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An Intelligent Classroom Attendance and Examination Logging System for Students of Nigerian Universities

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Abstract

Traditional means of taking attendance in our tertiary institutions are faced with challenges ranging from impersonation, to improper documentation, to inability of parents to keep track of their children's class activities on campus etc. The biometric-sensor-based method used for this design operates on two modes: class attendance and examination modes. ESP 32 microcontroller, SM630 fingerprint sensor and SMTP google email server function as the controller, biometric sensor and communication channel respectively. The fingerprint of each student was read by the system and stored in the database and thereafter the logged information was sent to the department and also to the parent of the student through email. Two students were used to test the system using two courses and 75% requirement was used to grant them access to log for the examination of these courses. The system successfully aggregated the attendance into 75%requirement for sitting for an examination.

Keywords*: *Biometric; Sensor, Data logger, Atmega 328p Microcontroller, Automation, Intelligent

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1.0 Introduction

Attendance, being an important daily time record of the number of students present in a particular lecture over a period of time is a vital tool used in tertiary institutions in West Africa. Tracking students' class attendance and ensuring they meet the requirement to seat for an examination are essential administrative

tasks. However, the traditional manual methods of recording attendance and examination data are time-consuming (Garg et al., 2018), prone to errors (Selvi et al., 2014), and lack efficiency (Babu et al., 2020).

The current traditional methods of attendance tracking and examination logging pose several challenges; the reliance on paper-based systems or manual data entry is susceptible to errors and can lead to inaccuracies in attendance and examination records. Additionally, the traditional process is time-consuming, placing a burden on teachers and administrative staff (Onyishi & Igbinobo, 2021). These limitations necessitate the implementation of an automated system that improves efficiency, accuracy, and data management. In the traditional methods in West Africa, lecturers give out a sheet of paper containing the list of students' names for them to sign or/and in some cases, the students will be the ones to write their names and matriculation numbers to indicate their presence for a particular class. Falsification in student attendance does occur uncontrollably with this method (Alhothaily et al., 2015).

As part of Nigerian Universities Commission (NUC) regulations, a student must meet 75% requirement of attendance for a particular course before he or she can write the examination of that course (NOUN, 2023). Even though such regulations exist, there has been no significant means of implementing it. It has been difficult for universities to effortlessly implement the 75% class attendance rule as a requirement to write the examination of a particular course. With these highlighted problems, it is necessary to develop an intelligent Classroom Attendance and Examination Logging System that will proffer solutions to these highlighted existing problems which this research seeks to address.

Onyishi & Igbinobo, (2021) developed a biometric students' time and attendance logging system where the student attendance is captured through his/her fingerprint using the RS305 fingerprint module, ATmega328p microcontroller. Visual studio and MYQL2008 were used to design graphical user interface. The design appeared better off than manual attendance writing after analytic comparison. Ezema et al., (2015) designed a fingerprint-based attendance management system using SM630 fingerprint module and Atmel 8052 microcontroller. The database and user interface were designed using MS-Excel and Visual Basic.net (VB.net). The system performed better than other sensor based method like RFID when compared. Akinduyite et al., (2013) designed a fingerprint-based management system to tackle the issue of ghost workers among staff in a university environment. The system was categorized into two: enrolment and authentication. In enrolment, the fingerprint of a staff was captured and some unique features were extracted using the cross-number method and stored in the database. While in the authentication method, the fingerprint was captured and compared with the one already stored in the database. The system was designed using c#, VB, NET framework and MYSQL 2005 for user interface and backend. The system

gave a performance accuracy of 97.4% with a response time of 4.29. However, the system is not flexible as it require pre-enrolment before it can successfully carry out authentication of staff. (Olagunju et al., 2018) designed a fingerprint attendance monitoring system for staff of companies using VB framework as the frontend and Microsoft Access database as the backend. The system is based on a personal computer and could be bulky. In another work by Ittal et al., (2015), a fingerprint biometric based system was designed for an Access control system (ACS) and classroom attendance management system (CAMS). These systems store the fingerprint of a user alongside the date and time of entry. Results show that ACS and CAMS had recognition accuracies of 87% and 92% respectively.

2.0 Materials and Methods

The methodology used for this research was the biometric-sensor-based method. The system senses the fingerprint authentication of the student which serves as his/her attendance for that course. This is then stored in a temporary storage (Google Server) and at the same time it is been sent to the parent of the student and the head of the department via email through the help of ESP32 Wi-Fi.

The system thereafter aggregates the cumulative attendance of the student to ascertain if he meets the 75% attendance requirement to write the examination for that particular course. Figure 2.1 shows the block diagram of the system.

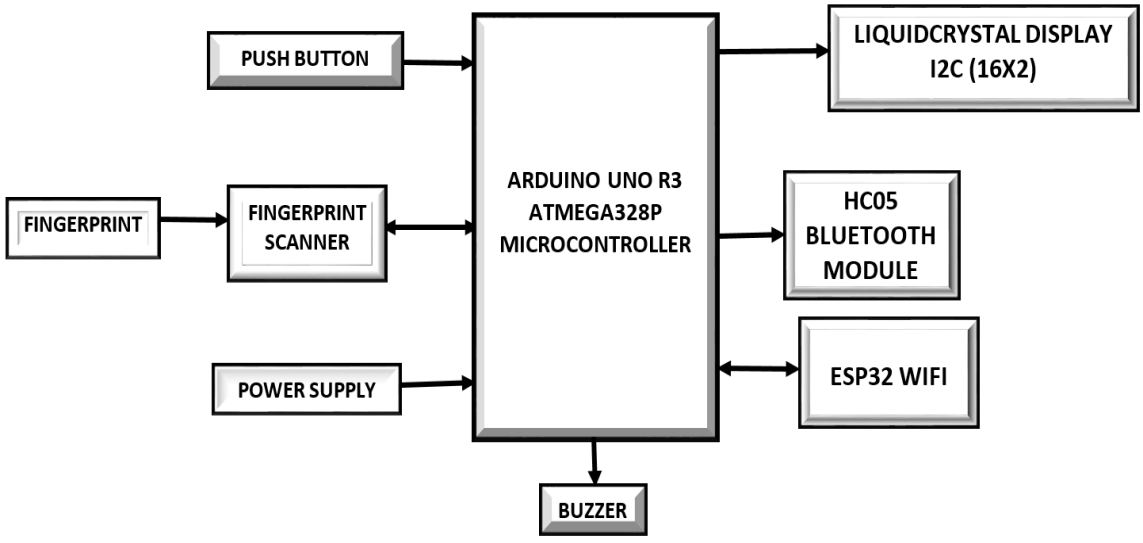


Figure 2.1. Block Diagram of the component selection

2.1 THE SENSING UNIT

2.1.1 SM-630 Fingerprint Sensor

The SM-630 fingerprint sensor (shown in Figure 2.2) was used for this design because of its exceptional accuracy in fingerprint recognition. Its capacitive sensing technology allows for reliable and secure biometric authentication.



Figure 2.2. SM-630 Finger print sensor (Github, 2018)

The SM630 perform functions such as fingerprint enrollment, image processing, minutiae extraction, template storage, fingerprint verification and fingerprint searching.

The SM630 module algorithm is specially designed according to the image generation theory of the optic fingerprint collection device. It has the ability to correct as a well as tolerate deformed and/or poor-quality fingerprints. Table 2.1 shows the design specification of SM630 fingerprint sensor.

Table 2.1. Design Specifications of SM 630 Fingerprint sensor

Parameter	Unit
Fingerprint enrollment time	<250ms
Fingerprint search time	<1s (100 fingerprints, average value in test)
Resolutions	500DPI
Capacity	768 templates
FAR	<0.0001%
FRR	<0.01%
Supply power	4.3V ~ 6V
Working current	<80mA
Peak current	<90mA

Communication interface	TTL
Communication Baud rate	57600bps
Working temperature	-10°C ~ +40°C
Working humidity	40%RH ~ 85%RH (no dew)
Module dimension	60.0x21x25mm (L*W*H)

The fingerprint of the students is acquired or rather pre-enrolled by the fingerprint sensor by scanning the fingerprint and stores it in the fingerprint register and thereafter processed by the microcontroller and saved. This process is done for all students to enroll their fingerprints.

The student is thereafter required to place his/her finger which was initially registered and stored on the fingerprint sensor for matching. This matching process is facilitated by the microcontroller.

2.2 Controlling UNIT

2.2.1 ATmega 238p Microcontroller

ATmega328p is the microcontroller used for this work. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), 16 MHz resonator, USB connection. It has a processor speed of 20MHz, an in-circuit serial programming (ICSP) header, and a reset button. The interface between the SM630 fingerprint sensor and the microcontroller is shown in Figure 2.3.

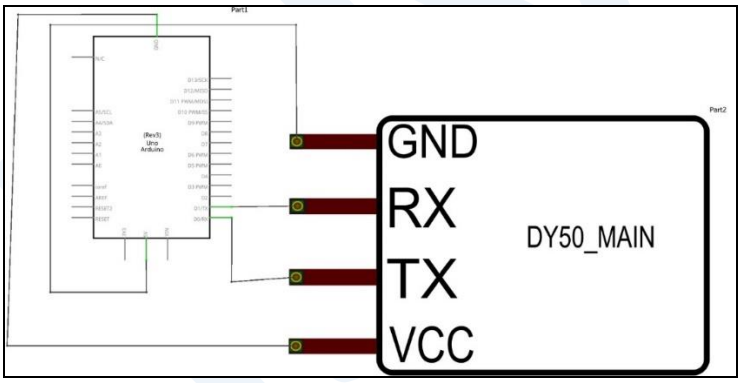


Figure 2.3. Interface between SM 630 and ATmega 328p

2.3 Communication Units

2.3.1 WIFI Communication Module

The Wi-Fi system was used as the communication channel for this work. The ESP32 microcontroller was integrated to provide Wi-Fi connectivity for this work to enable remote data access, allowing for real-time monitoring of attendance and examination logs.

2.4 Display Unit

The display unit shows graphically the input, and different mode switching commands. It gives a machine human interface and interaction. The 16x2 Liquide crystal display (LCD) shown in Figure 2.4 was used for the display unit in this work.



Figure 2.4: 16X 2 LCD display

2.5 System Mode of Operation

The system has two modes: EXAMINATION MODE and ATTENDANCE MODE. These two modes can be activated by a switch. The system is switched to the attendance mode when attendance for a particular course is to be taken. The attendance mode will appear on the LCD screen, then a student whose fingerprint is pre-registered on the system will place his finger on the SM630 fingerprint sensor. This process will be done for every student who attends the lecture. And this will be accumulated over a period of time and stored in the cloud. During examination, the system is switched to examination mode. The student is also required by the system to place his finger on the SM630 fingerprint sensor again, the LCD will display approve for that student only if the student accumulated class attendance meets up with the 75% requirement. For every fingerprint scan, an email will be sent to the parents and the department with the help of ESP32 Microcontroller Wi-Fi module as shown in Figure 3.3.

3.0 Results and Discussion

The system was successfully implemented on two modes; attendance mode and examination mode shown in Figure 3.2. The program code initiating these two modes was written in c++ programming language using Arduino ide as shown in Figure 3.1. An external button to switch these modes was also developed as shown in Figure 3.1.



Figure 3.1. program code on Arduino IDE software



Figure 3.2a. Attendance mode



Figure 3.2b: Examination mode

Every attendance logging for each student was sent to the department and the parent of that particular student via an email registered in the program code as shown in Figure 3.3. Figure 3.4 shows the fabricated implementation of the work.

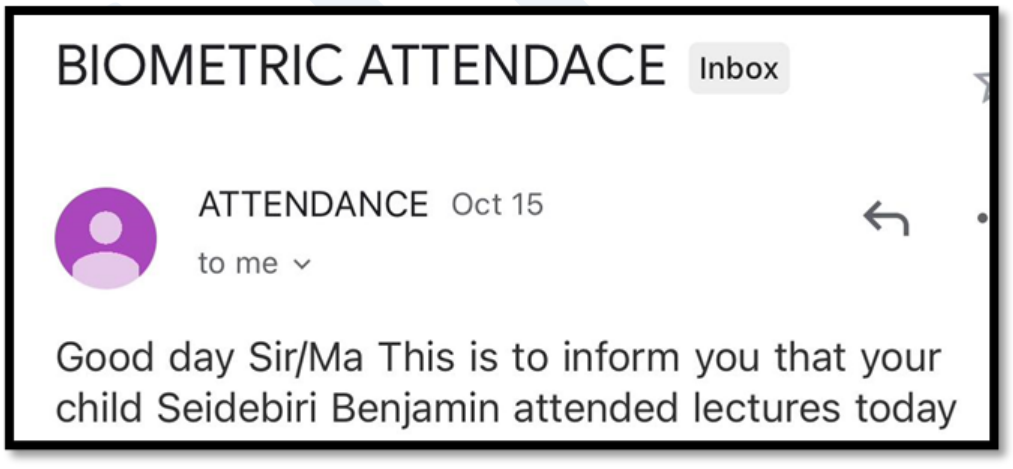


Figure 3. Attendance notification email to parent

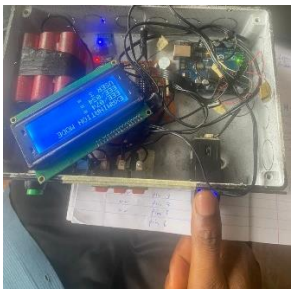


Figure 3.4a: Fingerprint sensor testing



Figure 3.4b: Internal view of the design



Figure 3.4c: Side view of the design

4.0 Conclusion

Biometric-sensor base method for classroom attendance is an ideal solution for educational institutions that enables student authentication in real-time and maintain compliance without expensive hardware, storage solutions or any privacy risk. Results obtained from this work have shown that this system can be implemented in academic institutes for better results regarding the management of attendance. This system will save time, reduce the amount of work the administration has to do and will replace the stationery material with electronic apparatus and help NUC to implement the 75% requirement needed to seat for an examination in Nigerian Universities.

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