LAUTECH Journal of Engineering and Technology 12 (2) 2018: 123-135

FINGERPRINT BASED STUDENT ATTENDANCE MANAGEMENT SYSTEM WITH AUTOMATIC EXCEL COMPUTATION

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ABSTRACT

Fingerprint is considered to be the best and most widely used biometrics recognition and verification pattern due its uniqueness for every individual. This study focused on the development of a fingerprint students' attendance system carried out to curb the problems associated with manual methods of taking students attendance in institutions. The design was carried out using appropriate mathematical model, formulae and block diagram representation while Proteus software simulator was used to simulate functionality of the designed circuit. An attendance algorithm was developed and implemented using coolTerm software and Excel spreadsheet. The system was tested using 15 students' fingerprints which involves enrollment, authentication and report generation processes. Each student was enrolled with a unique identification. During verification and attendance capture at different times, the system exhibits extremely low (0%) False Acceptance Rate (FAR), extremely high (100%) True Accept Rate (TAR) and extremely low (0%) False Reject Rate (FRR). This study has established the effectiveness of students attendance capture using fingerprint as a more secure, credible and error free to impersonation and buddy punching as associated with the existing manual-paper based system.

Keyboards: Attendance Management System, Authentication, Coolterm Software, Excel, Enrollment, Fingerprint

Introduction

Attendance management is a method employed to keep track of employee hours by an organization. This is necessary in order to minimize losses due to employee downtime. Attendance management helps in evaluating the salaries of employees most especially those who are paid based on the number of hours they have put in. It also indicates/reveals employees' punctuality which could be used to schedule leave and vacation. Besides, it plays a vital role in the academic environment such as in the university where a certain percentage of lecture attendance in a course is required for a student to partake in the examination for that course (Senate Committee on Review of Academic Programme, 2009). Studies have shown that a high percentage of lecture attendance can improve the potentials of a student in having good performance and students are more likely to succeed in their academics when they attend classes regularly.

Attendance management methods can be divided into the conventional or manual and the automated methods. The conventional methods include roll call and marking of students' details in the attendance register. These methods are rigorous and time consuming, leading to waste of time and paper as the number of students increase. It also faces problems such as; lack of backup for the attendance record, in case it goes missing and buddy signing (signing the attendance register for a friend who is absent from class). Moreover, students often get distracted when the attendance is ongoing and pay less attention to the lecture.

The automated methods on the other hand, are generally more efficient compared to conventional methods. They include use of barcode, Radio Frequency Identification (RFID) and Biometric systems. The barcode based attendance management system requires the use of card with barcode that is swiped on a time clock to take the attendance and the data is captured by the clock (Kizildag, Basar, Celikag, Atasoylu, & Mousavi, 2011). Radio Frequency Identification (RFID) makes use of radio waves to transfer data from an RFID tag embedded on the identity card (Zhao, Gao, Liu, & Wu, 2012). Biometric attendance system uses biological characteristics like the palm, jaw, iris, face and fingerprint for identification and verification (Ruud & Sharath, 1998).

Fingerprinting is one of the best biometric identification methods. It has become widely accepted since the fingerprint of every individual is unique and does not change during a person's lifetime. Moreover, it has proven over time to be the most rapid, reliable and cost effective means of identifying individuals (Adámek, Matýsek, &

Neumann, 2015) because its data is inexpensive to collect, easy to classify, analyze and sort. The use of fingerprint in monitoring students' attendance to a great extent will eliminate the need for passwords which could be hacked and the use of identification card which can get missing. This study/project seeks to curtail the shortcomings of conventional and other methods of attendance management systems by developing a fingerprint based attendance management system which will be used to take students attendance in the class with the ability to export these attendance records automatically to Microsoft Excel spreadsheet. The implementation of this system will help lecturers to effectively manage and analyze students' performance based on their attendance. Besides, it will also help in increasing students' academic performance since absence from class without being noticed will no longer be possible due to the minimum possible error and high efficiency guaranteed by the system.

Many related works regarding attendance management has been proposed recently (Patel & Priya, 2014). Kizildag (2011) proposed an attendance management system using identity cards barcode scanners. RFID technology attendance system proposed by Zhao and Gao (2012) have students' RFID cards embedded with RFID chip which transmits signals that are detected by the RFID reader when the attendance is taken. Shoewu and Lawson (2011) proposed an embedded computer based attendance system with electronic card comprising the student ID, name, matriculation number and five pin encrypted code. Attendance of the student is authenticated via a card reader interfaced with the computer, which compares the entrance code with the encrypted code on the card when swiped through the card reader.

Furthermore, mobile cloud attendance system proposed by Al-Shezawi, Yousif (2017) uses the Bluetooth address on the students' smart phone to identify them whenever the application on the computer system discovers the students' Bluetooth addresses. A connection is then made to the cloud to mark students who are present. Lodha, Gupta (2015) proposed a Bluetooth based smart attendance management system that issued an identification card which has a Bluetooth smart chip imbedded in it. Attendance monitoring system based on GPS module using Raspberry PI has been proposed (Sonali & Madhuri, Badole;Ompriya, 2017; Uddin, Allayear, Das, & Talukder, 2014). The students' GPS module sends GPS location to Raspberry PI when taking the attendance. The students whose GPS location is the same with the class coordinates are marked present.

Hameed (2017) and Jadhav & Makone (n.d.) proposed an android based attendance system. The studies make use of an android mobile operating system for attendance management. The attendance of a student is marked by the lecturer's android mobile device via Bluetooth and fingerprint authentication of the students' phone. A wireless attendance management system based on Iris recognition proposed by Kadry and Smaili (2013), uses Daugman's algorithm to search over an image of the eye to detect the iris borders in the high quality images with high accuracy. Okokpujie, Noma-Osaghae (2017) proposed a face recognition attendance system with GSM notification using a camera as the input device. The camera acquires the detected faces during enrollment and stored it in the database. Verification is done when the images of the faces detected are compared to the template stored in the database and attendance is taken if a match is found. Verma and Gupta (2013) proposed a fingerprint-based student attendance system which uses fingerprint acquisition module to capture students fingerprint and stores it in the database during enrollment. The system matches the data with the template stored in the microchip during authentication and the student is marked present, if a match is found. These studies suffer from the risk of impersonation as absentees can still be marked present. Moreover, some of these studies require a constant high speed internet connection.

Major components and software used in the study

Battery

A battery is a device consisting of one or more electrochemical cells with external terminals provided through which electrical devices such as watches, smart phones and electric cars among others are powered (Crompton, 2000). Batteries could be either rechargeable or disposable types. They can also be dry cell or wet cell. Two wet cell Lithium ion batteries were used in this study due to their capacity to effectively power the system and its components. Each has a typical voltage of 3.7V, 2.2Ah and when connected in series they produce 7.4V 2.2 Ah DC. Figure 1 depicts the Lithium ion batteries used in this study.

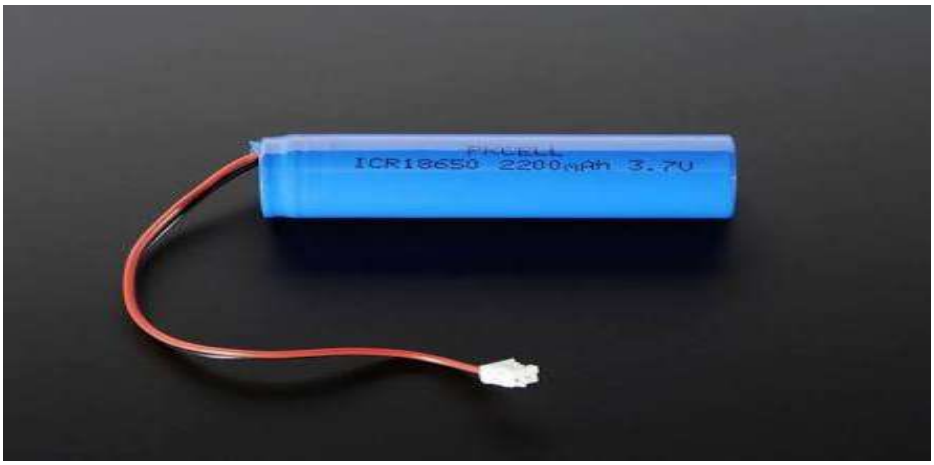


Figure 1: A typical 3.7V DC battery

Charge controller

A charge controller is an electrical device that limits the rate at which electrical current is added to or drawn from electric batteries (Crompton, 2000). It prevents complete overcharging of a battery which can reduce the lifespan and performance of the battery. An ON and OFF switch which is basically a relay switched with a transistor is the charge controller type employed in this study as its suites other deign considerations in terms of costs, availability and function. The charge controller was connected in between the jack plug and the battery bank as well as interfaced with the sensing unit. The output from the sensing unit activates the switching control process.

The charge controller was designed using resistor (R1), transistor (NPN), diode and relay as shown in Figure 2**.** The resistor is connected at the base of the transistor to control against high base current, the transistor switches to engage and disengage the relay which completes the charging circuit. The diode acts to allow current to flow in one direction only.

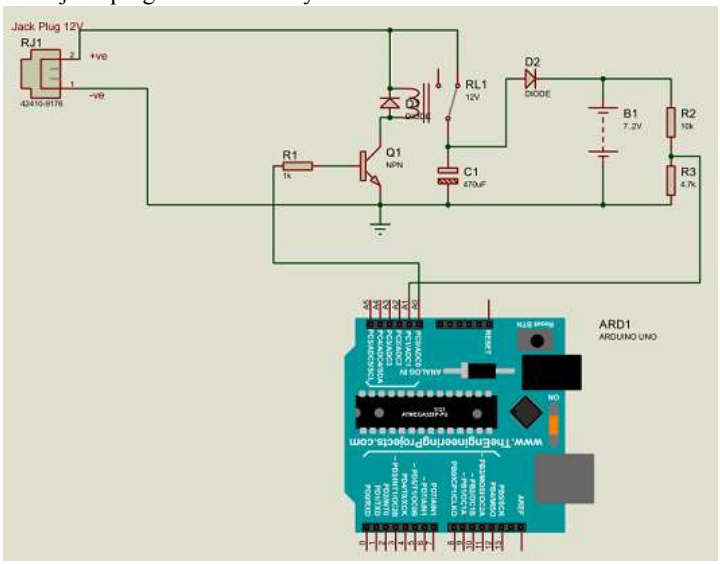


Figure 2: Charge Controller

Microcontroller.

A microcontroller is an integrated circuit that incorporates the functions of a central processing unit of a computer. The microcontroller used for this design is ATMega328P. A computer program was embedded in the microcontroller with the aid of Arduino Uno Rev3 board and Arduino software as its Integrated Development Environment. The microcontroller fetches set of instructions from its program memory, decodes these instructions and carries out the required operation. This way, the

microcontroller together with the fingerprint module, buttons, memory and LED performs matching and authentication functions of the system and displays the result on the LCD. Figure 3 shows the description of a 28-pin ATMega328P microcontroller. The microcontroller was selected due to its availability, cost, design requirements, ease of use and positioning on the board during construction.

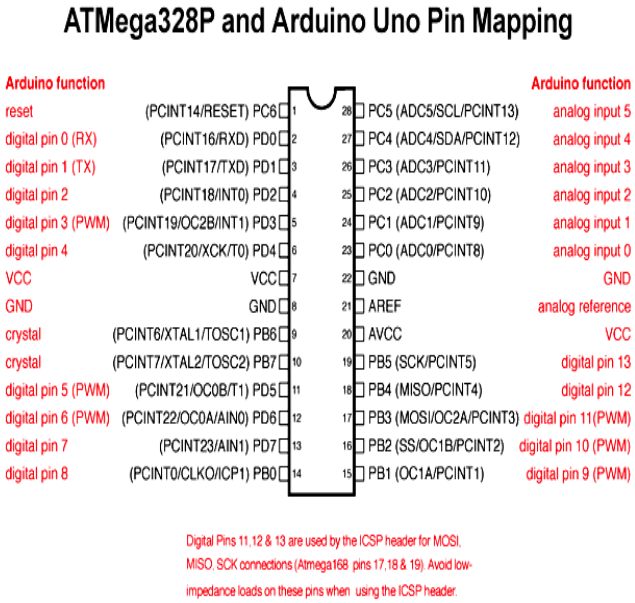


Figure 3: ATMega328P and Arduino Uno Pin mapping representation

Fingerprint Module

The fingerprint module used in the scanning of the finger is the first contact point between the user and the attendance system for data acquisition. It processes the input data to the processor unit. Figure 4 shows the fingerprint module R307 used in this study. It supports functions such as fingerprint enrollment, deletion, authentication and storage. The specifications of R307 are illustrated in Table 1.

Figure 4: Fingerprint module

Table 1: R307 Pin Description

Pin no	Pin Name/Symbol	Details
1	5V, VCC	Regulated 5V
2	Ground (GND)	Common ground
3	Transmitter (TXD)	Data output-Connect to MCU RX
4	Receiver (RXD)	Data input-Connect to MCU TX
5	TOUCH	Active low output when there's touch on sensor by finger
6	3.3V	Used to give 3.3V to sensor instead of 5V

Graphic Liquid Crystal Display (LCD)

A 16×2 graphic LCD was used to display the interactions in the system. It was chosen because it is programmer friendly and available. It is so called because it could display 16 characters in each row (16×2=32 characters in total) and each character will be made of 5×8 pixel dots. This LCD function is based on two registers, the command register and the data register. The former stores the command instructions given to the LCD such as clear the screen, setting the cursor position and controlling display. While the later stores the data to be displayed on the LCD. Figure 5 shows a typical LCD used in the study.

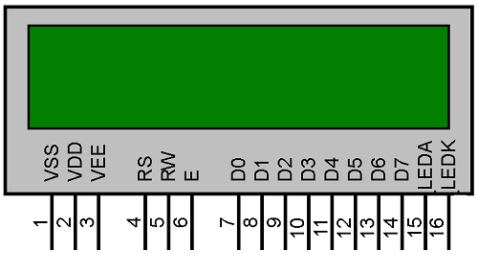


Figure 5: Graphic Liquid Crystal Display (LCD)

Coolterm Software

CoolTerm is the software interfaced with the device which imports the attendance record to an excel spreadsheet. This software has the ability to communicate and exchange data with the microcontroller through the Arduino board. It is an easy-to-use terminal used for exchanging data with hardware connected to serial ports such as servo controllers, robotic kits, GPS receivers and microcontrollers. CoolTerm comes without an installer and can be placed anywhere on the hard-drive as long as the correct folder structure is maintained. For the Windows version, the "CoolTerm Libraries" folder must reside in the same location as the "CoolTerm.exe" executable. Version 1.5.0 of the software was installed and used in this study.

Construction of the system

The circuit diagram used in the construction of the system is illustrated in Figure 6. The jack plug serves to connect the charger to the system while the battery's voltage is monitored using a voltage divider (R2 and R3) connected to the microcontroller. The microcontroller switches the charge controller which is basically a relay RL1 connected to transistor Q1 to control the amount of charges getting to the battery. R1 and R4 serve to prevent high currents from the transistor (I_b) and LED, D3 respectively. The microcontroller is programmed in C programming language and it is interfaced with the graphic LCD, buttons and fingerprint module to enroll and authenticate fingerprints for attendance purposes.

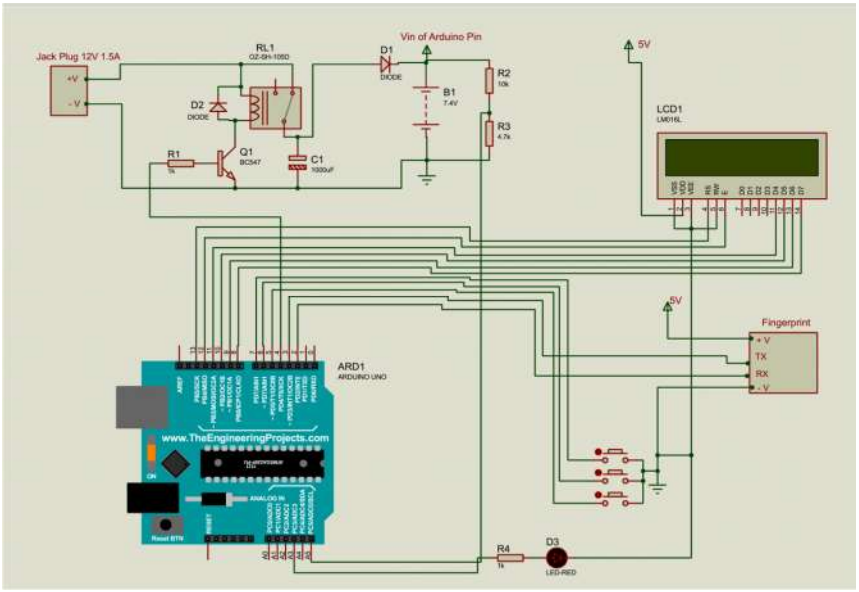
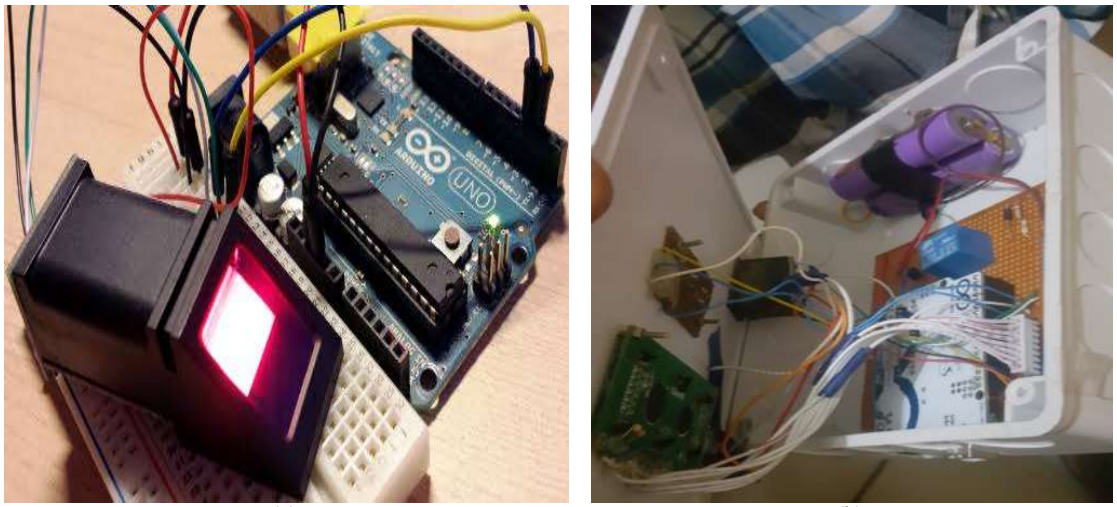


Figure 6: Circuit diagram of the system

Pre-soldering

In this stage, the circuit diagram was simulated to determine the effectiveness of the circuit; the circuit was then assembled on a breadboard as shown in Figure 7(a) so as to determine the functionality and efficiency of the component and the device. Having ascertained it functionality, the entire circuit components were transferred to the Vero board Figure 7(b) and proper soldering was carried out.

After all the components were tested and the faulty ones replaced, the entire circuit was housed in a case made of plastic material. Plastic case was chosen because of its light weight and high resistance to corrosion which makes it a better alternative compared to materials like metal case. The cost and availability of the plastic material is another reason to mention few. Parts of the casing were drilled to accommodate some components and the entire circuit was tightly screwed to the casing to prevent free movement of the components that could result to system failure as seen in Figure 7b.



(a) (b)

Figure 7: Attendance system construction

Microcontroller Programming

The microcontroller is programmed in C programming language to enroll students and admin, delete students and admin record and also to take students attendance as shown with the aid of flow chart algorithms in Figure 8.

Testing and Performance Evaluation of the System

Admin login stage

This stage is restricted to the system administrator only. This is to avoid unauthorized access to the attendance management system log menu, as this is an administrative phase. Figures 9b, 9d and 9e demonstrate access to all the functions that can only be granted on provision of a valid fingerprint of the system administrator, thus provides full device security. The administrator in this case could be the lecturer/tutor/laboratory technical although more than one administrator can be assigned to the same class/student attendance without interrupting other system functions as shown in the figures 9c and 9f. Figure 9a shows the Admin Enroll Process interface. This is an iterative process until the Admin's fingerprint match is found.

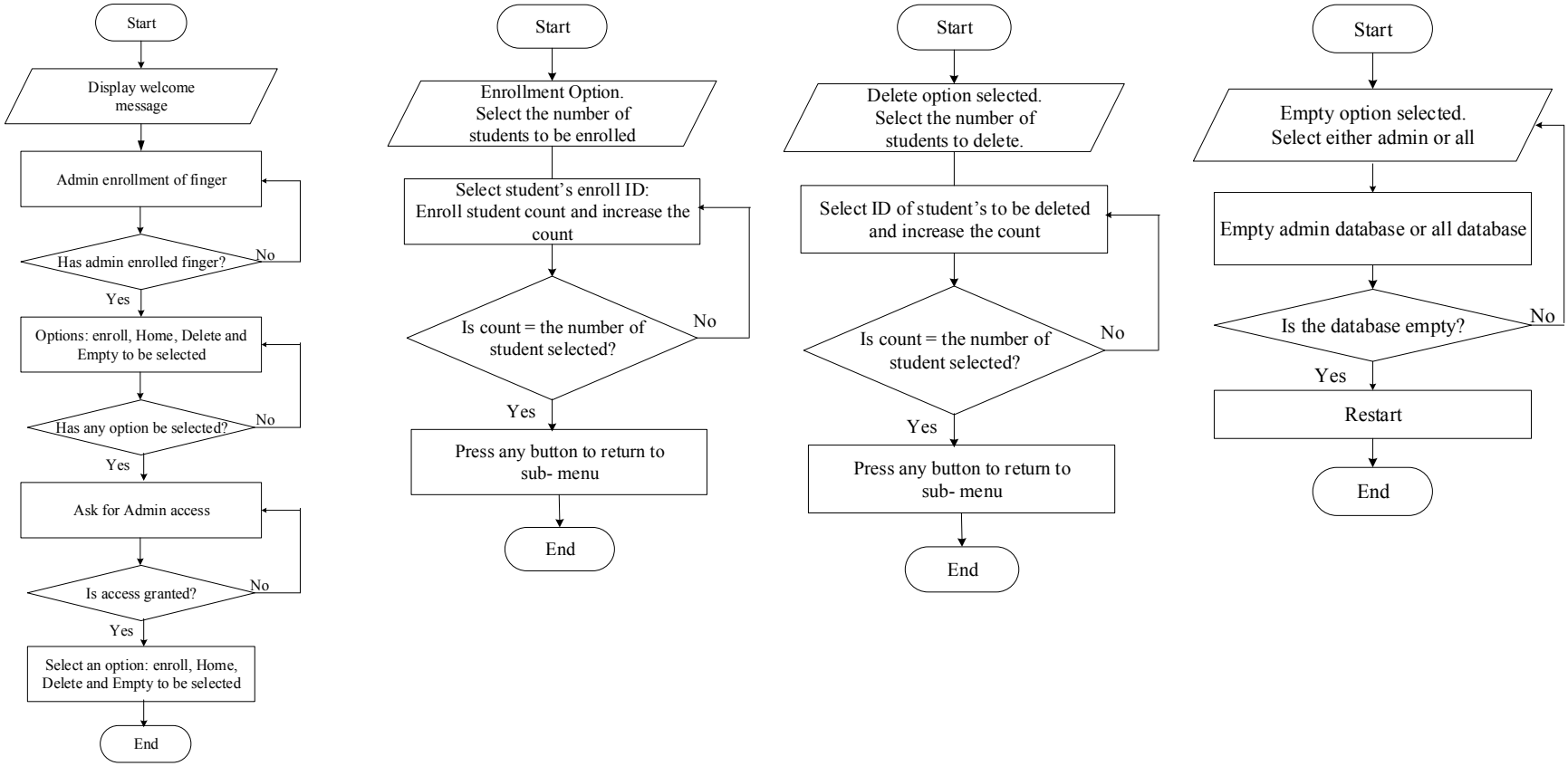


Figure 8 (a) Admin Sub-routine (b) Enrollment module sub-routine (c) Delete Sub-routine and (d) Empty Sub-routine

(a) Admin Enroll Process

(b) Access Denied interface

(c) Empty ADM Database

(d) Place Admin Finger to interface nlock interface

(e) Access Granted interface

(f) Admin DataBase Cleared; Restart interface

Figure 9

Enrollment stage

This stage involves the registration of all students that registered for the course for which attendance record will be generated. Each student is required to enroll his or her fingerprint to a particular enrolment ID corresponding to that already saved in the excel spreadsheet. Fifteen students were enrolled and the enrolment interfaces are shown in Figures 10 (a-k). Figure 10a displays the sub-menu from where the administrator can click on *Enroll<, Figures 10b and 10c show the interface to select the number of students to enroll while Figure 10d describes the interface to enter fingerprint ID to enroll. Figures 10(e-k) demonstrates the enrolment process until the students' fingerprint match is found and stored.

(a) Sub-menu interface

(b) Press UP/DOWN to Select No of Student 2Enroll interface

(c) Select No of Student Enroll interface

(d) Enter Fingerprint ID to Enroll interface

(e) Waiting interface

(f) Image Converted interface

(g) Remove finger interface

(h) Place same finger interface

(i) Finger Not match interface

(j) Waiting for Valid Finger to Enroll interface

(k) Stored interface

Figure 10

Authentication stage

This is the stage where attendance is taken by students. No student can take attendance for another, since all students are uniquely identified. This curbs the problem of buddy punching and impersonation. The interface is shown in Figures 11(a-c). Figure 11a displays the sub-menu from where the administrator can click on *Home<, Figure 11b shows the home menu interface from where the administrator can click on *Attendance and Figure 11c describes the attendance process.

Figure 4.3a Sub-menu interface Figure 4.3b Home menu interface Figure 4.3c Attendance subroutine interface

Figure 11

Report Generation Stage

The system administrator generates the attendance report on a regular basis. This report can be accessed under the home menu, where daily attendance of all students can be generated. The report is generated by exporting the attendance record to excel spreadsheet through the coolTerm software; the percentage attendance for the period can be gotten as well. This is used as examination eligibility criteria in most colleges and institutions. A report generated for fifteen registered students as well as the coolTerm interface are as shown in Figures 12 and 13 consecutively.

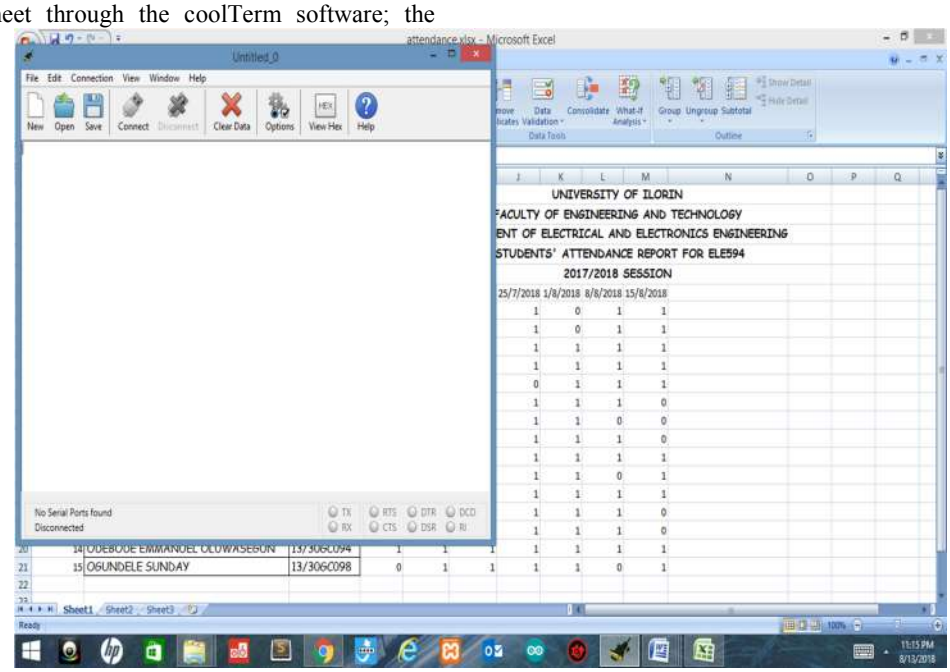
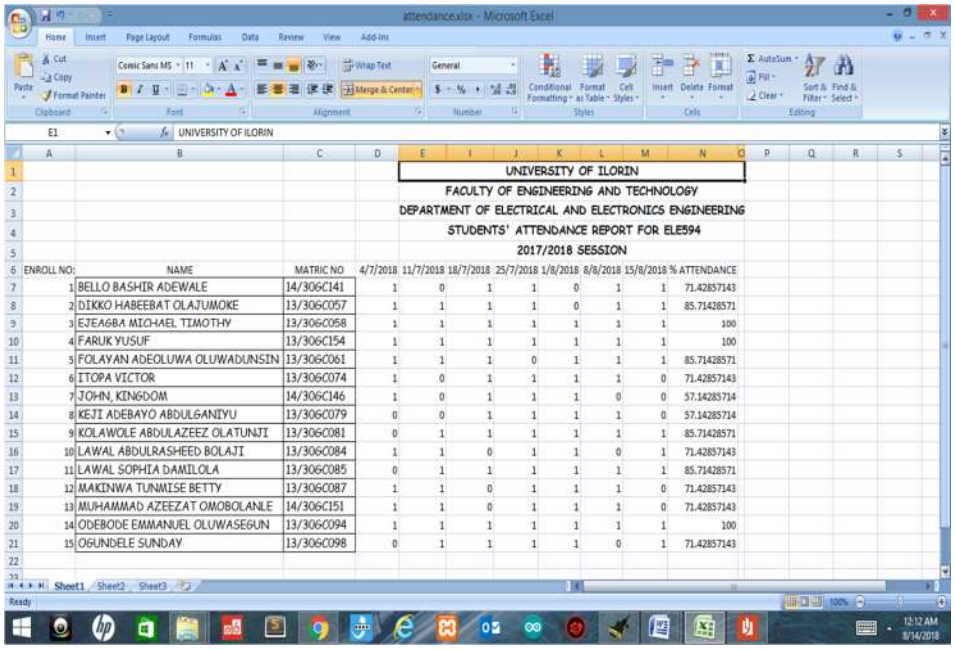


Figure 12: CoolTerm software interface.



UNIVERSITY OF ILORIN
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
STUDENTS' ATTENDANCE REPORT FOR ELE594
2017/2018 SESSION

ENROLL NO:	NAME	MATRIC NO	4/7/2018	11/7/2018	18/7/2018	25/7/2018	1/8/2018	8/8/2018	15/8/2018	% ATTENDANCE
1	BELLO BASHIR ADEWALE	14/306C141	1	0	1	1	0	1	1	71.42857143
2	DIKKO HABEEBAT OLAJUMOKE	13/306C057	1	1	1	1	0	1	1	85.71428571
3	EJEAGBA MICHAEL TIMOTHY	13/306C058	1	1	1	1	1	1	1	100
4	FARUK YUSUF	13/306C154	1	1	1	1	1	1	1	100
5	FOLAYAN ADEOLUWA OLUWADUNSIN	13/306C061	1	1	1	0	1	1	1	85.71428571
6	ITOPA VICTOR	13/306C074	1	0	1	1	1	1	0	71.42857143
7	JOHN, KINGDOM	14/306C146	1	0	1	1	1	0	0	57.14285714
8	KEJI ADEBAYO ABDULGANIYU	13/306C079	0	0	1	1	1	1	0	57.14285714
9	KOLAWOLE ABDULAZEEZ OLATUNJI	13/306C081	0	1	1	1	1	1	1	85.71428571
10	LAWAL ABDULRASHEED BOLAJI	13/306C084	1	1	0	1	1	0	1	71.42857143
11	LAWAL SOPHIA DAMILOLA	13/306C085	0	1	1	1	1	1	1	85.71428571
12	MAKINWA TUNMISE BETTY	13/306C087	1	1	0	1	1	1	0	71.42857143
13	MUHAMMAD AZEEZAT OMOBOLANLE	14/306C151	1	1	0	1	1	1	0	71.42857143
14	ODEBODE EMMANUEL OLUWASEGUN	13/306C094	1	1	1	1	1	1	1	100
15	OGUNDELE SUNDAY	13/306C098	0	1	1	1	1	0	1	71.42857143

Figure 13: Report Generated on Excel spreadsheet

Conclusion

Biometric recognition is a better substitute for the manual paper-based method of attendance management. This study revealed that Automated Fingerprint Based Students Attendance Management System is more secure, credible and error free to impersonation and buddy punching associated with the existing manual-paper based system. The natural uniqueness in the use of fingerprint makes it a reliable access control technique thereby eliminating the aforementioned practices. This study has established the effectiveness of students attendance capture using a biometric system.

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