

Development of an enhanced student identification system

Gelişmiş öğrenci tanıma sisteminin geliştirilmesi

Ajibola OYEDEJI^{1*}, Ignatius OKAKWU², Olatilewa ABOLADE³

^{1,3}Department of Computer Engineering, Faculty Of Engineering, Olabisi Onabanjo University, Ogun State, Nigeria.

²Department of Electrical/Electronic Engineering, Faculty Of Engineering, Olabisi Onabanjo University, Ogun State, Nigeria.

¹oyedeji.ajibola@ouagoiwoye.edu.ng, ²okakwu.ignatius@ouagoiwoye.edu.ng, ³abolade.raphael@ouagoiwoye.edu.ng

Received: 01.02.2023

Accepted: 02.04.2023

Revision: 15.03.2023

doi: 10.5505/fujece.2023.70299

Research Article

Abstract

Identification, verification, and student authentication to prevent impersonation during examinations are essential. This is a predominant issue in institutions in developing countries such as Nigeria. This paper designed and developed an enhanced student identification and authentication system capable of verifying and admitting only duly registered students into an examination hall in Nigerian higher educational institutions. The system uses radio frequency identification and biometrics for identification and comprises an Arduino microcontroller, a fingerprint reader, radio frequency identification (RFID) reader with a user-friendly desktop application. The registered students' data and fingerprints are captured and stored in the database. The verification and authentication of the student's identity are observed when the stored information matches the identity of the student presenting the RFID card or fingerprint. The enhanced identification system was rated as good with an average of 4.35 out of 5.0 based on the functionality, ease of use, efficiency and user interface. The developed system is more reliable and efficient than the existing systems in Nigerian institutions as it provides solutions for the identification and verification of students accurately.

Keywords: Radio frequency, Biometrics, Student identification, Fingerprint, Arduino microcontroller

Özet

Sınavlar sırasında kimliğe bürünmeyi önlemek için kimlik doğrulama ve öğrenci kimlik doğrulaması çok önemlidir. Bu, Nijerya gibi gelişmekte olan ülkelerdeki kurumlarda baskın bir konudur. Bu makale, Nijerya yüksek öğretim kurumlarında yalnızca usulüne uygun olarak kayıtlı öğrencileri bir sınav salonuna kabul edebilen ve doğrulayabilen gelişmiş bir öğrenci tanımlama ve kimlik doğrulama sistemi tasarladı ve geliştirdi. Sistem, tanımlama için radyo frekansı tanımlama ve biyometri kullanır ve bir Arduino mikrodenetleyici, bir parmak izi okuyucu, radyo frekansı tanımlama (RFID) okuyucusu ve kullanıcı dostu bir masaüstü uygulamasından oluşur. Kayıtlı öğrencilerin verileri ve parmak izleri alınır ve veri tabanında saklanır. Öğrencilerin kimliğinin doğrulanması ve doğrulanması, saklanan bilgiler RFID kartını veya parmak izini sunan öğrencinin kimliğiyle eşleştğinde gözlemlenir. Geliştirilmiş tanımlama sistemi, işlevsellik, kullanım kolaylığı, verimlilik ve kullanıcı arayüzü temelinde 5,0 üzerinden ortalama 4,35 puan alarak iyi olarak derecelendirildi. Geliştirilen sistem, öğrencilerin kimliklerinin doğru bir şekilde tanımlanması ve doğrulanması için çözümler sunduğu için Nijerya kurumlarındaki mevcut sistemlerden daha güvenilir ve verimlidir.

Anahtar kelimeler: Radyo frekansı, Biyometri, Öğrenci tanımlama, Parmak izi, Arduino mikrodenetleyici

1. Introduction

Nowadays, there exist so many universities around the country with a large student population. Handling a large number of students, especially during examinations is a problem. The issue of impersonation, identity theft and other fraudulent activities among students in the country has been of great concern among university administrators. University administrators have introduced the use of ordinary identity cards which is prone to forgery and duplication by students to gain unauthorized access to the examination venue. The process of identifying and verifying the identity of registered students for individual course examinations has become a priority for university management across the country [1], [2].

*Corresponding author

The traditional method of attendance-taking manually is a time-consuming task and is always prone to human errors or cheating of the system [3]. This manual method may also lead to misconduct and also there is a waste of valuable time.

Biometric systems are used primarily for the identification and verification of individuals. Identification is matching a query biometric sample with the stored biometric data. Verification is the process of authenticating if a query biometric sample belongs to the claimed identity or not [4]. The frequently and commonly utilized biometric systems are fingerprint and face images [4, 5]. An electronic identity card contains an embedded computer chip that stores and transacts data. RFID technology used collation of information using radio frequency data communication between a mobile object and an RFID reader to identify them and are often referred to as tag and reader respectively [6-8].

Several studies have been carried out on student identification and management systems using RFID and biometrics systems individually. A study carried out an extensive literature review of diverse technologies to address issues related to attendance system technologies, including the advantages, schemes and methods and obstacles. Out of the 204 identified papers, 90 were reviewed [9]. The selected articles were comprehensively reviewed, criticised and assessed and future research opportunities were highlighted [9].

A student attendance management system utilizing RFID technology was designed by [10]. The developed system in which all students were given identity cards with electronic tags; was able to capture and record statistics of students attending lectures. Furthermore, similar to the work done in [10] is the student attendance monitoring using NFC by [8], which was implemented at the Budapest University of Technology and Economics (BME). A biometric attendance system to record and monitor the attendance of students in class using fingerprint technology was presented [11]. The system's application is implemented using Microsoft Visual Basic Studio and also integrated using the fingerprint reader. The result is a reduction in fraudulent activities committed by the students. To enhance the reliability and efficiency of the systems designed, a web-enabled secured system for attendance monitoring was designed and implemented [12]. The system was enabled for real-time location tracking with RFID and biometric technologies.

Internet of things (IoT) based smart attendance system was designed using RFID and Raspberry Pi as the microcontroller [13]. The system stores the student's attendance record in the microcontroller and sends it to the server database over the internet anytime the student clocks into a registered class. A buzzer was incorporated to sound an alarm anytime an unauthorized card was detected and this system ensures the accurate and safe record keeping of students' attendance [13]. In addition, research focused on replacing the manual attendance recording system with an automated one and also maintaining the attendance records with higher accuracy [3]. The system was developed to incorporate an internet of things-based RFID attendance system [3]. In [14], a smart classroom attendance management system developed with RFID technology and face recognition technology was developed. IoT was also incorporated for the transmission and safe storage of the data gathered. The results show that the smart classroom attendance management system based on RFID technology was able to accurately identify students entering and leaving the classrooms promptly and at a low cost [14].

An automated attendance management system using facial biometrics automatically detects students when entering the classroom, and identifies and authenticates the student. Upon authentication, the attendance is marked for the student. Upon evaluation, the system saved time when compared to traditional methods of marking attendance [15]. In [16], an RFID attendance system would detect assigned User IDs to check for students' data using Micro Controllers like Arduino or Raspberry Pi. By entering the class with the ID card, the individual's attendance will be noted automatically. Face ID is used for verification to avoid impersonation [16].

This project aims to develop an enhanced student identification system using fingerprint technology and a radio frequency identification system for use in examination venues. As an alternative to the existing system in the country, an enhanced student identification system which utilizes a radio frequency identification (RFID) system in combination with a fingerprint biometric identification system is developed. This enhanced identification system also includes a user-friendly desktop application for all registered students' records which includes their biodata, pictures, RFID codes and their fingerprints. These records and information are matched against the input which is the presented RFID tag and fingerprint.

2. Materials and Method

2.1. Functional requirements

The working principle of the enhanced student identification system is the matching algorithm where specified templates of fingerprints and RFID codes are initially stored before the input fingerprint and RFID codes of the user are compared with the pre-stored templates of fingerprints. It afterwards verifies the authentication process and validity of the user. Once there is a match of the input data with any one of the stored data in the database, the output presents the user as eligible and grants the user access to the examination venue.

The enhanced student identification system supports the enrolment and storage of students' details including their biodata and fingerprint biometrics data. During an examination, the system is used to gain access to the examination centre by verifying the identity using both the identity card and fingerprint thereby guaranteeing dual authentication.

2.2. Hardware design

The system will use Arduino Uno as the microcontroller, and the RFID reader and fingerprint module will be connected to the microcontroller. The RFID reader and fingerprint module will obtain students' information and send it to the microcontroller. The different connections are shown below in a block diagram shown in Figure 1.

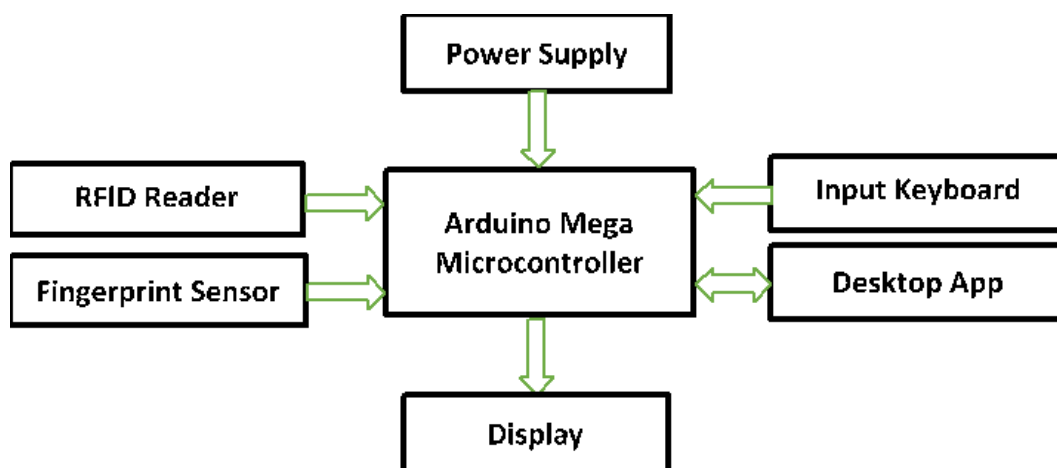


Figure 1. Block diagram of the system

The fingerprint sensor and RFID reader are all integrated with the Arduino via connection channels. The RFID module and Fingerprint sensor are connected to the digital I/O pin of the microcontroller to send digital data to the microcontroller. The power supply is connected to the 5v and ground pin of the microcontroller.

2.3. Software design

Arduino IDE is the environment where the microcontroller code will be written in C++ and then uploaded to the microcontroller. The IDE comes with different libraries and drivers, so the uploading will be done via a USB cable connected to the microcontroller.

The software applications consist of the database application and the application program. The database consists of students' records such as matriculation number, name, department, fingerprint and ID information imported into the Microsoft SQL Server database. The desktop application program was developed with Visual Basic using Microsoft Visual Studio framework (IDE).

3. Results and Discussion

3.1. System development result

The system combines hardware design, software design fingerprint authentication and Radio Frequency Identification. The system operating flowchart is presented in Figure 2. Fingerprint authentication comprises two processes namely; enrolment and student identification and verification. The enrolment process covers capturing the biometrics of a person and storing it in memory against the person's I.D. The fingerprint Module and RFID Module send data to the desktop application for the enrollment and verification process. The desktop application has a login module where the administrator can supply the login credentials to use the application.

The enrolment module aims to capture and record the user using his/her I.D. and fingerprint into memory after feature extraction. During identification, the biometric of the person is captured and compared with all records in the memory to determine a match (verification). If a match is found, then the student information is displayed. The memory includes the fingerprint template and other details of the person/users. The RFID part comprises storing students' information in the RFID tag and identification using the RFID reader. The reader will be connected to a database, so once the tag is swiped against the reader, they will read the information stored on the tag and compare it with the one in the database. If a match is found, it allows access and the student information will be displayed; if a match is not found, access is denied.

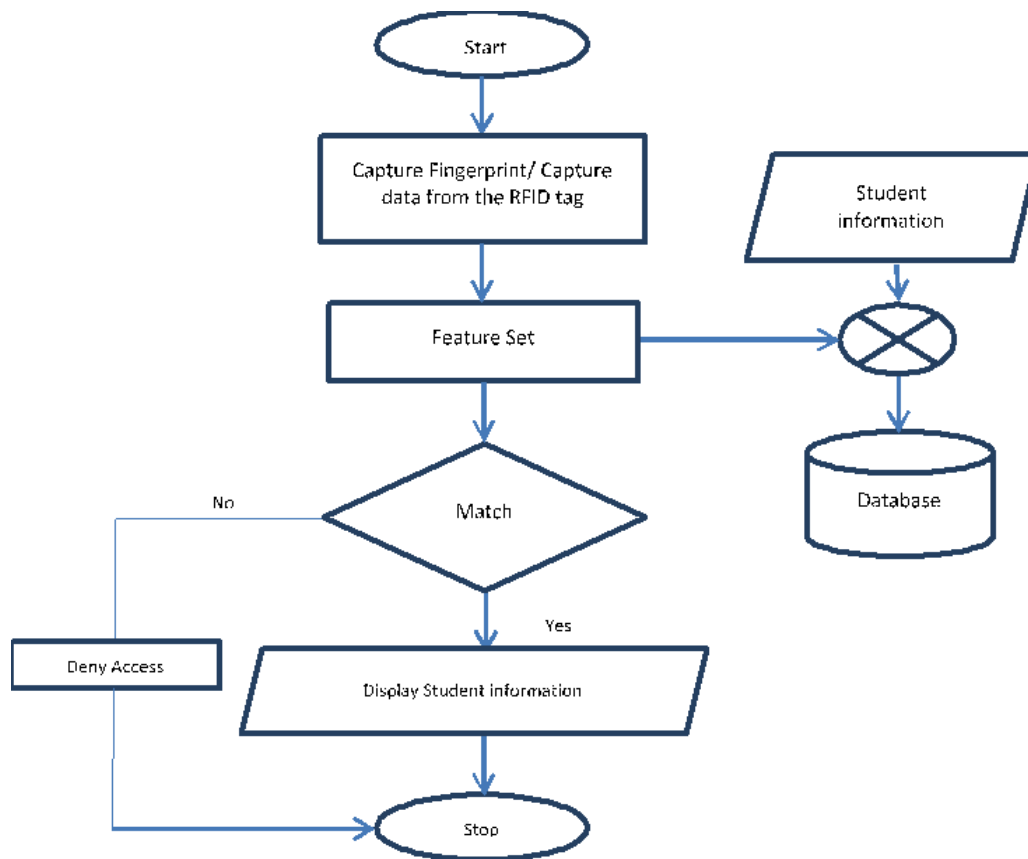


Figure 2: The System Flowchart

3.2. System testing

To test the developed system, an experiment was conducted with 10 registered students of the Department of Computer Engineering, Olabisi Onabanjo University, Nigeria. The inclusion criteria for selecting the participants include male and female participants that are students of the department who were provided with unique RFID cards. Each participant was

asked to complete an assessment form to evaluate the system's performance and the summary and result of the analysis of the respondents' responses are presented in table 1 and table 2 respectively.

The analysis of the respondents' responses shows that on functionality, 60% found the system excellent while only 30% found it excellent on the ease of use with 30% rating the system as average. On efficiency and user interface, 70% and 40% of the respondents found the system to be excellent respectively with 10% rating it as average on the user interface. With the overall mean of the system calculated to be 4.35 out of a possible 5.00, the respondents found the system to be good enough for implementation in the university.

Table 1. Summary of respondents' assessment

	Excellent	Good	Average	Bad	Poor
Functionality	6	4	0	0	0
Ease of Use	3	4	3	0	0
Efficiency	7	3	0	0	0
User Interface	4	4	1	1	0

Table 2: Summary of qualitative analysis of respondents' assessment

	5	4	3	2	1	Average	Description
Functionality	6	4	0	0	0	4.60	Excellent
Ease of Use	3	4	3	0	0	4.00	Good
Efficiency	7	3	0	0	0	4.70	Excellent
User Interface	4	4	1	1	0	4.10	Good
Average						4.35	Good

Figure 3 presents the desktop application login page for the administrator to sign in to the system where the administrator gains access to add and modify students' records through the desktop application. Figure 4 illustrates the enrolment process both on the hardware device and the desktop application. In addition, Figures 5 and 6 show the identification and verification of students' identities both on the hardware and desktop application.

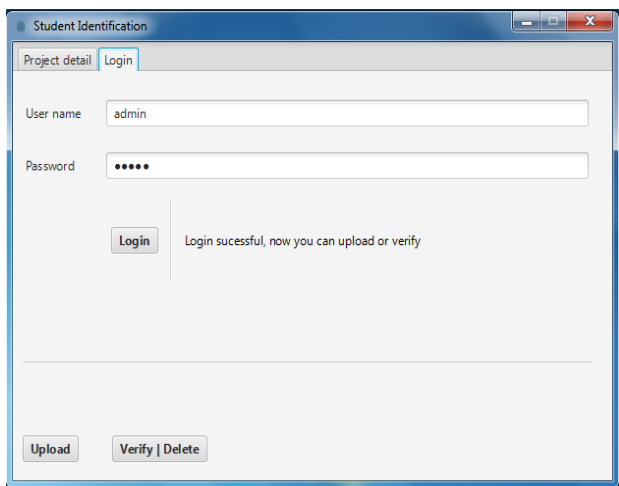


Figure 3. Login Interface

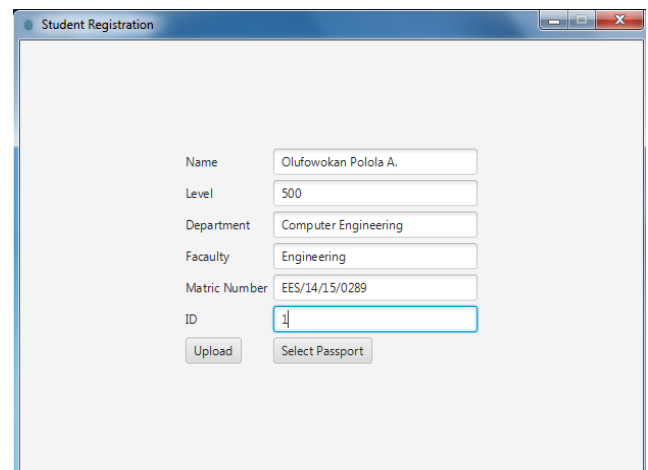


Figure 4. Desktop Application Enrolment Interface



Figure 5. Hardware Verification Interface

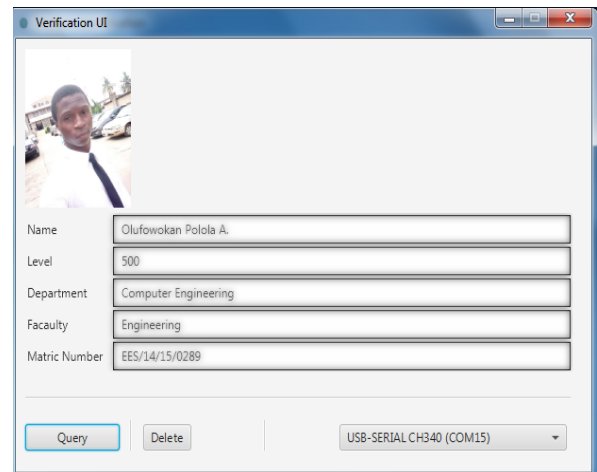


Figure 6. Desktop Application Verification Interface

4. Conclusion

An enhanced Student Identification system using Radio Frequency Identification and Fingerprint was developed in this project. The emergence of various issues in the existing system such as impersonation, arguments on the authenticity of examination cards/passes and confirmation of student eligibility when checking in and accessing the examination hall is a routine in institutions motivated this project. The system comprises an RFID card and reader, fingerprint Module, Arduino Uno Microcontroller and System Application to enrol and display student information. Students' data are first captured and stored in the system's database. Upon presentation of the students' means of identification either through the use of an RFID card or fingerprint, the system checks the database to see if there is a record of such a student. The occurrence of a match (that is the student is captured in the system) verifies and authenticates the student for examination. The systems were rated excellent in terms of functionality and efficiency with average ratings of 4.60 and 4.70 out of 5.0 respectively. Overall, from the results of the assessment gotten from 10 respondents, the identification system was said to be good with an average rating of 4.30 out of 5.0. Student information retrieval and updating will be easy and fast as the application uses a centralized database to store student information. It is recommended that the desktop application be connected to the school's database.

In future studies, the student identification system can be improved by implementing other biometric technology such as facial recognition. The student identification system will be further integrated with the electronic voting system within the institution. This can be the basis for further development, deployment, studies and research in the application of biometrics systems.

5. Author Contribution Statement

In this study, Author 1 contributed to forming the idea, design and manuscript preparation; Author 2 contributed to manuscript preparation; Author 3 contributed to the design and manuscript preparation.

6. Ethics Committee Approval and Statement of Conflict of Interest

“There is no need for an ethics committee approval in the prepared article”

“There is no conflict of interest with any person/institution in the prepared article”

7. References

- [1] Rjeib HD, Ali NS, Al Farawn A, Al-Sadawi B, Alsharqi H. "Attendance and information system using RFID and web-based application for the academic sector". *Int. J. Adv. Comput. Sci. Appl.*, 9(1), 266–274, 2018.

- [2] Chandramohan J, Nagarajan R, Kumar MA, Dineshkumar T, Kannan G, Prakash R. "Attendance monitoring system of students based on biometric and gps tracking system". *Int. J. Adv. Eng. Manag. Sci.*, 3(3), 241–246, 2017, doi: 10.24001/ijaems.3.3.16.
- [3] Shrivastava A, Suji Prasad SJ, Yeruva AR, Mani P, Nagpal P, Chaturvedi A. "IoT Based RFID attendance monitoring system of students using arduino ESP8266 & adafruit.io on defined area". *Cybern. Syst.*, 1–12, 2023.
- [4] Nawaz T, Pervaiz S, Korrani A. "Development of academic attendance monitoring system using fingerprint identification". *IJCSNS Int. J. Comput. Sci. Netw. Secur.*, 9(5), 164–168, 2009.
- [5] Abaza A, Ross A Hebert, C, Harrison MAF, Nixon MS. "A survey on ear biometrics". *ACM Comput. Surv.*, 45(2), 2013.
- [6] Patel R, Patel N, Gajjar M. "Online Students attendance monitoring system in classroom using radio frequency identification technology : a proposed system framework". *Int. J. Emerg. Technol. Adv. Eng.*, 2(2), 61–66, 2012.
- [7] Ranky PG. "An introduction to radio frequency identification (RFID) methods and solutions". *Assem. Autom.*, 26(1), 28–33, 2006.
- [8] Benyo B, Sódor B, Doktor T, Fördös G. "Student attendance monitoring at the university using NFC". *Wirel. Telecommun. Symp.*, 201.
- [9] Ali NS, Alhilali AH, Rjeib HD, Alsharqi H, Al-Sadawi B. "Automated attendance management systems: systematic literature review". *Int. J. Technol. Enhanc. Learn.*, 14(1), 37–65, 2022.
- [10] Arulogun MO, Olatunbosun OT, Fakolujo A, Olaniyi OA. "RFID-based students attendance management system". *Int. J. Sci. Eng. Res.*, 4(2), 2013.
- [11] Said MAM. *et al.*, "Biometric attendance". *ISTMET 2014 - 1st Int. Symp. Technol. Manag. Emerg. Technol. Proc.*, 258–263, 2014,.
- [12] Srinidhi MB, Roy R. "A web enabled secured system for attendance monitoring and real time location tracking using Biometric and Radio Frequency Identification (RFID) technology". *2015 Int. Conf. Comput. Commun. Informatics, ICCCI 2015*, 2015.
- [13] Kumar SVT, Arulananth TS, Prasad SVS. "Raspberry pi-based smart attendance management system with improved version of RFID over IoT". 449–458, 2023.
- [14] Zhao M, Zhao G, Qu M. "College smart classroom attendance management system based on internet of things". *Comput. Intell. Neurosci.*, 2022.
- [15] Chintalapati S, Raghunadh MV. "Automated attendance management system based on face recognition algorithms". *2013 IEEE Int. Conf. Comput. Intell. Comput. Res. IEEE ICCIC 2013*.
- [16] Rashmi A, Brindha S, Srinithin SB, Gnanasudharsan A. "Smart Attendance system using RFID and face ID". *Int. Conf. Commun. Comput. Internet Things, IC3IoT 2022 - Proc.*, 2022.