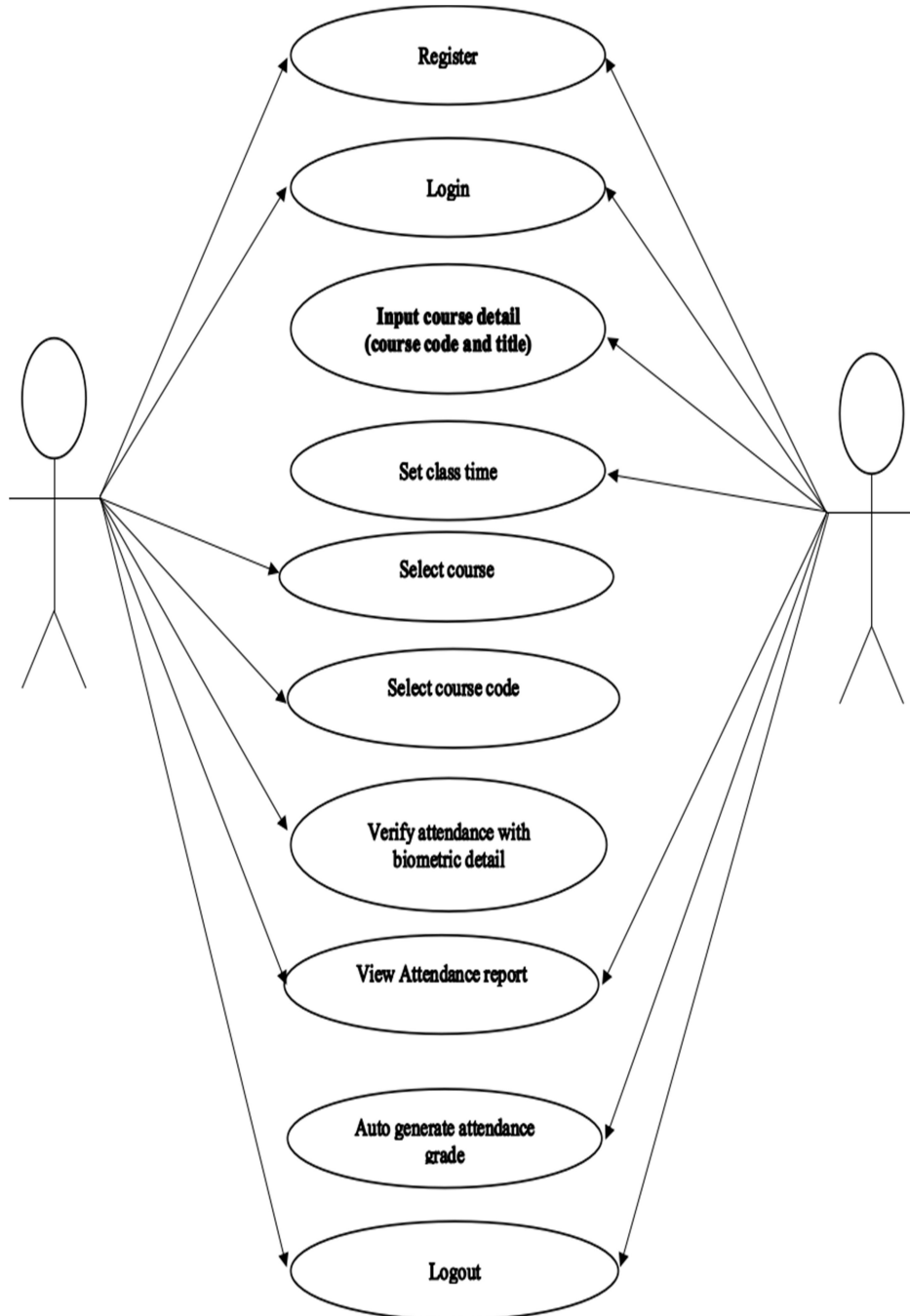


Fig. 2: UseCase Representation of the System

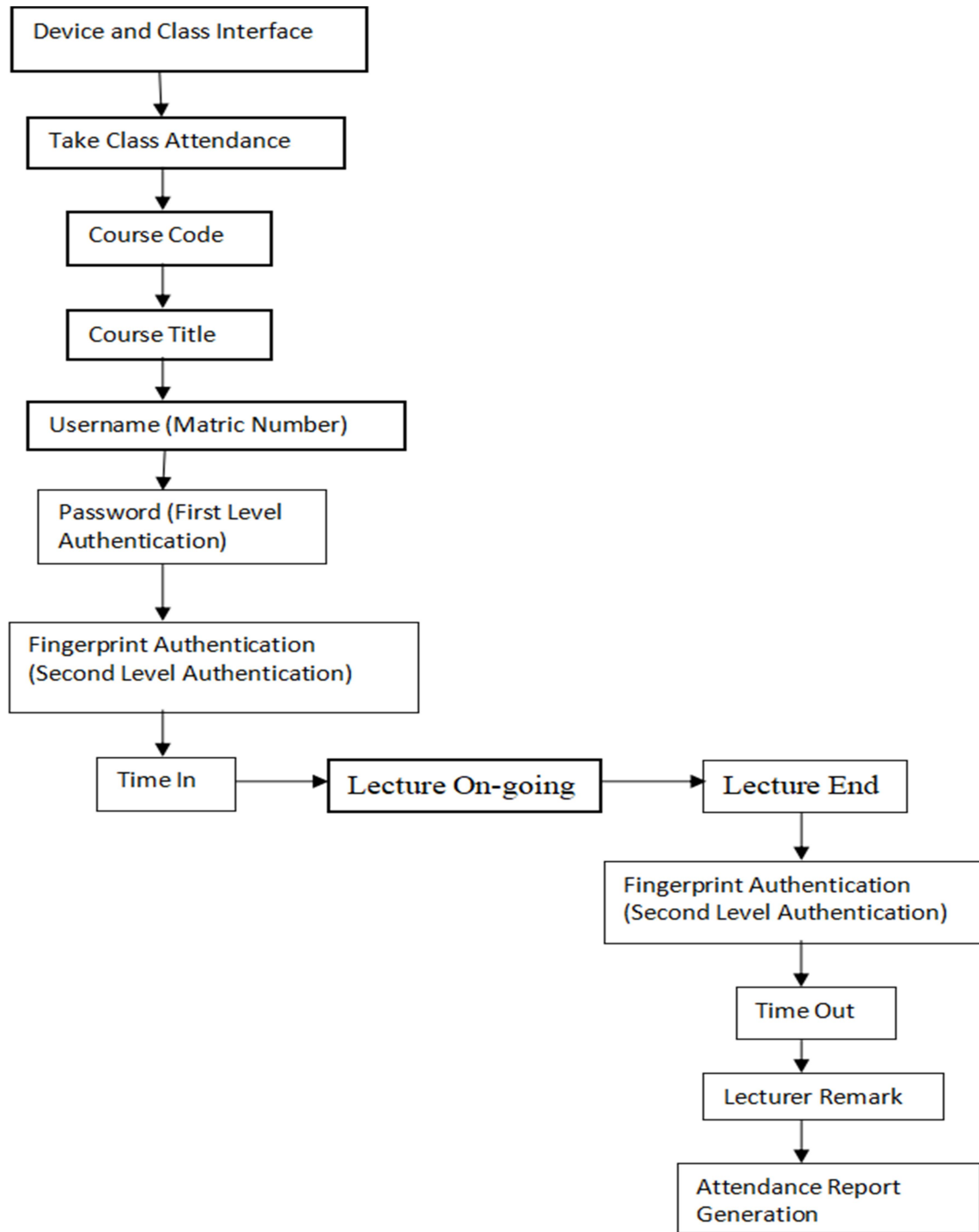


Fig. 3: Block Representation of the System

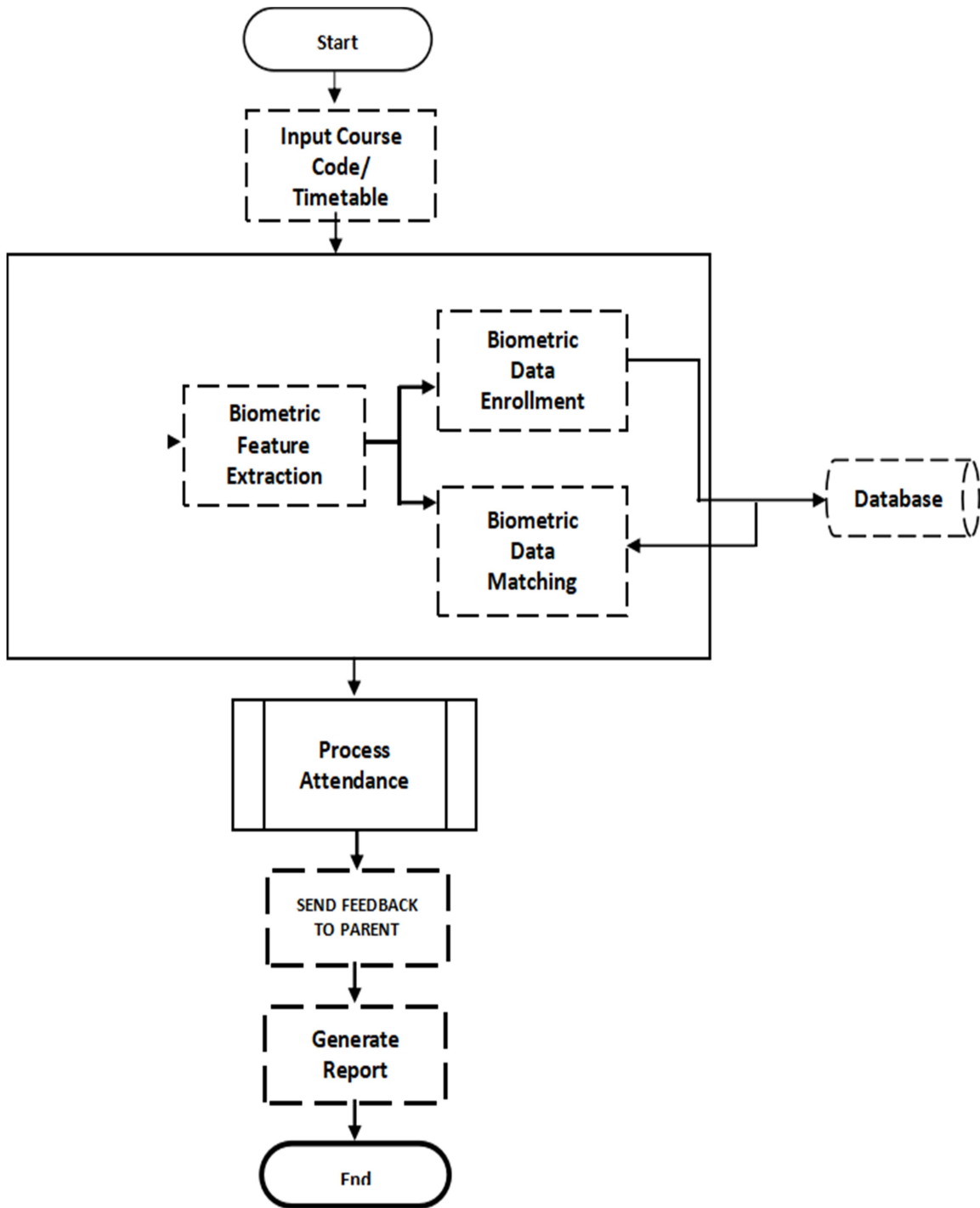


Fig. 4: Biometrics Authentication

4. RESULTS AND DISCUSSION

The implemented system demonstrated a high level of accuracy in attendance tracking. Statistical analysis carried out shows a significant reduction in absenteeism and an improvement in lecture attendance. Comparative studies also indicated that biometric attendance reduces fraudulent entries and enhances administrative efficiency. The designed system was implemented using MySQL, PHP, HTML, JAVASCRIPT, and CSS. HTML, JAVASCRIPT and CSS was used to develop the frontend while PHP and SQL were used for the backend. The code to capture the fingerprint was also written using python programming language. The student is enrolled into the system (AAMS). The student’s bio-data, courses, and fingerprints are captured, processed and stored in the database. When the course is being taken, the system carries out authentication. The system captures the current fingerprint of the student, compares it to the stored fingerprint in the database using a matching algorithm. If the fingerprints match, it marks the attendance of the student and sends an SMS notification to the parent and administrator confirming the successful attendance recording. When the student did not come and no match to the fingerprint(s), the system will send none attendance notification to the parent and administrator.

4.1. Result of Data Collection

After the design of the system, data was collected from the students, administrator and the instructor/teacher/lecturer, for input, to create the database required. The designed forms are shown in Fig. 5, Fig. 6, Fig. 7, Fig. 8, Fig. 9, and Fig. 10. The figures display with the values input on them.

Fig. 5 is the interface that the students will use to input their biodata

Instructor FORM

Instructor Staff Number: ST0002

Instructor Surname: ADE

Instructor First Name: Olami

Instructor Middle Name: daniel

Instructor Department: Chemistry

Instructor Faculty: Natural and Applied Science

Instructor Gender: male

Instructor Username: Ade@yahoo.com

Instructor Password:

Instructor email Address: Ade@yahoo.com

Instructor Contact Address: 12 Jubilee Estate Lagos Sta

Instructor Phone Number: 08021369784

Register

Fig. 6 is the interface that the instructor's biodata

Administration Staff Table FORM

Admin Staff Number: AD001

Admin Surname: Adewummi

Admin First Name: Akin

Admin Middle Name: Victor

Admin Department/Unit: Information Technology

Admin Faculty: Natural and Applied science

Admin Gender: Male

Admin Email Address: A.akin@yahoo.com

Admin Contact Address: 1a isheri excellence hotel o

Admin Phone Number: 09156355489

Register

Fig. 7: the interface that the School's Administrator

Student Course Attendance

Matric Number: 2023?HM001

Student email Address: dave@gmail.com

Student Phone Number: 09032168495

Student Department: Computer Science

Student Faculty: Natural and Applied Science

Course Unit: 3

Course Code: CST 101

Course Title: Fundamental Of Computer

Course Details: Introduction on Computer

Course Lecturer: Mr Ken

Instructor Department: Computer Science

Instructor Faculty: Natural and Applied Science

Instructor Phone Number: 08123167948

Instructor email Address: Ken@yahoo.com

Lecture Time: 12:30:00 PM

Lecture Date: 20/09/2023

Activity Details: Year 1 course

Other Remarks: NA

Fig. 8: The interface that handles the Students' Attendance

Finger Print

User Matric/Staff Number: HM\2023\001

User Surname: Okey

User First Name: Victor

User Middle Name: Chidi

User Gender: Male

User email Address: OkeyVictor@gmail.com

User Department: MicroBiology

User Faculty: Natural and Applied Science

Fig. 9 is the interface that the students will use to Finger print

Fig. 10: The interface that handles the Passcode

4.2. Implementation of the Database Class.

Provision had to be made to store every data item for this system in the database. Data that pertain to the instructor, the students, the course, the fingerprint, enrolment of students to the school, enrolment of the student to the course to be studied, enrolment of the instructors, the courses to be taught, lecture time table, capturing of the finger print of the system users and so on. Fig. 11, Fig. 12, Fig. 13, Fig. 14, Fig. 15 and Fig 16. show the records that were inserted into the system, being stored in different tables in the databases created. The system was developed using MySQL, PHP, HTML, JAVASCRIPT, CSS, and Python.

1 • SELECT * FROM universitydb.student_enrolled;

Matric Number	Student_Surname	Student_First_Name	Student_Middle_Name	Student_Gender	Student_contact_Address	Student_email_address	Id	Student_phone_number	Student_Departme
2023/HM23	David	Victor	Okon	Male	Lagos	davidvic@gmail.com	1	09031166345	Computer Science
2023/HM25	Chidi	Sonia	Joy	Female	Imo	soniajoy@yahoo.com	2	09022233512	Computer Science
2023/HM17	Okey	Kelechi	Victor	Male	Delta	Kelechi@gmail.com	3	30812357839	Computer Science
2022/HM19	Ade	Dami	ade	Female	Lagos	Dami@hotmail.com	4	09037463722	Biochemisrty
2022/HM22	Akin	Ore	olami	Female	Ogun	Ore@yahoo.com	5	09023317843	Biochemisrty

Fig. 11: Student data input

1 • SELECT * FROM universitydb.student_course_attendance;

id	Fingerprint_Captured	Matric_Number	Email_Address	Phone_Number	Department	Faculty	Course_Unit	Course_Code	Course_Title	Course_Details	Course_Leacturer/Instructor	Instructor_Depar
1	Yes	2023/HM/20	Taye@yahoo...	08122233189	Accounting	Manag...	3	CST101	Fundament...	Fundamental i...	Nr Ken	Computer science
2	Yes	2023/HM/10	ade@yahoo...	08024453427	Microbiology	Natur...	3	CST101	Fundament...	Fundamental i...	Nr Ken	Computer science
3	No	2023/HM/21	tanni@gmail...	09034428934	Computer ...	Natur...	2	CST101	Fundament...	Fundamental i...	Nr Ken	Computer science
4	No	2023/HM/22	Ore@gmail.com	07044338754	Biochemisrty	Natur...	2	CST101	Fundament...	Fundamental i...	Nr Ken	Computer science
5	Yes	2023/HM/12	dex@hotmail....	09129324543	Microbiology	Natur...	3	CST101	Fundament...	computer scienc	Nr Ken	Computer science

Fig. 12: Course attendance

1 • `SELECT * FROM universitydb.instructor;`

Id	Staff_Number	First_name	middle_Name	Department	Faculty	Gender	Username	password	email_address	Contact_Address
1	HM001	Chioma	Nice	Biochemistry	Natur...	female	Chioma	Nice	nice@yahoo....	imo
2	Hm202	Chinedu	Queen	Biochemistry	Natur...	female	Chinedu	Queen	queen@hotm...	imo
3	HM103	Jack	jam	Physics	Natur...	male	Jack	jam	jam@hotmail....	abuja

Fig. 13: Instructor

1 • `SELECT * FROM universitydb.fingerprint;`

id	FingerPrint_Capture	User_Matric/Staff_Number	Surname	First_Name	Middle_Name	Gender	Email_address	Department	Faculty
1	No	HG/001	Ojo	nkem	joy	female	ojo@gmail.com	Business A...	manag...
2	yes	HG/023	Osi	adam	philp	male	osi@yahoo.com	Business A...	manag...
3	yes	HG/003	Amin	stephen	tom	male	amin@hotmail...	Business A...	manag...

Fig. 14: Fingerprint

1 • SELECT * FROM universitydb.administration_staff;

id	Staff_Number	Surname	First_Name	Middle_Name	Department/Unit	Faculty	Gender	Email_addresses	Contact_Address	Phone_Number	Remark
1	HM?001	Ying	xin	oin	mass Com	NULL	female	xin@gmail.com	lagos	09023174983	ok
2	HM?202	Oba	faith	ore	mass Com	NULL	female	faith@gmail....	lagos	08029933822	ok
3	HM?002	Kan	musa	victor	Accounting	NULL	male	musa@gmail...	kano	09020392133	ok

Fig. 15: Administrator

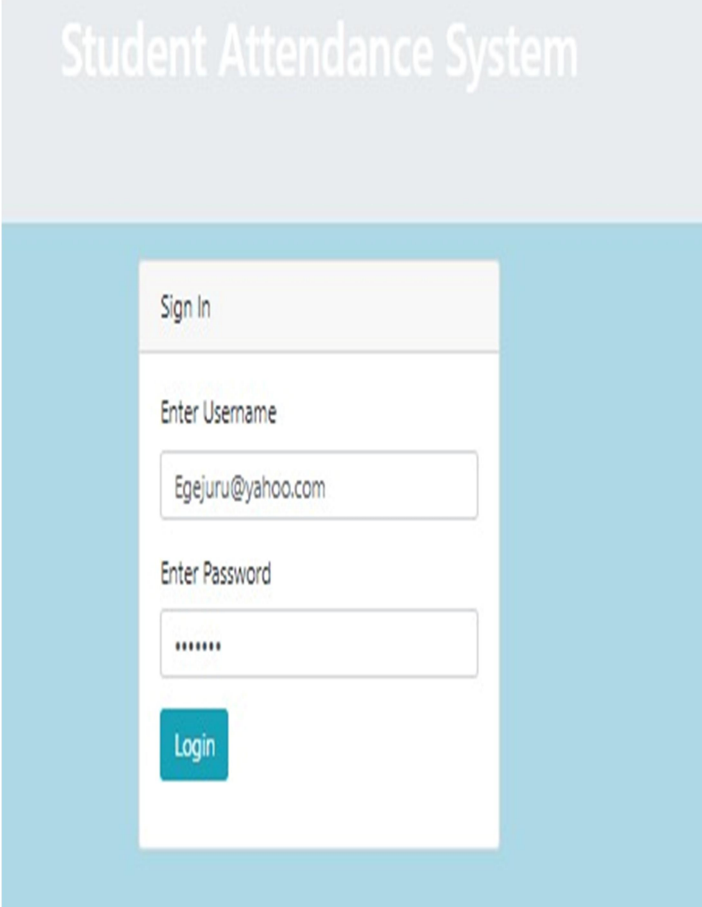
1 • SELECT * FROM universitydb.student_enrolled;

Matric Number	Student_Surname	Student_First_Name	Student_Middle_Name	Student_Gender	Student_contact_Address	Student_email_address	Id	Student_phone_number	Student_Departme
2023/HM23	David	Victor	Okon	Male	Lagos	davidvic@gmail.com	1	09031166345	Computer Science
2023/HM25	Chidi	Sonia	Joy	Female	Imo	soniajoy@yahoo.com	2	09022233512	Computer Science
2023/HM17	Okey	Kelechi	Victor	Male	Delta	Kelechi@gmail.com	3	30812357839	Computer Science
2022/HM19	Ade	Dami	ade	Female	Lagos	Dami@hotmail.com	4	09037463722	Biochemisrty
2022/HM22	Akin	Ore	olami	Female	Ogun	Ore@yahoo.com	5	09023317843	Biochemisrty

Fig. 16: Student Enrolment

4.3. Implementation of the System

The implementation of this research, development of automatic attendance monitoring system (AAMS), will lead to many advantages. First of all, using biometric traits like fingerprints to identify students reduces the likelihood of proxy attendance, by offering a secure and reliable way of authentication. Secondly, the use of identity numbers makes it possible to track student attendance in real-time, thereby simplifying effective record-keeping and producing precise reports. The monitoring will encourage consistent attendance because they discourage absence and motivate students to participate fully in class activities. The system's real-time monitoring and feedback features of sending report, will help the teachers to intervene at the right time for children at danger of performing poorly, promoting individualized attention and support. Fig. 17 shows the Home Page, which prompts the user to sign-in or sign up. Sign in signifies that it is not for the first-time user, while sign up is for the first time user. This is the first place the user will meet after installation. The system request for sign-in.



The image shows a screenshot of the 'Student Attendance System' login page. The page has a light blue background. At the top, the text 'Student Attendance System' is displayed in a large, light blue font. Below this, there is a white rectangular form. The form has a title 'Sign In' at the top. Below the title, there are two input fields: 'Enter Username' and 'Enter Password'. The 'Enter Username' field contains the text 'Egejuru@yahoo.com'. The 'Enter Password' field contains masked characters '*****'. Below the password field, there is a blue button with the text 'Login'.

Fig. 17: Login Page

4.4. System Evaluation/Testing

The AAMS allows users to have access using passcode, involves the use of username and password to have access to the AAMS system. As students resume, they are expected to get their course and register them with AAMS system. The system expects the student to input their courses with their time table. For them to have access then they need to sign up with the AAMS system, using passcode and biometrics (fingerprint). There are two levels of authentication in this system, namely passcode and biometrics. Student fingerprint templates are generated during enrollment and stored in the database for future authentication purposes. Fig 4.7 is used to show the way the passcode is being handled. When the student comes to class, the student is expected to login to the AAMS system using passcode, which request for username and password. The system will verify if the passcode is in order or matches before allowing the student for the next stage. There and then, the student will be allowed to enter the system and do the second level of verification.

After passcode approval, the student is expected to do second verification using the fingerprint in the AAMS system. The fingerprint is captured and compared with the existing fingerprint in the system, to see if the two matched. If it did not match, then there is a problem of identity. If it matches then the student will be allowed into the class and there will be a time log. Some information about the student were extracted and displayed after thumb matching process. When the student enrolls in the system, after using the passcode and the student used Fingerprint. The system will verify the fingerprint, by matching it with the stored fingerprint. If the verification is correct, the system will display the student detailed information. This is shown in Fig. 18.

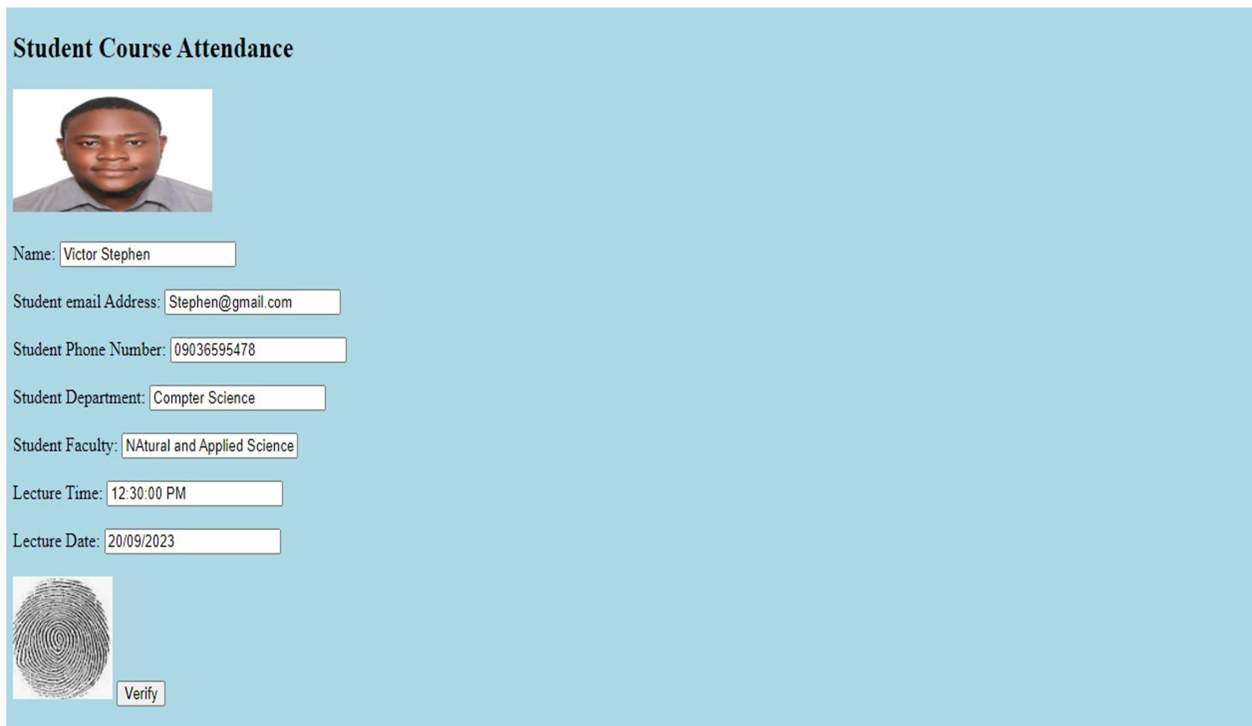


Fig. 18: Student Authentication Report with Fingerprint

4.5. Performance Evaluation

The system continuously monitors students' attendance over time, and allow patterns of participation to be identified and analyzed. When a student's attendance falls below expected levels, notifications are sent to both the management and parents, so as to encourage timely intervention. Correlation analysis is carried out to assess the impact of attendance on academic performance The effectiveness of the system is evaluated by comparing the automated attendance with the traditional or manual attendance methods. To find out how the automated system has improved and what benefits it offers, we look at key indicators including accuracy, reliability, time efficiency, and how it affects student involvement.

5. CONCLUSION

A web-based automated attendance monitoring system (AAMS) was developed, using fingerprint identification and identity number (student matriculation numbers). The use of the system can boost lecture attendance and help students do better in their academics. AAMS is an effective, dependable and safe way to keep track of attendance that is better than traditional or manual technique.

By integrating biometric authentication, SMS notifications to parents and administrators, the system ensures a seamless and reliable attendance management process. When the parents or guardians of students know what is going on in the student's attendance, it will make the students to improve in class attendance. The results indicated that biometric attendance systems effectively minimize impersonation, promote timely attendance, and provided real-time data on student participation.

6. RECOMMENDATION

Subsequent studies could explore extending the system by incorporating other biometric techniques. and artificial intelligence-driven attendance analytics to further enhance its effectiveness. More features can be incorporated to make the attendance to improve tremendously.

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