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Radio Frequency Identification (RFID) Based Attendance System with Short Message Service (SMS) Backup

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Abstract: *In this paper, we seek to address 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 finally making a decision on the eligibility of a student to sit for an examination course. Owing to the challenges of the manual method of taking attendance in Nigerian universities and colleges especially in the Michael Okpara University of Agriculture Umudike, an automated attendance system needs to be adopted. The challenges include difficulty in keeping the attendance list over a long period of time, unnecessary time wastage during writing and signing attendance, improper documentation, students forgetting to write or sign the attendance paper, lecturers forgetting the attendance list in the classroom, students writing or signing illegally for an absentee amongst others. A modular approach was utilized in the design. The design has four major parts: input section (RFID tag and RFID reader), control section, power section and display unit. All simulations were performed using the PROTEUS software. Results obtained show that when a student who enters a classroom swipes the RFID tag near the reader that is connected externally to microcontroller based embedded system, the system grants access to a registered student and stores the attendance information on a PC database. An SMS containing the same details is sent to mobile phone for data backup through the GSM SIM 900 Modem. The design was successfully tested and implemented.*

Keywords: *Radio Frequency Identification (RFID) Tag and Reader, Liquid Crystal Display (LCD), ATMEGA 328P Microcontroller, and GSM Module.*

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I. Introduction

Students are expected to attend 70 percent of a lecture class before they are allowed to sit for an examination as directed by the Nigerian Universities' Commission (NUC) policy. The manual method of taking attendance in universities and colleges in Nigeria over the years has become a thing of concern. In the manual method of taking attendance, students are required to write down their names and sign an attendance list. The problems associated with the manual method of taking attendance vary from unnecessary time wastage to improper documentation, students forgetting to put down their names on the attendance list or students writing on behalf of other students that are absent from the class [10]. To eradicate the deficiencies associated with the manual attendance system, an automated approach is implemented using the RFID technology. The design incorporates an RFID reader, RFID tags, computer system, mobile devices, and host system application. The design ensures that students attendance is taken automatically as well sending short message to the student mobile phones which serves as a means of alternative backup in the case of data loss by the lecturer and also serves as a means of giving warning to students in cases of low attendance which could degrade their performance or prevent them from taking the course examination, if the class attendance percentage is less than 70.

The need for the application of RFID technology to student class attendance in this proposition will lead to elimination or reduction of the quality time wasted during manual collection of attendance. The need will also lead to the creation of a student database management system that is not prone to errors or being manipulated by anyone and above all aids in better management of classroom statistics for participation in examination and allocation of attendance scores in the final grading of student performance in a particular course. A number of related works pertaining to the application of RFID and GSM Technology to different areas and specifically to the area of attendance monitoring exists.

Mohamed in [11] designed and implemented a model of a secured and portable embedded reader system to read the biometric data from the electronic passport. The authors attempted to solve problems of reliability, security and privacy in E-passports by authenticating holder online using Global System of Mobile Communications (GSM) network. The GSM network is the main interface between identification centre and the e- passport reader. The communication data is protected between server and e-passport reader by using AES to encrypt data for protection while transferring through GSM network. In [12], Nambiar reviewed the current research application of RFID to different areas with emphasis on application for supply chain management. This developed a taxonomic framework to classify literature which enables swift and easy content analysis to help identify areas for future research. A reviewed on the use of RFID in an integrated circuit (IC) packaging house to resolve inventory transaction issues was conducted in [7]. His study suggests that RFID contributes significant improvements to the water receiving process and the inventory transaction process that reduce labour cost and man-made errors. Automatic Access Control Using Student ID Card Based on RFID Technology in [4] enables the automatic access control system to prevent illegal entry of people into a building and preventing unauthorized people from gaining access to certain organization resources. The door locking system functions in real time, the door opens as soon as the user scans the tag. The system also stores the login and logout information of the user.

[15] presents the designed and implemented RFID Based Exam Hall Maintenance System which resolves the problem of students searching for their examination halls and seating arrangements. The card reader is provided at the entrance of the building. A student needs to swipe his tag in front of the reader at any hall and his hall and seat number would be displayed on the LCD. Mahajan in [9] designed and implemented the application of RFID Technology in Libraries termed RFID based library management which saves the library staff's time and energy by automating their task. Borrowing and returning of books are automated using the check-in, check-out system which is RFID based. The limitation of the system is that it is costly to implement. [2] propose an automatic attendance system using fingerprint verification technique. The fingerprint technique verification was achieved using extraction of abnormal point on the ridge of user's fingerprint or minutiae technique. The verification confirms the authenticity of an authorized user by performing one to one comparison of a captured fingerprint templates against the stored templates in the database. The proposed automatic attendance system signals either true or false based on logical result of previous one to one verification of person's authenticity. However, the various researches conducted so far on the RFID attendance system does not incorporate a backup system. In a situation where there is loss of data on the PC due to system crash or malfunction. See: [1, 3, 5, 6, 8, 12-14, 16-20].

In this work, we developed a graphical user interface (GUI) using Visual Basic 6 that will integrate an RFID system to capture and record student attendance with a backup SMS.

II. Materials and Method

This project is divided into software and hardware development. The software developmental program used for interfacing RFID to Arduino (ATMEGA 328P) microcontroller can simply be divided into four parts: Configuring the serial communication, reading the RFID card, fetching it from the memory location and displaying it on the LCD which is executed using C language. The hardware comprises of four main units: Power Supply Unit, Input Unit (RFID Tag and Reader), Control Unit (ATMEGA 328PArduino Microcontroller and GSM Module), and the Output Unit (PC, LCD, and GSM). When the system is powered, the RFID reader starts monitoring and sensing for any scanned card within its electromagnetic region. When a card is scanned near the reader, the reader will decode the details (card number) of the card and sends the information to the central ATMEGA 328P Microcontroller for processing. The microcontroller processes and decodes the card number to ascertain if it is a valid one. If it is valid, access will be granted, and it displays the Student Name and Registration Number on LCD. The microcontroller also sends a signal to the Sim900 GSM module which then sends short message (SMS) notification containing students name, Reg. number, department, card number, etc., to a designated/student phone. This serves as data backup. The microcontroller will also send the details of the card and the number of times the card has been scanned to the PC database. This information can be accessed at any time using programmed staff tags which is designated to the lecturers to access the student attendance.

Table 1: Design materials

S/N	DESCRIPTION
1	16x2 Liquid Crystal Display (LCD)
2	SIM900 GSM Module
3	RC522 Radio Frequency Identification Module (RDIF Reader)
4	Radio Frequency Identification Tag (RDIF Tag)
5	Arduino Uno module
6	Transformer (2000mA, 240/15V)
7	SIM Card
8	Light Emitting Diode (LED)
9	IC Voltage Regulators
10	ATMEGA 328P Microcontroller
11	1000µf Capacitor
12	1kΩ Resistor
13	Bridge Rectifier (IN4001 power)
14	Connecting Wires
15	Connecting Wire Socket
16	Vero Board
17	A-B USB Cable
18	2.5mm^2 Cable
19	13A Fuse Plug

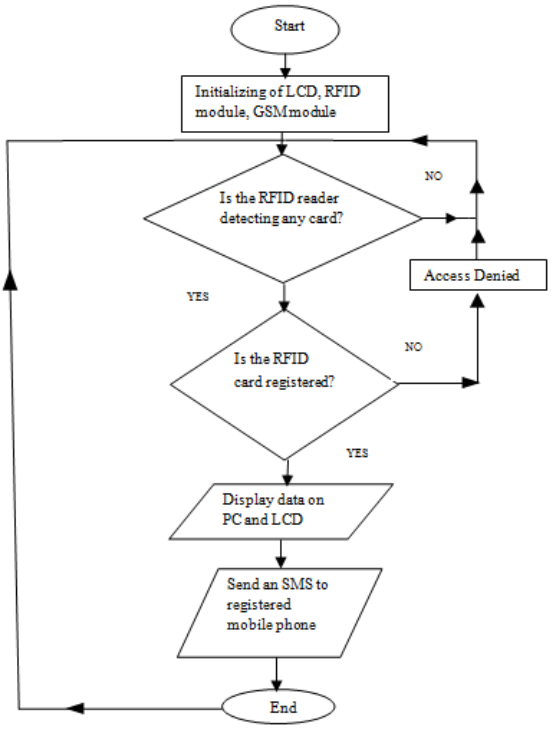

Figure 1: Design Flow chat

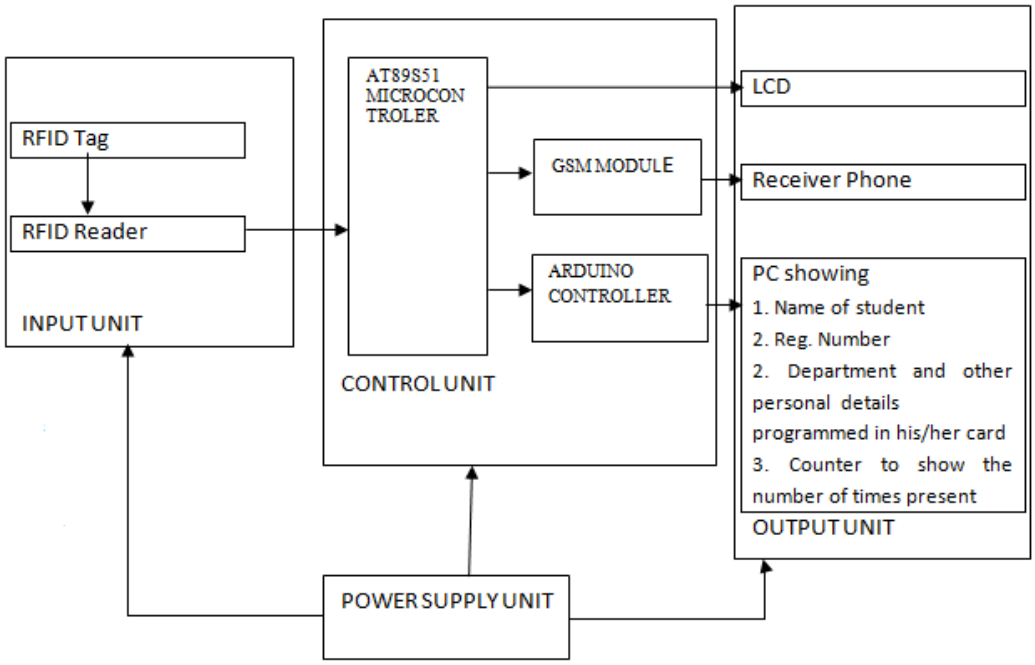

Figure 2: Block Diagram of the System

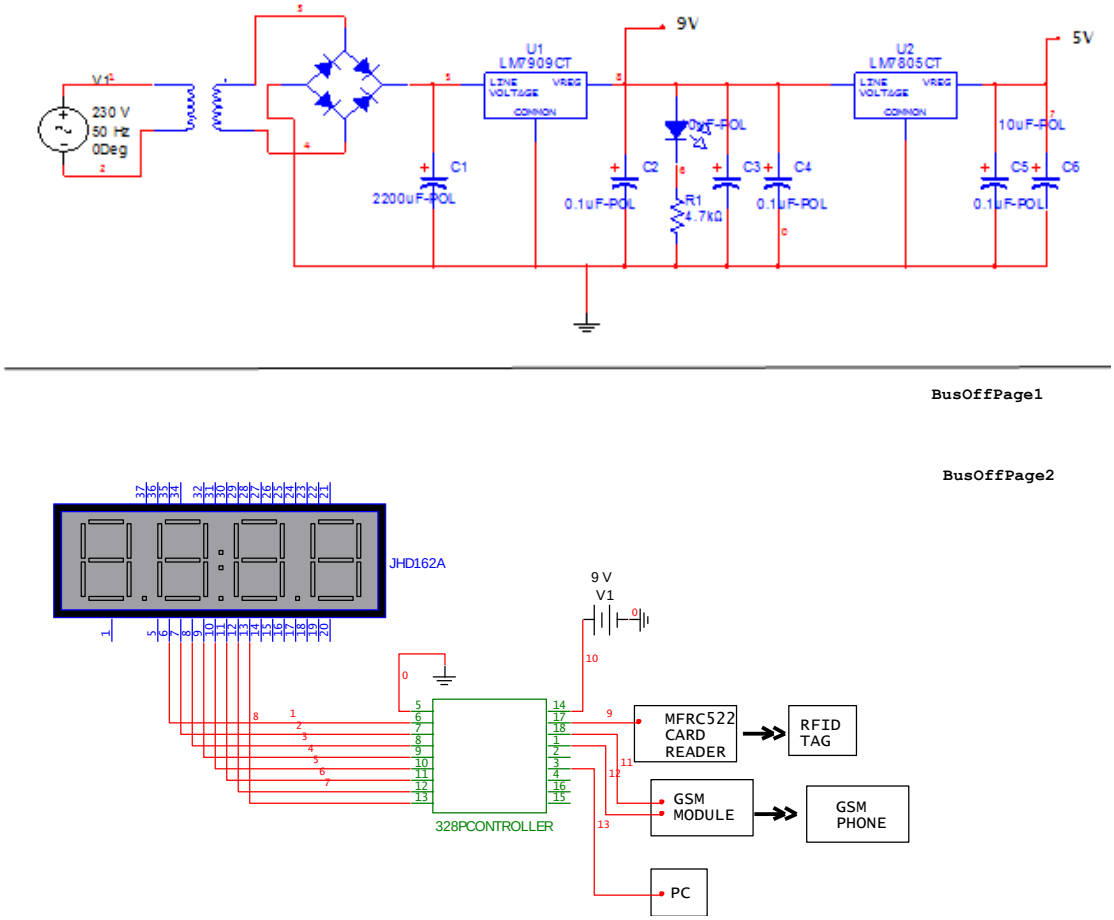

Figure 3: Circuit Diagram of RFID Based Attendance System with SMS Back Up

III. Design Specifications

The current and voltage requirements of the components needed and used for this projected are stated below:

i. RFID Module……..5v/35mA
ii. GSM Module……5v/500mA
iii. LCD module……5v/40mA
iv. Arduino……9v/100mA
v. USB-TTL converter……..…5v/20mA

Total voltage sources required = 5v and 9v sources

Total current rating required = 695mA

3.1. Power Supply Unit

The power supply unit used for the RFID Based Attendance system provides the system with 5volt/695milliamp and 9volt/695milliamp.The following components and values were chosen

i. A 230v/15v, 1500mA step down transformer
ii. A bridge rectifier IC of 2A current capacity
iii. 5v (7805) voltage regulator IC of 1A current capacity for the 5v voltage source
iv. 9v (7809) voltage regulator IC of 1A current capacity for the 9v voltage source

3.1.1. Capacitor Selection:

Capacitor value, C_1, can be calculated using the following:

$$C1 = \frac{1}{(4 \times F_o \times V_r \times R_L)} \quad (1)$$

Where: F_o = Output frequency; V_r = Assumed ripple voltage (5mV)
R_L = Expected load resistance taken to be 300Ω; F_i = input frequency
But, $F_o = 2 \times F_i = 2 \times 50 = 100H_z$
Therefore $C1 = \frac{1}{4 \times 100 \times 0.005 \times 300} = 962\mu f$

But standard value of capacitor is 1000µf
Also, the working voltage should be equal or greater than the V_{max}, and the working voltage from transformer is 15v.
Therefore, choice value of C_1 chosen = 1000µf, 25v.

3.1.2. Indicator (LED) Calculation
Working voltage of LED = 3v
Operating current = 20mA
From the circuit diagram,

$$V_s = V_{led} + V_r \quad (2)$$

Where $V_s = 15V, V_{led} = 3V$
$V_r = V_s - V_{led} = 15 - 3 = 12V$
But, $V_r = I \times R$ (3)

$$R = \frac{Vr}{I} = \frac{12}{20mA} = 600\Omega$$

R was chosen as 1KΩ (R = 1kΩ) for a lower current.
Power rating of $R = I^2 \times R = (20\times0.001)^2 \times 1000 = 0.4w$
Standard value of Resistor used = 1kΩ, 1w

IV. Test and Results

After constructing the overall system circuit, the various segments were tested for appropriate functioning as shown below;

4.1 Testing the RFID Card, RFID reader and LCD display

This has to do with powering and testing the RFID Card of each student, the RFID reader and the LCD segment. When the system is powered, it displays "Swipe your RFID CARD", meaning that the system is ready to scan card as shown below in plate 1.

Plate 1: LCD powered ON

When the card is swiped across the RFID reader, the reader will sense it, decode the embedded code (information) on it and sends the decoded signal to the central microcontroller (ATMEGA 328P Arduino) to process, if found valid, the code (Student Name and Registration Number) will be display on the LCD screen as shown below in plate 2.

Plate 2: LCD Display when card is swiped

4.2 Testing the RFID Card, RFID reader and Computer Screen

The central microcontroller (ATMEGA 328P Arduino) also sends the details of the card to be displayed on computer screen through Arduino serial Monitor screen which also include the number of times the student has attended lectures.

When the card has not been swiped, the screen is empty as shown below in plate 3.

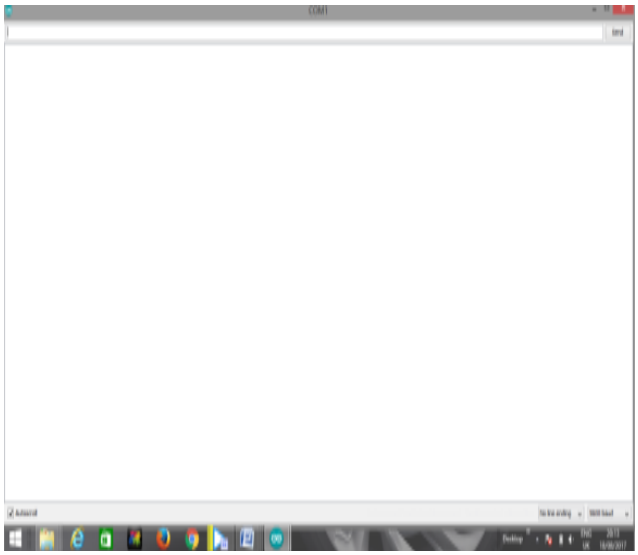

Plate 3: Arduino screen on switched ON

Plate 4 below shows the information displayed when two different student cards are swipe for the first time.

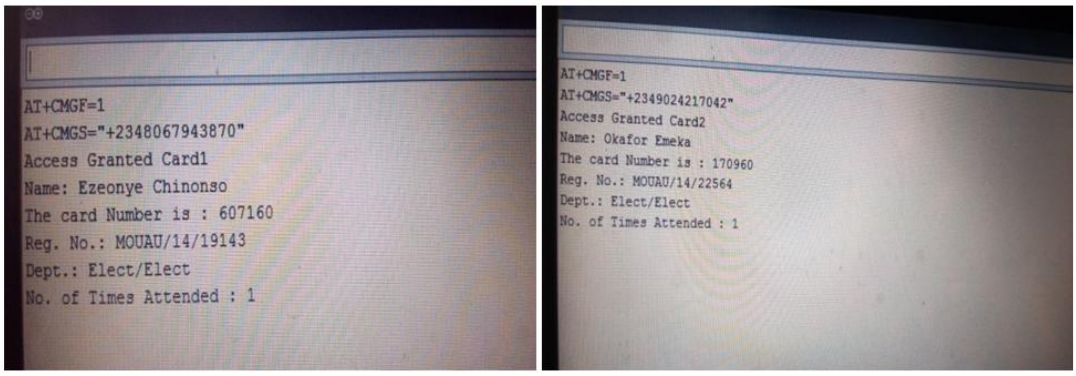

Plate 4: Arduino page when Student card is swiped ONCE

When both cards are swiped the second time, the information in plate 5 below is displayed.

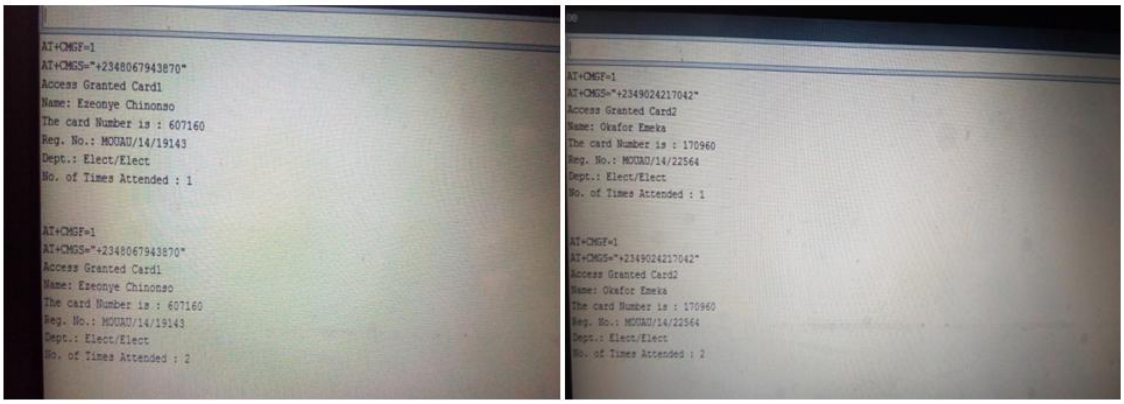

Plate 5: Arduino page when Student card is swiped TWICE

There is also a tag programmed to reset the database and a tag programmed to access the database. When the tag for the database and the reset is swiped, the display is shown below in plate 6 and plate 7.

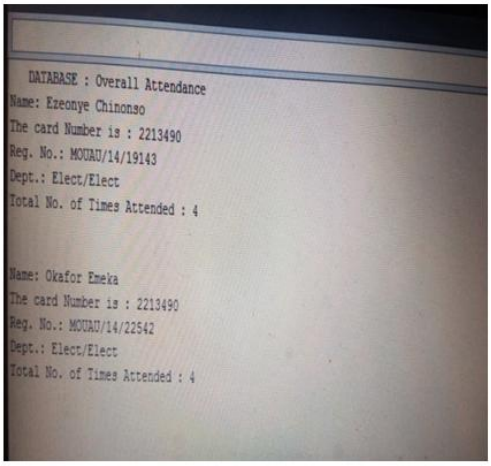

Plate 6: Arduino page when Database card is swiped

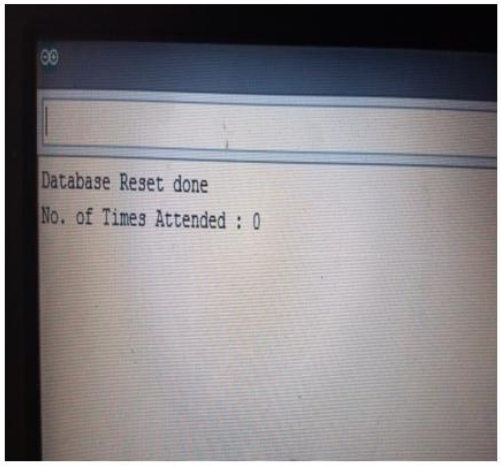

Plate 7: Arduino page when reset card is swiped

4.3 Testing the Sim900 GSM module.

As the central microcontroller is sending the decoded information from RFID reader to LCD and computer screen for display, it also sends SMS notification through the Sim900 GSM module to a particular programmed student phone number as back up means. The SMS notification will read "Access Granted, Students' name, card serial number, Registration number, Department, Number of Times Attended" as shown below in plate8.

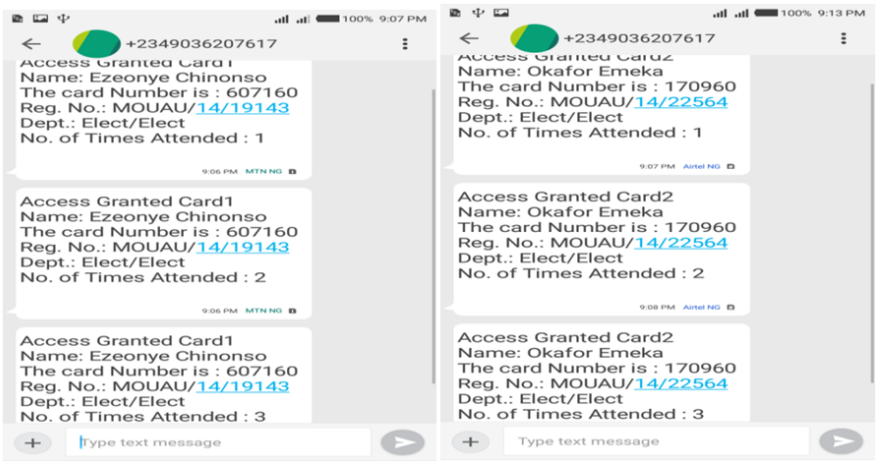

Plate 8: SMS Notification to Student Mobile Devices

Conclusion and Recommendations

We have developed an RFID based student attendance system with short message service (SMS) notification backup which is helpful in saving valuable time of both students and lecturers and helps to generate accurate reports when required. The SMS feature serves as a backup if data loss occurs on the PC. For future work, we recommend incorporating a facial recognition application that would serve to further increase the biometric security of the system against impersonation by erring students. Also, we recommend including a timing circuit in order to specify the exact time/date each student enters the classroom so that erring students that use the card twice at the same time without the consent of the lecturer can be dictated.

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