




Simulation of Barcode Based Students' Examination Attendance System

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Abstract:

Every educational institution has specific standards when it comes to student attendance in classes and exams. The significance of students' presence during exams cannot be overstated, leading administrators and professors in various academic settings to be vigilant about attendance issues. In many Nigerian institutions, the requirement is that students must achieve a 70% attendance rate, which is also factored into their final grades. Consequently, there is a substantial demand for a system to track and document student attendance, highlighting the necessity for a tool to manage students'

presence effectively. This research students' examination attendance using barcode focuses on developing a web-based application that would capture students' attendance details using barcode technology. In eliciting data to develop a new system, the primary and secondary methods were used and evolutionary model was adapted for the software development. For the system design, various tools were used to captured basic system functionalities and attributes and to model the design including flowcharts, UML use case, class diagrams, entity relationship (ER) in a bid to develop the new system. For the front-end design, PHP, CSS5, JavaScript and HTML5 were used. While for the back-end, PHP, Apache and MySQL were used. The entire system was tested using XAMPP server to provide an enabling environment. After which it was concluded the system works according to specification, in conformity with the original aim.

Keywords: Attendance, Barcode, Examination, Institutions, Irregularities.

Introduction

It is widely acknowledged that all organizations, be it, in the commercial sector or academic institutions have a fundamental need to accurately track the attendance of their students or employees. This is crucial, for planning, management and overall operation of the organization (Bryson, 2018). It has been quite a

time that institutions in developing countries record their student attendance traditionally. This involves calling out student's names and using paper sheets (Bryson, 2018).

The impact of the revolution can be seen in aspects including marketing strategies, business practices and educational applications to address real world challenges. Nowadays Artificial



Intelligence (AI) algorithms play a role in solving problems such as image analysis, medical imaging, nurse scheduling, healthcare monitoring systems, information retrieval and recognition patterns learning management systems and even predicting river flow. Consequently, many researchers have successfully implemented attendance systems using AI algorithms and web technology to tackle attendance related issues faced by students (Wright, 2018).

Considering these challenges, this project was undertaken to create and put into operation a solution aimed at addressing the issues related to tracking attendance. With the growing trend in educational institutions adopting modern identification methods, such as providing students with ID cards containing RFID tags, barcodes, and ID chips, there is an opportunity to develop and put into practice a student attendance system based on barcodes. This system serves as a classroom management tool, offering solutions to various problems encountered by educators and students, including security concerns and the inefficiencies associated with conventional attendance record-keeping methods (Wright, 2018).

Renata (2019) contends that headmasters' supervision significantly impacts the effectiveness of teachers. Managing attendance records and calculating class attendance percentages for subsequent result processing and exams poses a challenge for university administrations, as highlighted by Taxila (2019). Tracking student attendance and university assets are critical aspects of evaluating students and conducting annual asset audits. While various methods exist in the literature to address student and asset tracking issues, we have opted for barcode technology due to its cost effectiveness and ease of implementation.

In this paper, we commence by providing a historical overview of the origins of barcode technology, identifying different types. The pioneers of this technology, Bernard Silver and Norman Joseph Woodland, invented the first optically scanned barcode, resembling a bullseye. They developed the barcode in 1952, making it

more cost-efficient and obtaining a patent. Subsequently, they devised solutions for automatically scanning product information during grocery store checkouts, initially implemented by the Food Fair chain. Since then, the use of barcode technology has proliferated. In the 1970s, the United States witnessed the first ever scanning of a Universal Product Code (UPC) in a grocery store. Additionally, the automotive industry and the US Department of Defense (DoD) embraced another barcode standard known as Code 39 (Singh, 2020).

Wijaya & Rusyan, (2013) Highlighted that significant role of educators in informal education, teachers emerge as prominent and pivotal figures. They often serve as role models for students and even play a part in students' self-identification. However, it is crucial to note that effective teacher supervision is an essential, facility for the school. This research's primary objective is to create a web-based application that utilizes barcode technology to efficiently record and manage student attendance information.

Related Work

Several concepts for Automatic Attendance Management Systems have been proposed both in academic literature and the market. Currently, barcodes find widespread application across various industries, including supermarkets and contexts where automated data retrieval is necessary.

In a study by Vinod et al. (2021), they introduced an electronic card-based solution for tracking lecture attendance in higher education institutions, particularly in developing countries. This system employed a single-chip computer that interfaced with subsystems serially through a digital computer's serial port. However, a limitation of this approach is its dependency on the availability of serial ports, which not all computer systems possess.

Another approach, as suggested by Maghana et al. (2020), involved a student attendance management system using Radio Frequency Identification (RFID). This system relied on

student cards to either grant or deny access to attendance recording. Nonetheless, it did not provide individual identification, which left room for potential impersonation.

Chavan et al. (2021) introduced a system designed for tracking student attendance at wolf pack club events to streamline ticket distribution. However, this system lacked integration for general student attendance monitoring.

In contrast, Becerra et al. (2023) proposed a fingerprint verification technique for attendance-taking. Their system employed minutiae extraction for fingerprint verification, automating the entire attendance tracking process.

Alnuaimi et al. (2023) have presented a prototype system that utilizes facial recognition technology for monitoring and verifying user or student attendance. They employed a neural network-based algorithm to detect faces and employed the eigen face method for facial recognition. The experimental results demonstrate the feasibility of near-real-time continuous user verification, particularly for high-level security information systems.

Sata (2023) describes a software application that employs a barcode scanner to record and manage student attendance. Barcodes represent information visually and are readable by barcode scanners. Each student is assigned a unique barcode ID for identification and record-keeping purposes. Access to the system is restricted to teachers and administrators who require login IDs and passwords.

Yuliansyah (2021) introduces an Intranet Based Content Management System designed for students and departments to monitor student attendance. Both students and teachers have access to the system, where each individual is assigned a login ID and password after registration with the system admin.

Sun (2021) presents the realization of a Student Information Management System, encompassing the establishment and maintenance of a database and the development of a front-end application. The system's

architecture and functionality are emphasized, providing a flexible and user-friendly interface for effective student information management.

Akhade et al. (2019) describe a comprehensive tracking system that encompasses various student data, including attendance, course progress, semesters completed, curriculum details, exam information, and more. This information is accessible through a secure online interface embedded in the college's website and includes faculty and batch details, along with academic notifications from the college administration.

Muhammad & Darwesh (2020) implement a library management system using RFID technology. RFID tags facilitate smooth book transactions, tracking the issuance and return of books while maintaining accurate records, including fines associated with overdue books.

Herman et al. (2021) discuss their work on replacing manual attendance recording processes in Malaysian schools with a Student Attendance System (SAS). This system employs student cards with barcodes for identification and attendance tracking, significantly reducing the time teachers spend calculating attendance percentages. User acceptance testing and qualitative analysis were conducted to evaluate system effectiveness and gather user feedback.

Hoo & Ibrahim (2019) highlight the uniqueness of iris recognition and its potential for improving attendance systems. They proposed incorporating biometrics into a wireless attendance system, emphasizing the need for substantial network bandwidth and initial capital.

Wang (2020) proposes a Student Management system using iris recognition for authentication. Neural networks are suggested for pattern matching and image processing to create a web portal for efficient student attendance tracking. However, this method requires skilled personnel and significant initial capital.

Winiarski et al. (2020) present a secure biometric verification station based on iris recognition, utilizing a specially designed protocol and ZakGabor based iris coding. Their system includes a camera, processing unit, iris

recognition software, and an LCD display for controlled access.

Bansal (2018) proposes an Iris Recognition System using the Canny Edge detector algorithm for real-time person identification. This iris recognition method has potential applications in passports, aviation security, database access, computer login, and access control for restricted areas.

Analysis of the Existing System

The existing attendance and examination systems do not incorporate any barcode technology; instead, they rely on manual processes. In the current examination system, students begin by registering their courses on the institution's online management system. Subsequently, they receive an examination card or ID card, which is presented during exams. However, this method lacks robust security measures as it primarily relies on visual verification of the student's identity through their eyes. Unfortunately, this approach can be exploited, as some students, unmotivated to study, might hire others to take exams on their

behalf. These individuals, known as impersonators, engage in academic misconduct.

During exam time, students are required to bring their examination or ID cards as authorization to access the examination hall and participate fully. The authentication process is based on what the students possess (the card) rather than their true identity. Impersonators sometimes resort to creating black-and-white photocopies of the photo card, intentionally darkening their picture. As a result, during examination checks, the unclear photographs make it difficult to accuse them of taking exams for someone else.

Furthermore, within the university system, not all students are personally known to the lecturers. Students often enter the examination hall with their ID cards and course registration forms without thorough verification of their institution affiliation. This lack of proper security checks has led to instances where students from other institutions can impersonate others, typically for financial gain. This practice has become increasingly common among young people and graduating students due to the absence of rigorous identity verification procedures.

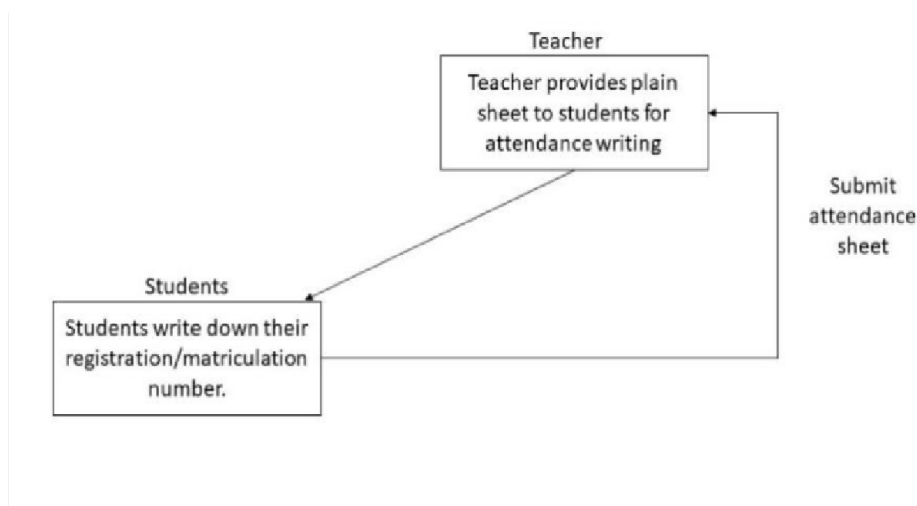


Figure 1. Existing System Architecture

Problems of the Existing System

Some several issues associated with the current system includes:

- It leads to a significant waste of time and resources since students can write exams on

behalf of their friends and even forge each other's signatures.

- It relies on a course approval process based on possession, which can be manipulated at any time.
- Establishing security measures depends on visual confirmation, which is a significant challenge and demands a high level of vigilance. Consequently, impersonators can exploit this vulnerability with ease.

Proposed System

The proposed system, known as the barcode verification system, relies on input from a barcode scanning device for student validation and authentication. This system aims to address the rising issue of students being absent from classes while maintaining a digital record of all student activities. The proposed system's design takes into consideration the limitations of the current system and introduces a new approach aimed at significantly improving overall efficiency. Below, you'll find an architectural diagram for the "Examination attendance system using barcode verification." In this system, each student is assigned a unique barcode. This innovative system employs a combination of a barcode scanner, the barcode itself, and a

computer equipped with specialized software housing a comprehensive database of student information. The barcode scanner consists of three primary components: the illuminator, the decoder, and the sensor/convertor. Initially, the illuminator system in the scanner projects red light onto the barcode. Subsequently, the sensor/convertor section of the scanner detects the reflected light, generating an analog signal. The voltage of this signal varies based on the intensity of light reflection. The sensor then converts this analog signal into a digital format, which is subsequently interpreted by the decoder. The decoder then transmits this information to the computer connected to the scanner.

To initiate the system, the administrator is required to log in using the appropriate login ID and password. After successfully logging in, the administrator utilizes the barcode scanner to scan a particular student's unique barcode, which in turn retrieves the student's details including personal information, examination records, attendance records, and curricular activity details. Each student's information is stored within a database, enabling the administrator to access, modify, or delete the data as necessary.

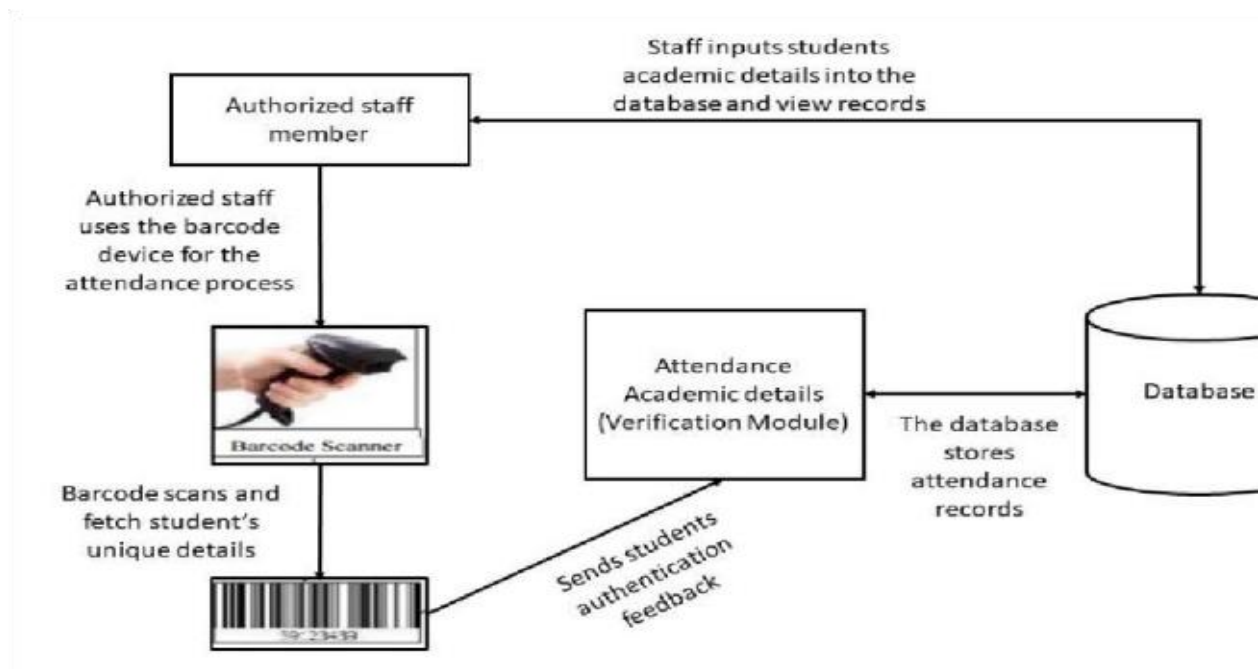


Figure 2. Proposed System Architecture

To resolve the problems on existing Student attendance monitoring. System, a new system known as “Examination attendance system using barcode verification” is essential to eliminate the rate of examination impersonation. The proposed system will solve the problems related to traditional student attendance system. This system comprises of Barcode scanner, Barcodes, Authorized Administrator and Database. This approach is to be built keeping the current system as it is and including as less modification as possible to the current system. This system will basically work on the following components.

- Barcode Scanner use to scan the barcode of the students.
- Barcodes are generated for every student using their unique id number.
- Authorized members can scan the barcode to get the record of particular student.
- iv. Database stores the overall all record of students.

Algorithm to Compliment the Proposed System

STEP 1: Initialize the attendance system and necessary data.

STEP 2: Set up the barcode scanner or camera for capturing barcodes.

STEP 3: Start the system and wait for barcode inputs.

STEP 4: When a barcode is scanned or captured:

1. Extract the barcode data.
2. Decode the barcode to obtain the relevant information (student ID)
3. Validate the extracted ID:
 - a. Check if ID exists in the database or registered users.
 - b. Verify any additional criteria for attendance eligibility (active status or enrolled for the course)
4. If the ID is valid:

- a. Retrieve the user’s information from the database
2. (Name, department and class).
 - a. Get the current timestamp.
 - b. Record the attendance by associating the user ID with the timestamp and any
3. additional relevant information (location).
 - a. Update the attendance record in the database or store it in a suitable data structure.
 - b. Provide feedback to users indicating successful attendance marking (display a confirmation message).
4. If ID is invalid or the user is not eligible for attendance:
 - a. Provide feedback to the user indicating the issue (display an error message).

STEP 5: Repeat steps 3-4 for additional barcode inputs until the system is stopped or a specified condition is met.

STEP 6: Generate reports or perform any necessary calculations based on the attendance records stored in the database or data structures (attendance percentages, late arrival statistics).

STEP 7: Provide administrative interfaces for managing user registrations, generating reports, and performing other system-related tasks.

System Design

System design encompasses the definition of a system's structure, its component modules, interfaces, and data, all tailored to meet specific requirements. It offers users a comprehensive understanding of how the system operates and provides the detailed architecture necessary for building a system or product.

The proposed system's architecture, as illustrated in Figure 3.2, reveals the interconnections among various modules, offering a clear and thorough depiction of how

the system operates. The administrator assumes the responsibility of enrolling students and managing their data within the database, where it is stored as input. The link between the barcode, scanning device, and database serves as the medium for transmitting information into the database. Once the data is transmitted into the database, it is directed to the data record module for the storage of attendance records. Students' sole responsibility is to be physically present for authentication by presenting their identity cards to the barcode scanning device, which proceeds with verification and searches for the student's data in the database to confirm its existence. After successful validation, the database provides feedback to the administrator. System specification can take formal or informal forms, and in this research, formal system specification is employed. It is a type of system specification that articulates various aspects of the system verbally. Informal system specification may also incorporate diagrams to describe system design specifications, but the use of diagrams is not obligatory as long as the system's description is sufficiently clear.

Input Interface Design

The interface serves as the point through which data is supplied to the system. Input design specifies the input data that the system requests from users or input functions accessible to system users. In the input interface design of this system, two key components are identified:

- Administrator's login.
- Creation of student profiles.

The figure shows a login interface with the following elements:

- A label "USERNAME" above a text input field.
- A label "PASSWORD" above a text input field.
- Two buttons: "LOGIN" and "CANCEL" side-by-side.
- A button "FORGOT PASSWORD" below the "LOGIN" and "CANCEL" buttons.

Figure 3. Administrators Login Input Interface

Admin Login

A use case is a visual representation illustrating how a user might.

Create Students Profile

The figure shows a "Create Student Profile" interface with the following elements:

- Title: "Add student"
- Fields: "ID number:", "Name:", "Gender:", "Course:", "Unique Barcode:", "Level:"
- A "Scan" button next to the "Unique Barcode" field.
- A large rectangular area labeled "Barcode image" below the "Unique Barcode" field.
- Buttons: "Exit" and "submit" at the bottom.

Figure 4. Create Student Profile Interface

Modelling the system using unified modelling language (UML) Currently, several object-oriented methodologies are in use, with the most prominent one in recent times being the Unified Modeling Language (UML). UML was developed by BOOCH, Rumbaugh, and Jacobson in 1997 and has gained widespread recognition as a standard for conveying system requirements (Chiemeka and Egbokhare, 2006). UML is a versatile visual modeling language that emphasizes conceptual and physical representations of systems. It was intentionally created to encompass the best contemporary practices in modeling techniques and software engineering (Jim and Ila, 2004). UML's appeal lies in its ability to offer a visual syntax that facilitates the construction of models or artifacts.

Jim and Ila (2004) note that before 1994, object-oriented methods were somewhat disorganized, but UML stands out as a deliberately designed and architecture system. It's crucial to emphasize

that the Unified Modeling Language is most suitable when the software methodology employed in modeling or design adheres to object-oriented analysis and

design methodology (OOADM). In the context of this research, the following UML diagrams were employed to model the application.

Class Diagram

Class is a set of objects that share the same attributes and behavior. It is sometimes referred to as object class. Figure 5 shows the class diagram of the application with the various object classes of the services in the system.

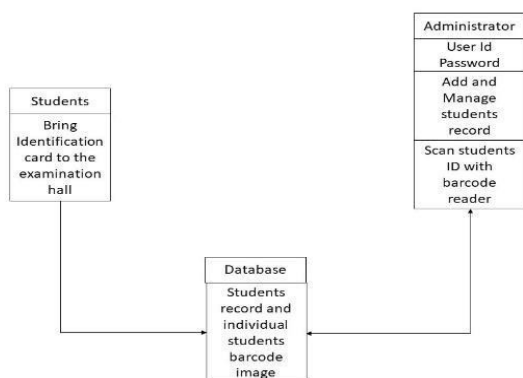


Figure 5. Class Diagram of the Proposed System

Sequence Diagram

Interaction diagrams describe interaction between the objects. They show their relationships, including messages between the interact with a system. A use case diagram illustrates different scenarios involving various types of users of the system and is typically accompanied by other types of diagrams. These use cases are typically symbolized by circles or ellipses, while the system's users are commonly depicted as stick figures. You can reference Figure 7 for the application's use case diagrams objects. Sequence diagram emphasizes the order of the application messages.

Figure 6 shows the application sequence diagrams.

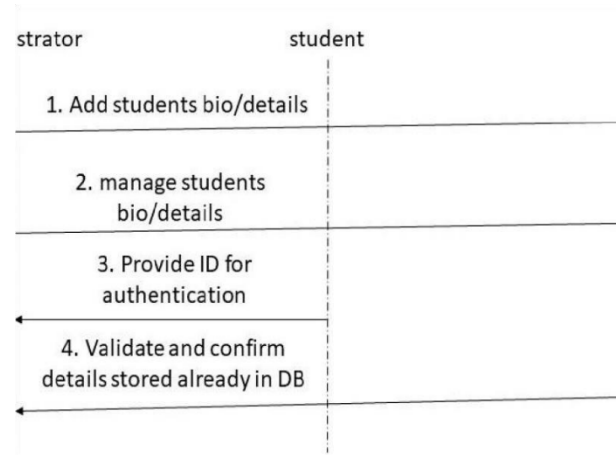


Figure 6. Sequence Diagram for the System

Use Case Diagram

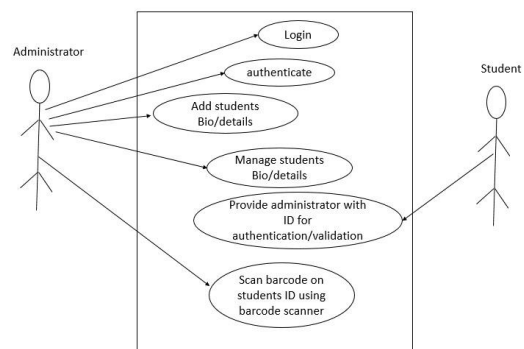


Figure 7. Use Case for the System

System Development

Flowchart Diagram

A flowchart is a type of diagram that represent a workflow of process. A flowchart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solving a task.

The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows. The diagrammatic representation illustrates a solution model to a given problem. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields (SEVOCAB, 2008).

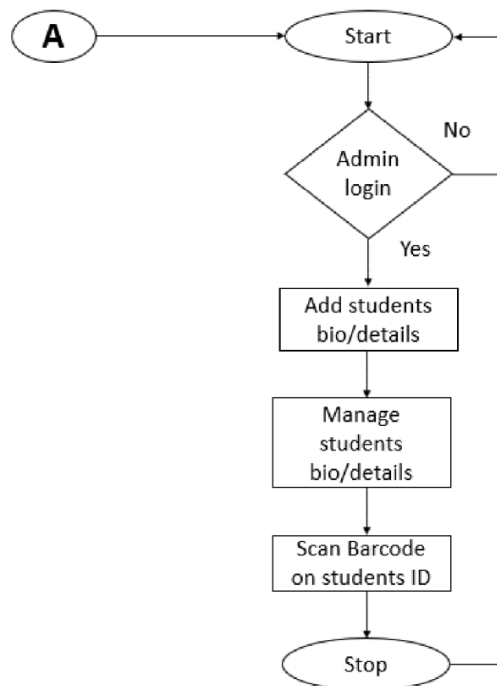


Figure 8. Flowchart for the System Administrator and Data Capture

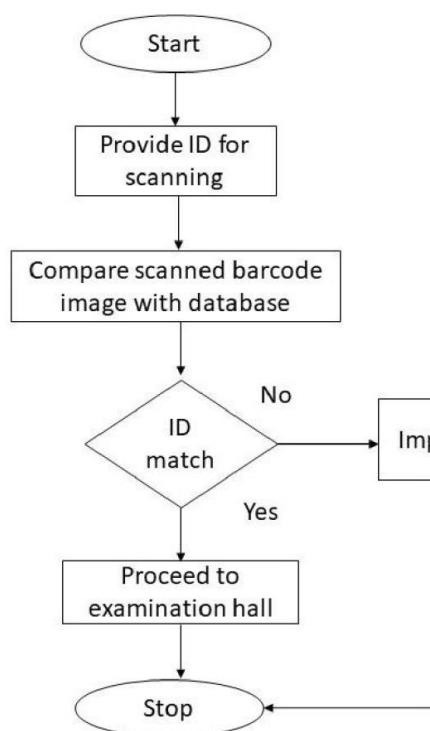


Figure 9. Flowchart for the Proposed Barcode Authentication System

3.7 Database Design

The project's files encompass various data formats, including integers, characters, doubles, dates, and more. Some of these files are specifically crafted and interconnected with a database. Moreover, in the project's blueprint, we employed MySQL database technology for the purpose of capturing and preserving records in the database. Below, you'll find the detailed specifications for the database associated with these files.

Table 1. Student Bio-Data Database Table

File Name	Data Type	Size	Relation
Student_id	Int	11	Primary key
First_name	Varchar	30	Not null
Last_name	Varchar	30	Not null
Gender	Varchar	10	Not null
Faculty	Int	20	Not null
Department	Int	20	Not null
DOB	Varchar	30	Not null
Nationality	Varchar	20	Not null
State	Varchar	30	Not null
LGA	Varchar	30	Not null
Marital status	Int	15	Not null
Email id	Int	20	Not null
Phone no.	Int	11	Not null
Barcode	Varchar	30	Not null

Table 2. Administrator Login Table in the Database

File name	Data Type	Size	Relation
Id	Int	11	Primary key
Username	Char	25	Foreign key
Pwd	Char	25	Not null

Table 3. Attendance Record Table in the Database

File name	Data type	Size	Relation
Record_id	Int	11	Primary key
Course code	Int	10	Not null
Course title	Int	50	Foreign key
Credit unit	Int	11	Not null
Barcode	Int	11	Not null

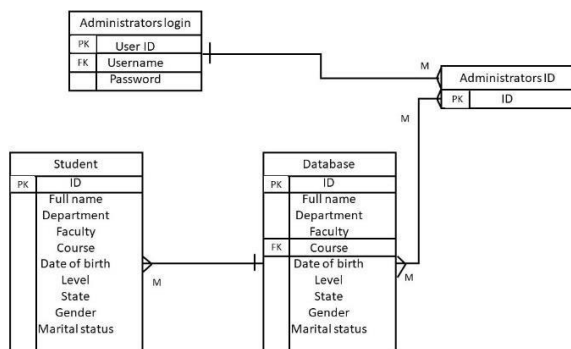


Figure 10. Entity Relation (E-R) Diagram for the Proposed System

Technologies for Development

The developmental tools and technologies used in this research include PHP. PHP/MySQL is used for my database because according to my little knowledge PHP/MySQL is more secure and robust than other database, it is easy to implement.

The system is a web-based application system therefore html and CSS is used as frontend, JavaScript and PHP as scripting of the system. XAMPP server is also used as local server.

Entity-Relation Diagram

An entity-relationship model, often abbreviated as ER model, delineates a database's structure using a visual representation known as an Entity Relation Diagram (ER Diagram). This ER model serves as a plan or template for a database that can subsequently be put into practice. The

primary elements within the E-R model encompass entity sets and relationship sets.

Results

The results of this study is the students' attendance management system using barcode identification. Below are some of the interfaces of the proposed system.

The Home Page / Dashboard

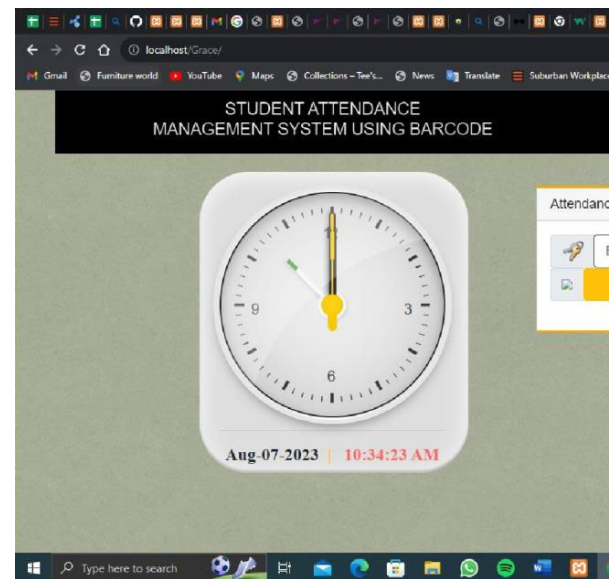


Figure 11. The Administrator's Dashboard

This is the landing page; this is the first page that appears when the web application is being launched. The interface displays different entities and data, the interface is the possible means through which an administrator can gain access to add student, view student, view attendance and also take attendance.

The Create Student Profile

The below interface is a clear view of the create student profile for new students by the administrator. The administrator is the only person capable of creating a student's profile in the attendance system. The fields consist of different data to be obtained from students who wants to register for their respective courses.

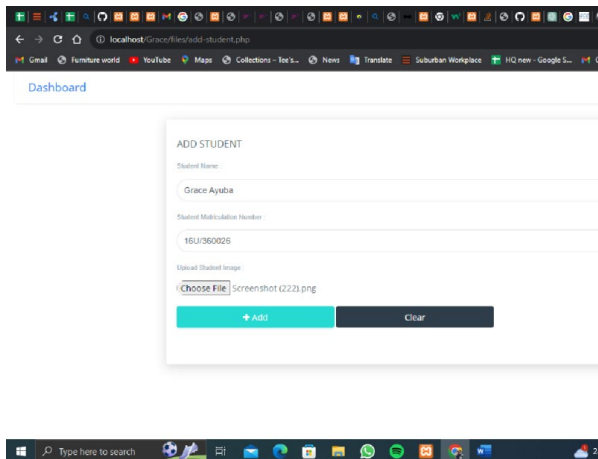


Figure 12. The Create Student Profile Interface

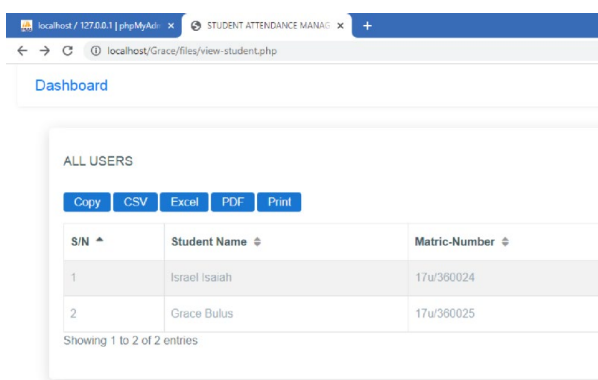


Figure 13. The View Student Interface

The interface above displays list of registered students on the attendance management system. The interface captures all students that are captured on the system. And the list of student on this interface can be exported in either a PDF file or an excel file.

View Student Details

The below interface is the vivid and clear depiction of the student's details after being registered on the system. This detail comprises of the students' picture, registration number, and student name and student unique barcode.

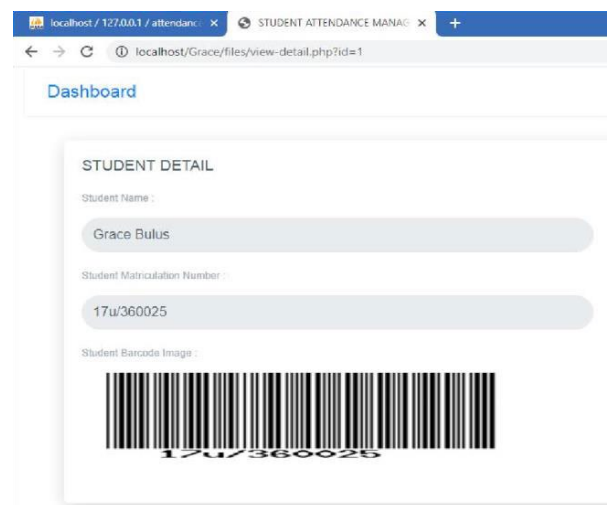
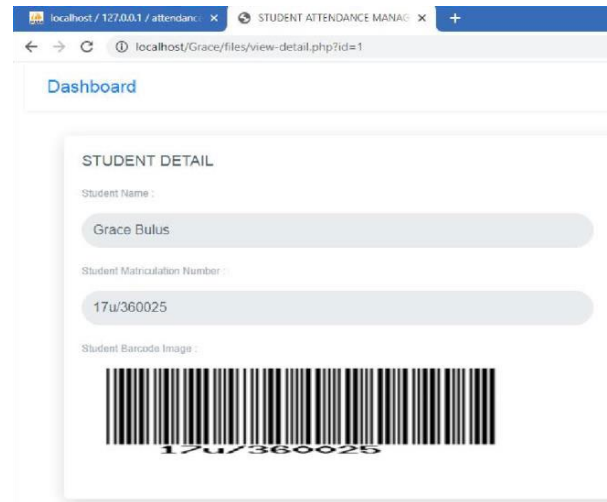


Figure 14. The View Student Detail Interface

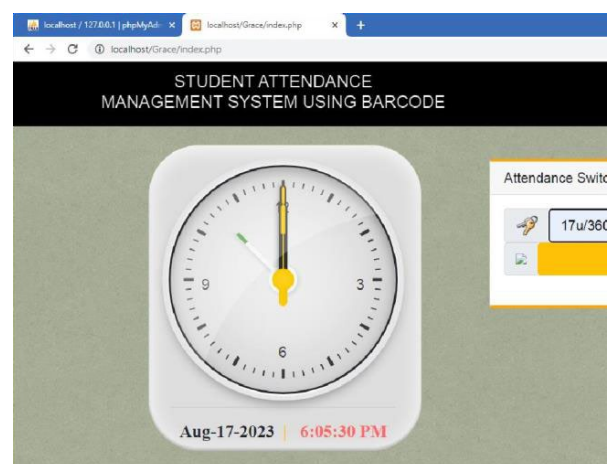


Figure 15a. The Take Attendance Interface

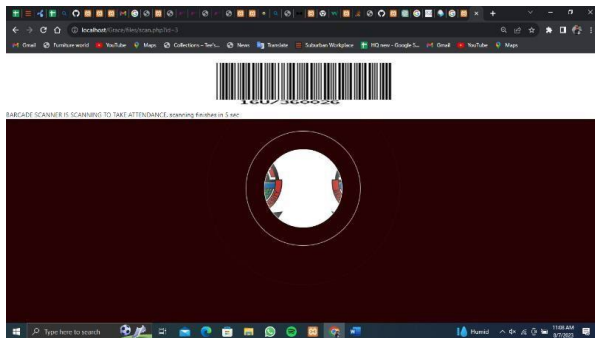


Figure 15b. The Take Attendance Interface

The interface in figure 15a and figure 15b above depicts the attendance taking process, the administrator inputs the student id and then the system checks for authenticity if the student id is a valid one.

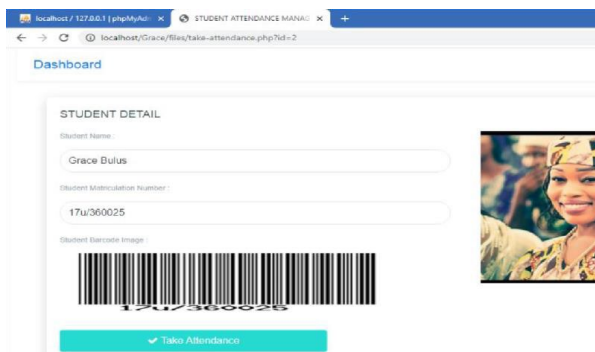


Figure 16. The Take Attendance Interface

After checking for the students' details in the database, the system pulls the details of student that correspond with the Id and this details include: the student name, picture, matric number and unique barcode. This shows the administrator and then if the details are correct, the administrator marks the students' attendance which will reflect as present.

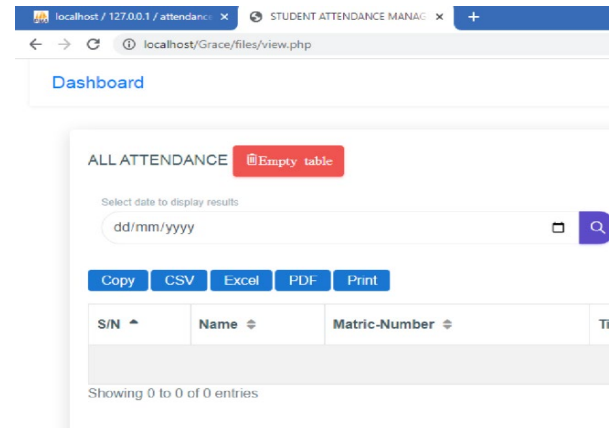


Figure 14 The All-Attendance Interface

The interface above displays the list of all attendance taken in the system and their details such as attendance status, name, time and date.

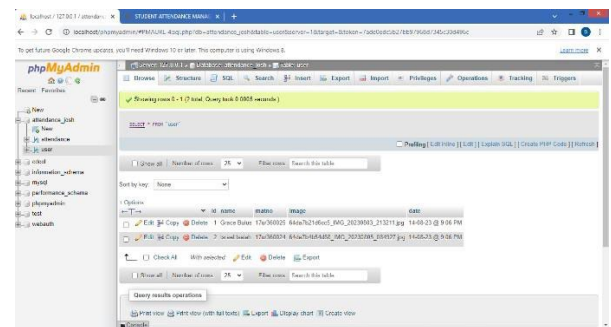


Figure 18. User File System Implementation: This is the Users Table in the Database

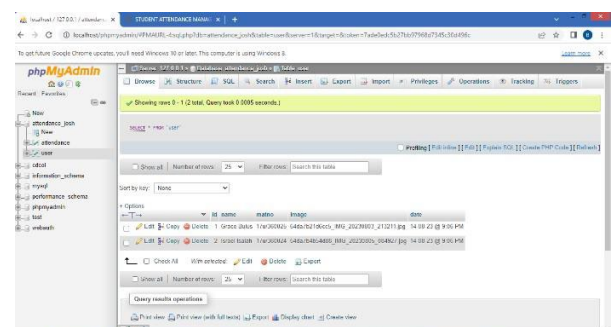


Figure 19. Record (Attendance) File System Implementation: This is the Attendance Table in the Database.

Discussion

Figure 11 shows the landing page; this is the first page that appears when the web application is being launched. The interface displays different entities and data, the interface is the possible means through which an administrator can gain access to add student, view student, view attendance and also take attendance.

Figure 12 The interface provides a straightforward view of the process wherein the administrator creates a new student profile. Only the administrator possesses the authority to initiate the creation of a student's profile within the attendance system. The fields within this interface contain various pieces of information required from students who intend to enroll in their respective courses.

Figure 13 depicts a list of registered students on the attendance management system. The interface captures all students that are captured on the system. And the list of student on this interface can be exported in either a PDF file or an excel file.

Figure 14 displays a vivid and clear depiction of the student's details after being registered on the system. This detail comprises of the students' picture, registration number, student name and student unique barcode.

Figure 15a and figure 15b depicts the attendance taking process, the administrator inputs the student id and then the system checks for authenticity if the student id is a valid one.

Figure 16: After checking for the students' details in the database, the system pulls the details of student that correspond with the Id and this details include: the student name, picture, matric number and unique barcode. This shows the administrator and then if the details are correct, the administrator marks the students' attendance which will reflect as present.

Figure 17 displays the list of all attendance taken in the system and their details such as attendance status, name, time and date.

Figure 18 displays a User File System Implementation: this is the users table in the database.

Figure 19 depicts the Record (attendance) File System Implementation: this is the attendance table in the database.

Conclusion

The process of computerizing classroom attendance tracking offers numerous benefits when compared to the older system.

Information collected in classrooms can effortlessly be converted into databases for potential future analysis or applications, which could contribute to enhancing timetable design and decisions regarding classroom reservations. However, a notable drawback pertains to the maintenance of the software program for this system. The primary objective of this study was to assess and appraise a real-time system that utilizes barcodes on students' ID cards. The outcomes derived from the conducted tests collectively indicate that the system's design is well-suited for addressing technological challenges that demand real-time solutions. Furthermore, the successful test results provide unequivocal evidence that barcode solutions are straightforward to implement, cost-effective, and highly reliable and efficient. A minor consideration, though, might arise in the context of system maintenance.

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