



# DESIGN AND IMPLEMENTATION OF AN ENHANCED TIME-BASED RADIO FREQUENCY IDENTIFICATION (RFID) AND FACE-RECOGNITION BIOMETRIC ATTENDANCE CONTROL SYSTEM

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## Abstract

As a result of the challenges of the COVID-19 virus and the discrepancies encountered in the manual method of taking attendance in schools and institutions in Nigeria, an automated attendance system needs to be integrated. Some of these challenges in taking attendance include wasting time during signing attendance, improper documentation of records, the spread of the Covid-19 virus as a result of body contact, students signing attendance for absentee friends, and writing of wrong time in the attendance sheet. This study aimed to implement Face-Recognition and Radio Frequency Identification (RFID) time-based attendance control system to provide the functionalities of registering students, recording attendance, and sending an email notification to parents with the present picture of the student. The email notification helps the parents or guardians to have a picture of their child in school to be aware of their status in case of bullying among fellow students and teachers. This work curbs the deficiencies associated with body contact and manual method of attendance with an automated approach deployed through Radio frequency identification (RFID) and biometric (face-recognition) technology. Due to the COVID-19 pandemic, the attendance system will use face recognition instead of Fingerprint to avoid body contact.

**Keywords:** Student Attendance, RFID Tags, RFID Readers, Face Recognition, Notification System

## 1. Introduction

Some students do not report to school at appropriate time due to one reason or the other. Some of the teenagers will leave the house and branch to somewhere else instead of reporting directly to the school. In boarding schools in Nigeria, there have been a case of students being bullied

in school and most cases, parents were not aware of their wards situation when they leave the house to the school or while they are in boarding school. In the manual method of attendance, students are required to write down their names and sign the attendance list. The problems associated with this method vary from unnecessary time wastage, improper documentation, students writing attendance for their fellow students, wrong indication of actual time of attendance, parents unaware of the time their child reaches the school, and as well when they are bullied while in boarding school, etc. In biometric method (finger print), students are required to scan their finger to mark attendance and with this method, there is every tendency that the students easily contact COVID-19 virus due to body contact. To eradicate the deficiencies associated with these methods, an automated approach is implemented using RFID and biometric (face recognition) technology.

The Time-Based RFID and Face-Recognition biometric Attendance Control System includes RFID tags, RFID reader, Camera, Computer system and host system application. This system is used in registering students, taking attendance and sending notification to parents or guardian regarding the time the student marked attendance and the real-life picture of the student so that it can help parents to detect the situation of their child and the time he/she attended classroom. The Face recognition Biometrics is integrated to provide a more safe, comfortable, and faster user authentication method than password, token and fingerprints. Also, to prevent body contact among students to avoid spread of COVID-19 virus.

## **2. RFID and Biometric Technology**

The word Biometrics originates from the Greek arguments “bios” (life) and “metrics” (measure)[8]. Rigorously talking, this refers to an area connecting the statistical examination of natural characteristics. thus, we must relate to biometric gratefulness of people, as those safety operations that dissect mortal characteristics for individuality evidence or identification. Biometric recognition offers a talented approach for safety applications, with approximate advantages over the traditional methods, which depend on somewhat you have (key, card, etc.), or somewhat you know (password, PIN, etc.). A good property of biometric characters is that it is built on somewhat you are or somewhat you do, so you do not essential to recollect anything nor to grip any token [8].

Biometrics is the most acceptable method of identifying and authenticating individuals in a fast and proficient way through a unique biological characteristic.

RFID (radio frequency identification) is designed to serve the purpose of a barcode scanner or a magnetic strip on the back of the ATM card. It creates a unique identifier for that object and just like a bar code or magnetic strip it must be scanned to get the information RFID must be scanned to retrieve the information[3] It is a technology that transmit data using radio waves from an RFID tag attached to an object by the reader for tracking and identifying objects [8]. RFID reader and tags are the two main components of RFID. The reader detects the tags that are within the frequency range and reads or write to the tags and the tag on the other hand is normally attached to the objects to be monitored and carries information in a chip [1].

### **2.1 Related Works**

The student attendance management system based on RFID technology [6], the system was developed to eliminate the paper-based approach of recording attendance, thereby encouraging cheating and other forms of malpractice. Interestingly, the system aids the already tedious job of the lecturer in taking attendance and registering the unregistered student manually. “Firstly,

the lecturer needs to fill forms in an interface like lecturer name, subject and code subject. This interface is crucial because the information here will be used in the next interface. In the next interface, the lecturer needs to choose the port and speed to make a connection with an RFID reader. After the reader was ready, the process to get an attendant will start. Students need to swap their cards on the reader and the code from the card will use to compare with the database in Access. When the code is matched with the database, the student information like name and ID number will show on an interface and that information will trigger into a list. This list will use as student attendance. In that list, all information like student name and ID number will be attached including the lecturer's name and subject. If the code did not match with the database, it means that the student is in the wrong class or has not registered yet in that subject. When this happens, the lecturer can register that student by using registering the form and the information of that student will be updated into database". The authors maintained that the study will aid the easy and automatic collection of attendance.

An RFID-based student attendance system with short message service (SMS) notification backup which is helpful in saving valuable time for both students and lecturers and helps to generate accurate reports when required[10]. The short message service (SMS) feature is used as a backup whenever data loss occurs on the PC system. The authors addressed the means of automatically registering students, recording attendance, saving students' data on the personal computer (PC) as well as backing this data via the global system for mobile communication (GSM), and eventually making a decision on the eligibility of a student to sit for an exam course. The design has four major parts: the input section (RFID tag and RFID reader), the control section, the power section, and the display unit. When a student who enters a classroom swipes the RFID tag near the reader that is connected externally to a microcontroller-based embedded system, the system grants access to a registered student and record the attendance details on a PC database. An SMS containing the exact details is sent to the mobile phone for data backup through the GSM SIM 900 Modem [10].

A a system technology that alerts parents and guardians on the status of their wards [5]. Specifically, "The system is designed to check and discover any student enter the wrong school bus and control the entry and exit from school and buses using RFID, which provides great feasibility for schools and pupil's parent. Additionally, the system can be used anywhere such as in industries and educational institutions. However, RFID systems provide better solutions for protecting children within schools".

The importance of attendance in determining the regularity and sincerity of students cannot be overstated. Manually tracking student attendance with pen and paper had become a thing of the past because it not only flags fraudulent submissions by students but can also lead to inaccurate attendance evaluations. Therefore, [4] proposed a combination of the latest technology using RFID, the Internet of Things (IoT), and web-based development using PHP, Apache web server, and SQL. The Node MCU ESP8266 (Microcontroller) acts as an information acquisition system for the module. The Node MCU ESP8266 (Microcontroller) should be connected to the RFID module. By using the RFID Module, the RFID card and tag are scanned and by using ESP8266 data is sent to the MYSQL Database which is connected through a PHP web page.

An Attendance Monitoring System for Students based on a Biometric and GPS Tracking System A fingerprint-based attendance management system[2]. The system consists of a

fingerprint acquisition module and a GSM modem. The fingerprint and pre-treatment are captured using the fingerprint acquisition module. GSM modem is the tool used in sending to parents in form of SMS the attendance of the students, and the Global Positioning System (GPS) is a radio navigation system that allows sea, airborne, and land users to detect their exact location, velocity, and time in all weather conditions, anywhere in the world 24 hours a day, in all weather conditions, anywhere in the world. After some time, intervals the details of the students who weren't present were taken. Those persons' details were taken the message "NOT PRESENT" is sent to their respective parent's mobile numbers. So, the parents may know about the student's presence immediately [2].

Designed and Implementation of and Attendance monitoring system for colleges using RFID technology and fingerprint to identify the person [9]. "The fingerprint scanner process scans the image of the student's thumbs and performs the identification process. The image scanned is compared with the image stored in the database for every student and once the image is matched, it will mark Attendance for that student and enroll the time in the database automatically. The visual Basic front end is used to interface the microcontroller and PC through serial port and database connectivity and validation checking options. MS Access is used as the back end to store the details of every student" [9].

### 3. Methodology

In this research for the Design and Implementation of an enhanced Time-Based Radio Frequency Identification (RFID) and Face-Recognition biometric Attendance Control System, we employed the Instructional system's design (ISD), and ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. To create an effectual application, all design models need the following stages: analysis, design, development, implementation, and evaluation; these stages are abbreviated as ADDIE. The efficacy of ADDIE is found in its next-phase-informing nature, making it logical and viable for the development of any kind of Information tool. More so, it can therefore be used to produce a captivating experience for users. Acclaimed for its resounding popularity in the development of educational instruction, it also presents an easy process that even amateur analysts can follow.

The description of stages of the original model is described with the aid of Figure1 – the diagram depicting the ADDIE framework.

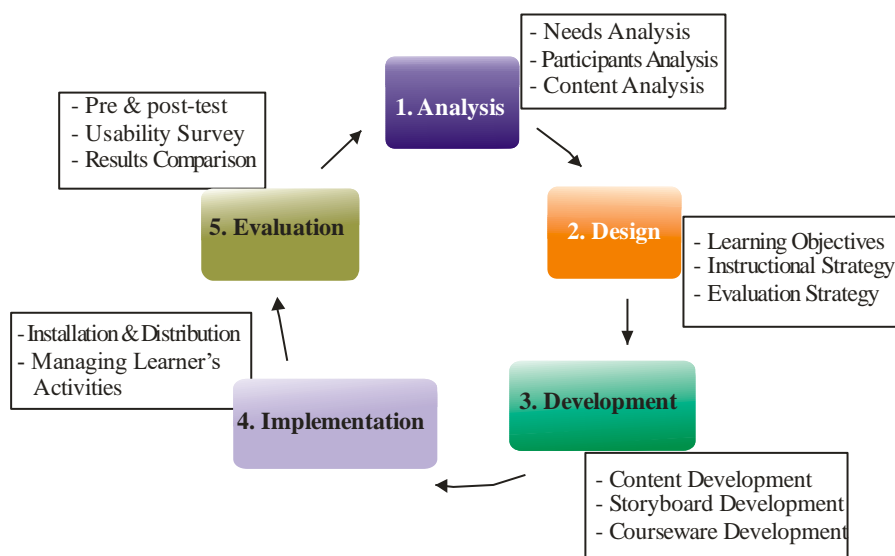


Fig. 1 Development process of the Attendance control system using the ADDIE model [7]

The cyclical ever-evolving ADDIE framework and how it can be used to achieve the objectives of the work are briefly described hereunder.

**Analysis phase:** In the analysis phase, the designers' main consideration is the target audience. First, a need analysis is conducted to determine the needs of the audience by distinguishing between what the School Security System already has and what it requires to be more effective. In this study, the analysis has already been implemented by in-depth review and observations on the SSS in Nigeria which its result indicated that there was a high rate of child kidnapping and mass abduction of schoolchildren by terrorists, lack of requisite technology, worries among parents and lack of security which this work is meant to resolve.

The materials needed include an RFID device, RFID tag, and biometric (face recognition).

**Design Phase:** is aimed at developing an SSS application. Therefore, we achieved that by pinpointing managing aims, plans, instructional approaches, and the selection of the appropriate methodology that allows for cyclic-prone constant feedback. In this phase, an outline and explanation of the system and storyboard are created. Module, software program, and instrument to assess the quality of system modules are designed and determined. In this study, the application of RFID and biometrics in SSS was the result of the analysis step, which aimed to help and facilitate the security of school children. The component of the systems consisted of Input, Process, and Output. (See Figure 4.1).

- Component of Input includes student's biodata, alongside that of their parent's information.
- Component of Process includes the processing from the input component to the form of information and graphics. The system will automatically record the time-out and time-in of students in the database.
- The output component includes the notification to parents via SMS two times when the student is entering and leaving the school premises.

**Development Phase:** Here we refer to the results from the previous two phases and construct a product for the delivery of the information during the development phase. This transitional stage transforms the role from research and planning to a production model. The development phase emphasizes three areas drafting, product, and evaluation. Evaluations during the development phase comprise a different focus than the factual evaluation layout that occurs during stage 5 of the ADDIE process. Encompassing a formative approach, evaluation during the development phase calls attention to the product (SSS) and the quality standards of the product. Here we determine if the users can handle the product and how it can be improved before implementation. For our study, the aim here is to, first of all, create prototypes and then perform initial tests to generate feedback. Additionally, we used C# programming language in Visual Studio Code for coding and Arduino IDE for the RFID controller development environment.

### **Implementation Phase:**

In the implementation phase, there must be an active role rather than a passive role. The designer or instructor's role intensifies with the advent of this phase. School authorities, parents, students, and security operatives were trained on how to use the system. For the product to be delivered effectively, we must continue to analyze, redesign, and enhance the product. It can be ineffective for the implementation of the program if the produce or program is left to work in its natural state. No product, course, or program can be efficient without

conducting an appraisal and required modifications throughout the execution phase. When the learners (users) and instructor are active contributors in the implementation, modifications can be made instantaneously to the course or program to ensure effectiveness.

**Evaluation Phase:** The evaluation phase is an essential component of the ADDIE process and is multidimensional. The evaluation phase can be during the development stage in the form of constructive evaluations, throughout the implementation phase with the help of the scholars and a stakeholder(educator), and at the end of the implementation of a procedure or program in the form of a summative evaluation for educational enhancement. Throughout the evaluation phase, the developer must determine if the problem has been answered(relative to training programs), if the objectives have been achieved, the impact of the product or course, and the changes that are necessary for the future delivery of the program or course. The evaluation phase can often be overlooked because of time or economic factors; however, it is a necessary practice. The evaluation phase should be an integral part of the continuation of analysis and effective implementation of future courses and programs. In our study, we conducted both formative assessments. This is to generate opinions, recommendations, and reports from the prototypes/application.

#### **4. System Architecture and Implementation**

This system is classified as an embedded system since it consists of both software and hardware elements. The hardware components include RFID reader, face recognition unit, and Arduino, an LCD, a buzzer and a passive RFID tag. Moreover, the project aims to achieve a specific goal, not to remain from its objective and can be summarized as follows:

- Data collection
- Data collection using the respective problem-solving choice approaches.
- Detection of construction tools and availability of materials.
- Construction of hardware.
- Programming selection of the microcontroller based on the availability of its shielding.
- Integration of technology and hardware for testing.

The RFID reader is connected to the microprocessor. The data (ID numbers) are registered as a part of the program into the Arduino Uno to identify each card automatically. A 12V power supply will power the RFID scanner and Aduino Uno of the system as shown in Fig. 2. During registration of the students, RFID tag is assigned to each student. The picture and biodata of the student is taken during registration while the ID numbers in the tag serves as the student's registration number. Once the RFID tag is been scanned on the RFID reader, it will trigger the system camera to take a picture of the student. The system after taking the picture trained the picture using machine learning model, the trained pictures will be stored on the database of the system. Attendance and notification to parents is being taken only when both the input data (ID number and Face of the User) match the previous stored data.

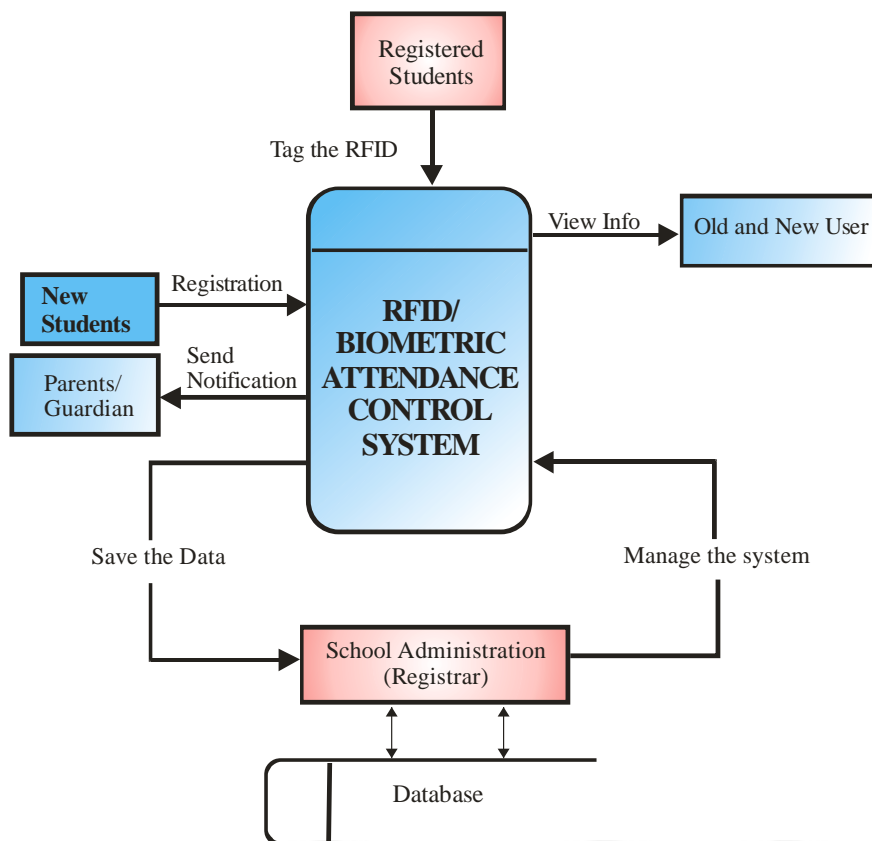


Fig. 2 Context Diagram of enhanced time-based attendance control system

#### 4.1 Implementation

The RFID system was successfully integrated with graphic user interface on the host system. The system consists of login form, connection button, database form, checkin form interface using USB UART serial communication with the RFID reader. The system performs two main function which are class attendance and parents notification.

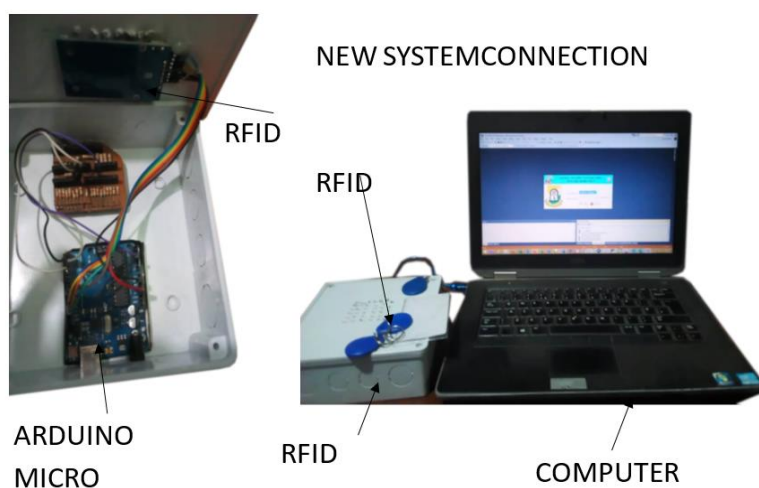


Fig. 3 Circuit diagram of the enhance attendance control system

### 4.1.1 Graphical User Interface

The graphical user interface is created using Visual studio 2015 and it consists of the database system used to store all students' details, parents' details, date and time. The database management system used for the application is a Microsoft SQL Server. The DBMS was used to create various database schema objects that store and retrieve information from the database. The database was used to create the tables such as user\_table, attendance\_table and rfid\_registration\_table. The databases were fully accessed using MySQLMAMP server from the phpMyAdmin providing an application programming interface (API) for accessing the database system programmatically. SQL statements were used in querying and updating records. The RFID tag is used in attendance marking while the biometric (face recognition) is used in authentication.

## 4.2 TEST AND DATA

### 4.2.1 A Login Window Form

The login is built with tightened security which allows only authenticated person to access this system to make connections, register students, edit records and generate report. The administrator needs to key in the correct username and password to access this system and can quit this system by clicking logout button. He can also create other users in the system. When the administrator log into the system, he can have access to connection, register new students, modify student record and generate report.

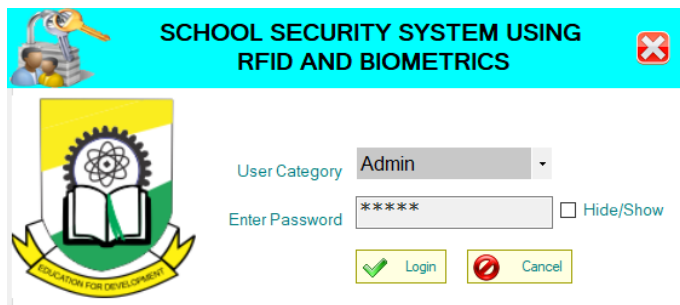


Fig. 4 Log in window form

### Steps on how to register students and modify the data

- i. Log in to the system
- ii. Connect the RFID Reader
- iii. Fill/Edit the student form with his/her biodata
- iv. Assign a tag to the student by scanning the tag to capture the tag number as the student number.
- v. Scan/Upload the student picture
- vi. Train the Image for facial recognition
- vii. Save to the database



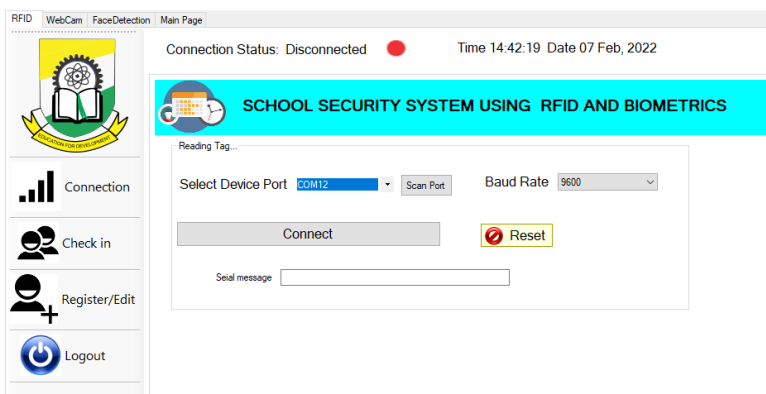


Fig. 5 System Connection

#### 4.2.2 Enrolment Page (Biodata)

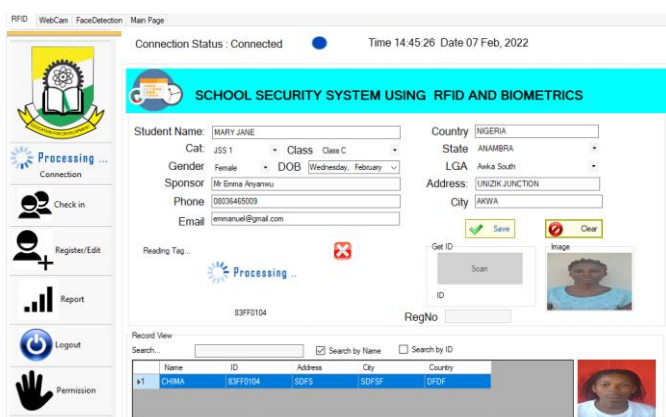


Fig. 6 student registration window

#### Steps on how to retrieve the report from the database

- i. Log in to the system
- ii. Click on report
- iii. Select the category (ie by class or as an individual)
- iv. Click on generate report
- v. Print report

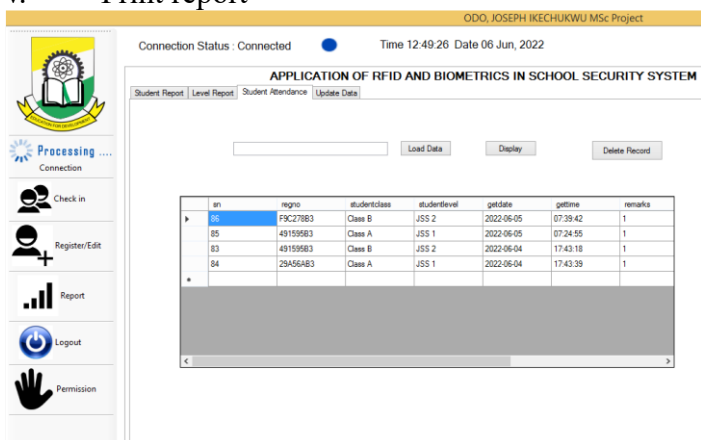


Fig. 7 Report generation window

### 4.3 ATTENDANCE MODE TESTING

Attendance mode is the first mode before using it, it does not need administration authorization.

Testing steps:

- i. When a student place his or her card at close range to the reader for scanning, the reader scan s the code and looks up the student's number in the database.
- ii. The system then asks the student to position his or her face on the camera for face-recognition.
- iii. After confirmation, the system then marks the particular student present and then stores it on the array created for attendance and send email notification to parents with the snapshot picture of the student at that moment.

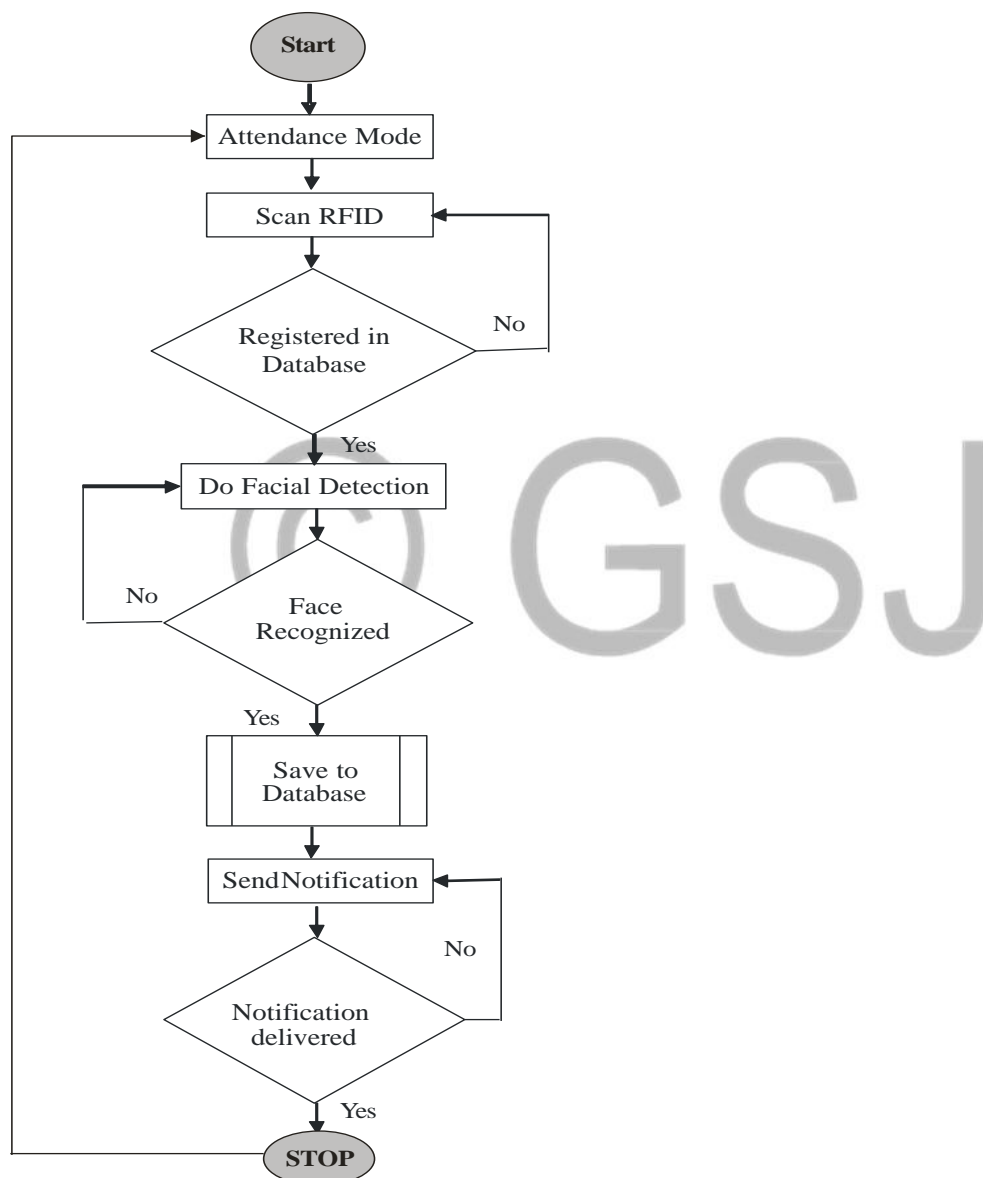


Fig. 8 Steps in testing the attendance mode.

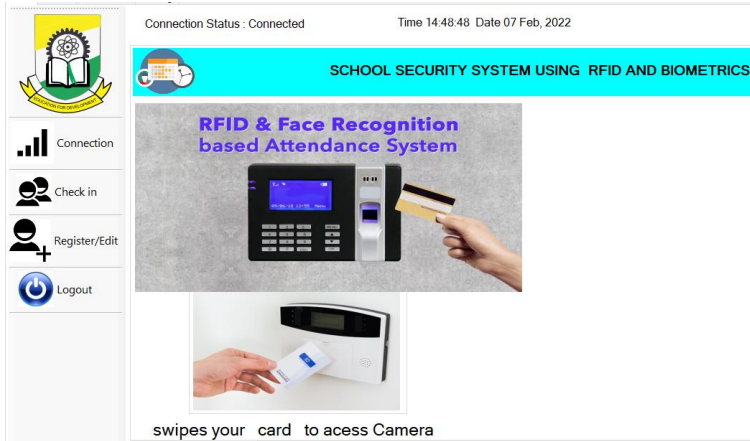
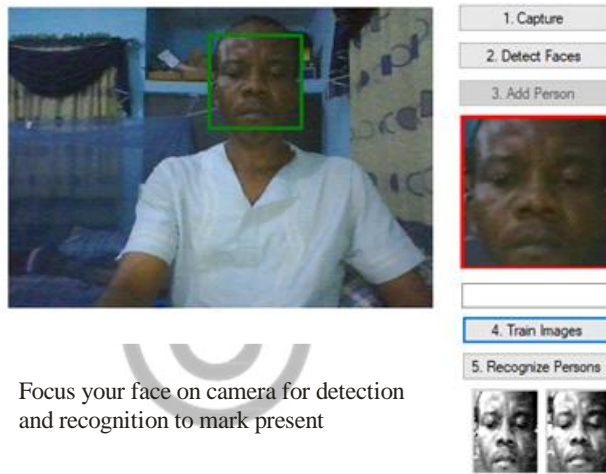


Fig. 9 Students checking in window



Focus your face on camera for detection and recognition to mark present

Fig. 10 Facial detection and recognition

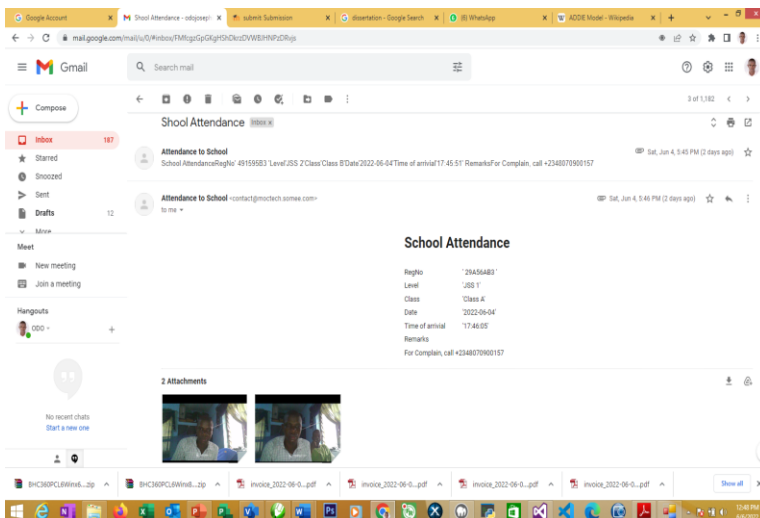


Fig. 11 Notification to Parents

## 5. RESULT AND CONCLUSION

Effectively, design and implementation of this project has created a long-lasting solution to some various problems encountered in attendance taking in various secondary schools and boarding schools. As a result, we resorted to combining RFID and biometrics (facial recognition) systems to develop a more efficient attendance control system. This new attendance System was implemented for marking attendance for students and storing the time of arrival to the school in the database. The system sends email notifications to parents in real-time of student attendance at the school. The facial recognition system helps to prevent the abuse of the RFID tag assigned to every student thereby reducing illegal activities of the school children. This approach offers a solution for various weaknesses that must be faced in the already existing system including:

- i. Real-time attendance recording for students.
- ii. Reduction of worries among parents/guardians on bullying among the students in boarding school.
- iii. Security of the system through the implementation of a login system whereby unauthorized persons cannot have access to the system.
- iv. Enhance to eradicate the spread of COVID-19 virus among school children.

## CONCLUSION

The Design and Implementation of an enhanced Time-Based Radio Frequency Identification (RFID) and Face-Recognition biometric Attendance Control System which is the aim and objective of this work was successfully implanted. This system provides an effective and more convenient method of taking attendance when compared to the manual method and finger print systems. Data are more organized, the system more friendly, the data manipulation and retrieval are done by an authorized user through the graphical user interface. The face-recognition curbs spread of COVID-19 virus and provides high security performance. The notification send to parents helps to reduce panic among parents about their child's whereabouts while in boarding school, and give them information on the time their children arrive to the school. The system can be implemented in any education institution in Nigeria and the world at large.

## REFERENCES

- [1] C.E. Geoffrey, "Automatic Access Control System using Student's Identification Card based on RFID Technology", Unpublished Thesis Faculty of Electrical Engineering, University of Teknologi Malaysia, (2012).
- [2] Chandramohan, J., Nagarajan, R., Kumar, A. M., Dineshkumar, T., Kannan, G., and Prakash, R. (2017). Attendance Monitoring System of Students based on Biometric and GPS Tracking System the Fingerprint-based Attendance Management System. *International Journal of Engineering Research & Technology*, 5(13), 1-5.
- [3] Chiagozie O.G and Nwaji O.G (2021): Radio Frequency Identification based attendance system with automatic door unit. *Academic Research International*. Vol 2 No 2.
- [4] Dandekar, P., Satpal, H., Hinge, A., Jain, J & Lohakare, A. (2020). School Security System using RFID. *International Research Journal of Modernization in Engineering Technology and Science*, 2(3), 565 – 573.
- [5] Elshaiekh, N. E. M. & A.I Darai, S. N. (June 2018). Radio Frequency Identification School Security System Enhancement. *Journal of Management Information Systems & E-commerce*, 5(1), 7-13. DOI: 10.15640/beds.v5n1a2

- [6] Mahyidin, M. F. B. (2018). Student Attendance using RFID System. Master Thesis, Electrical Engineering (Power Systems) Faculty of Electrical & Electronics Engineering, University Malaysia Pahang.
- [7] Parsazadeh, Nadia; Ali, Rosmah; Rezaei, Mehran (2018). A framework for cooperative and interactive mobile learning to improve online information evaluation skills. *Computers & Education*, 120(), 75–89. doi:10.1016/j.compedu.2018.01.010
- [8] Pujari V., Patil R. & Sutar S. (2021): Research Paper on Biometrics Security. *Contemporary Research in India (Issn 2231-2137): Special Issue: April 2021*
- [9] Subashchandraboss, S. and Pajany, M. E. (2015), Hybrid of Student Attendance Tracking System Using RFID Device and Finger Sensor. *International Journal of Computer Science and Mobile Computing*, Vol.4 Issue.3, March- 2015, pg. 271-278
- [10] Ukoima, K. N., Ekwe O. A and Ezeonye C. S. (2019). Radio Frequency Identification (RFID) Based Attendance System with Short Message Service (SMS) Backup. *IOSR Journal of Computer Engineering*, 21(2), 1-8.

