RFID-Driven Authentication Model for Examination and Assessment Settings

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ABSTRACT

With the rise of modern systems and technological innovations, many sectors have been transformed through various applications. Yet, educational environments, especially those handling large groups of learners have seen limited adoption of such technologies. This shortfall has affected the integrity and efficiency of academic processes, especially in student examination authentication and assessment. This study proposes the design, simulation, and evaluation of a student authentication system that integrates Radio Frequency Identification (RFID) with Internet of Things (IoT) technology. The system comprises microcontroller-based sensors, RFID tags, and reader devices, configured to provide a secure authentication process for verifying authorized students during examinations and other assessments. The proposed architecture addresses the shortcomings of traditional examination setups, where weak security measures have led to unauthorized student participation and compromised verification processes. Beyond authentication, the system also enables smart tracking and centralized management of student information through database integration. By facilitating these functions, the approach supports the transition of examinations and related assessments into fully digital environments. Furthermore, the proposed model offers a practical framework for educational institutions to modernize their assessment methods, while establishing a scalable foundation for smart campus solutions adaptable to various academic contexts.

KEYWORDS: RFID-reader, microcontroller, RFID-tag, servo-motor, authentication, Integration, Examination setting

1. INTRODUCTION

User authentication serves as the primary safeguard against impersonation and remains a core element of any security system (Velásquez and Rodríguez, 2018). Over the years, extensive research on authentication techniques has sought to enhance secure access, yet passwords have continued to dominate despite their decades-long utilization. Various academic efforts have explored alternatives to password-based approaches, including the use of smart cards and tokens (Riseul et al., 2023). To improve efficiency and minimize the administrative stress and costs associated with traditional authentication and attendance systems, biometric technologies such as facial recognition, fingerprint captures, Bluetooth, Near-Field Communication (NFC), and Radio Frequency Identification (RFID), Internet-of-Things(IoT) have been increasingly adopted (Hoo & Ibrahim, 2019) Among the various solutions available, integrating RFID technology with a microcontroller stands out as an effective approach to lowering system costs and minimizing human errors in automated identification and registration systems. RFID has broad applications across numerous fields and is classified under the Automatic Identification and Data Capture (AIDC) family of technologies, which are recognized for their speed, reliability, and accuracy in identifying objects(Badmus et al., 2021). The traditional student examination process in educational institutions often encounters challenges related to impersonation, unauthorized participation, manual verification, and inefficient attendance tracking. With the growing emphasis on digitization, the integration of RFID-IoT offers promising opportunities to streamline and secure student examination assessment systems.

RFID technology is a foundational component in the realization of the IoTs with integration of the system architecture. It comprises significant modules that include tags, sensor/readers, and a backend computer infrastructure. RFID are typically configured based on two categories: passive and active tags. The passive tags rely on energy emitted by the reader's antenna to communicate, eliminating the need for an internal power source, where active tags are battery-powered and capable of transmitting data over distances of several hundred meters. RFID operates across four main frequency domains that include low frequency (LF) at 125–134 kHz, high frequency (HF) at 13.56 MHz, ultra-high frequency (UHF) ranging from 433 to 956 MHz, and microwave frequency (MF) at 2.45 GHz (Tan et al., 2018). Consequently, various works testified that IoT-RFID inspired remain a pertinent wireless communication system that vividly transform the traditional architecture of a host application to modern and smart platforms. This has been testified in the previous literatures. For example, (Choe et al., 2023) clearly demonstrates that implementing a student recognition and registration system using RFID technology and embedded systems can offer significant advantages in promoting globalization and environmental sustainability. The RFID-based platform is designed to authenticate student identity, along with verifying the venue, time, and date, by receiving data transmitted from the RFID tag embedded in the student's identity card. Thus, this study is proposed to explore how an integrated RFID-IoT framework, and develop a real-time platform that enable perfect authentication and information detection during examinations, and other academic participation despite educational institutions in Sub-Saharan Africa—including Nigeria—remain significantly behind in implementing smart systems for monitoring, tracking, and verifying student participation in examinations, practical sessions, and other academic activities. This lag is

primarily due to the continued reliance on manual or semi-automated processes, which undermines efficiency and accuracy in academic operations. As s result, prone to;

- Unauthorized students' participation
- Time-delay and imprecise identity verification,
- Poor attendance record and authentication
- Challenge in real-time monitoring and data repository

Therefore, there is a critical need for a robust, scalable, and secure system that can effectively distinguish unauthorized students from legitimate participants during examinations and assessments, while ensuring accurate tracking of all academic activities.

2. LITERATURE REVIEW

In the recent years, advancement in RFID and IoTs inspired technology have deploy to diversify various sectors including health-care, agriculture, security, business, energy harvesting, smart cities, agriculture, and transportation. And in the recently, educational institutions have also started integrating RFID sensor to monitor student attendance, often merge with Google Sheets-integrated IoT to develop real-time security tracking systems(Taileb, 2020; Velasco, 2023). For instance, previously, RFID -inspired, IoTs, and RFID-IoT based systems have been developed improve security architecture.

In James et al., (2022), an improved school security system was developed using an RFID-based architecture, focusing on all entry points at Federal Government Girls College, Yola. The design successfully strengthens the security framework by mitigating potential threats. In addition, an innovative RFID-based smart lock platform has been developed with to actualize attendance tracking and monitoring for academic security. The developed work demonstrates improved security approaches compared traditional strategies, such as mechanical locks and manual attendance. An E-KTP cards employed as RFID identifiers, combined merge with IoTs technology. As a results, enhances the security performance accuracy of 99.5% aand reduces 91% (Imran et al., 2024). Moreover, to achieve a data storing, and management attendance systems, Izang et al., (2022)developed a RFID-inspired that captures students and staff information via the RFID tags embedded in their identity cards, with the data securely stored in a centralized database accessible by the institution. The system, implemented as a mobile application referred to as *BrasApp*, developed using the Java programming language. Additionally, the application includes module for monitoring student attendance at seminars, service halls and activities that contribute to their overall citizenship grade.

Akanksha et. al., (2024), designed an RFID-based door lock system utilizing an Arduino-controlled servo motor and a tag reader for user identification. The circuit relies on pre-programmed data within the controller to either grant or deny access according to the initial setup. A prototype of the system was built and demonstrated, with the results confirming its effectiveness as a reliable RFID security solution that meets user requirements. In addition, a similarly designed RFID-based automatic door system is suggested, powered by a 9-volt battery replacing the conventional 12-volt adapter. The system successfully demonstrated effective door activation (Soni, Soni, & Waoo, 2021) Sharma & Aarthy (2017) proposed a cloud-based automated attendance system that integrates RFID and IoT. The protocol enables authorized users to access attendance records remotely at

any time, while also reducing costs associated with computer maintenance and initial hardware investment. RFID technology has also been applied to employee attendance systems developed using the VB.Net programming language (Maramis & Rompas, 2018). Furthermore, Kong et al. created a student attendance system that incorporates an RC522 RFID reader, utilizes Visual C++ for development, and employs MySQL for data storage(Kong et al., 2015). The system automatically logs attendance data into a real-time database without requiring manual intervention.

3. METHODOLOGY

The system comprised of the five essential components or modules, that include the microcontroller module, consists of which Arduino Uno, the RFID reader/tags, buzzer, and the servo motor entrance boom. The microcontroller is activated by the RFID modules, where the tag is read by the module that subsequently activate the servo motor which serve as the entrance. Moreover, the servo motor mechanisms control the motor to open the entrance, equally closes after an interval of 10 seconds as the sets in the program. The system operates based on the mentioned component presented in Figure 1. Primarily, the RFID tags will be scanned by the reader, then the command read will be send to the microcontroller. Then the authenticity of the command check by the microcontroller, in which established activation of the servo motor, if the tags registered and stored in the database, otherwise, no possible activation of the servo-motor. This means the servo motor remain inactive, no access granted. Once, the motor activated, an access granted will be displayed on 16x2 LCD screen as programmed initially.

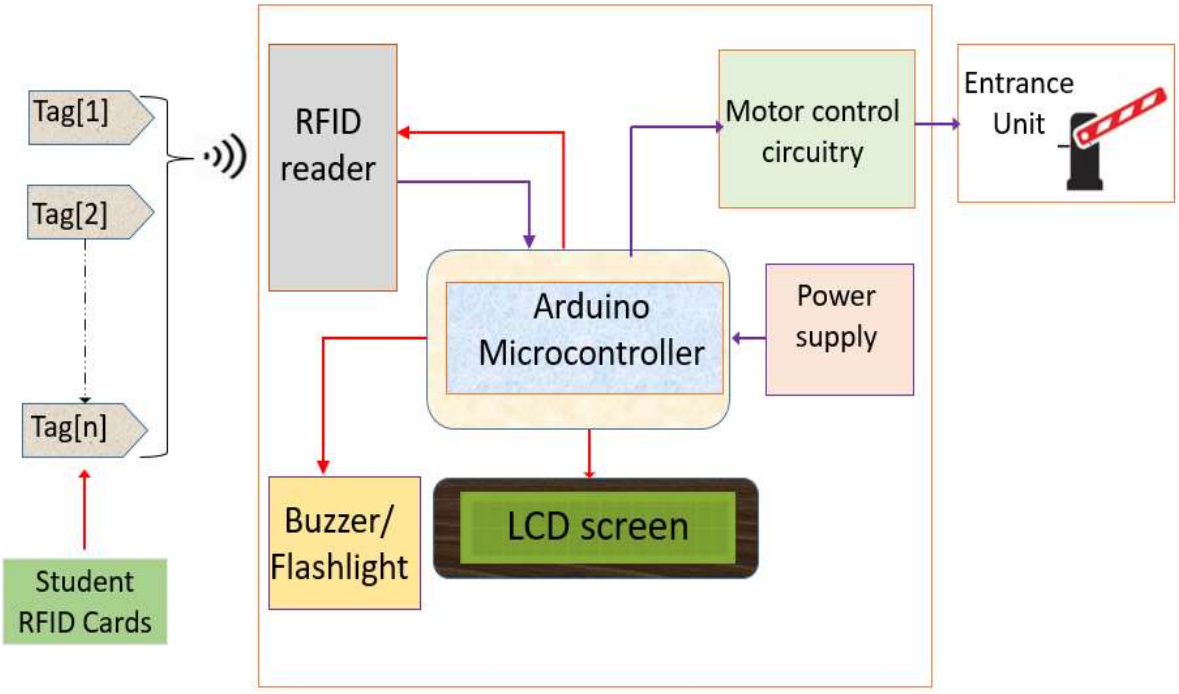

Figure 1. Proposed System Block Diagram

3.1. System Design

Achieving the development of a working framework system RFID reader and the tags assigned to students integrated with IoT modules such as Arduino microcontrollers, servo-motor, buzzer, LCD. The system presented The integrated system is to verify student identities in real time during exams, where students are provided with ID cards embedded with RFID tags, which they must scan at a reader located at the exam hall entrance. The reader sends the scanned information to a microcontroller, which then uploads it to a cloud database for immediate identity verification and, equally activate the motor system for the entrance activation. Figure 2 illustrates the flow chart of the proposed system architecture.

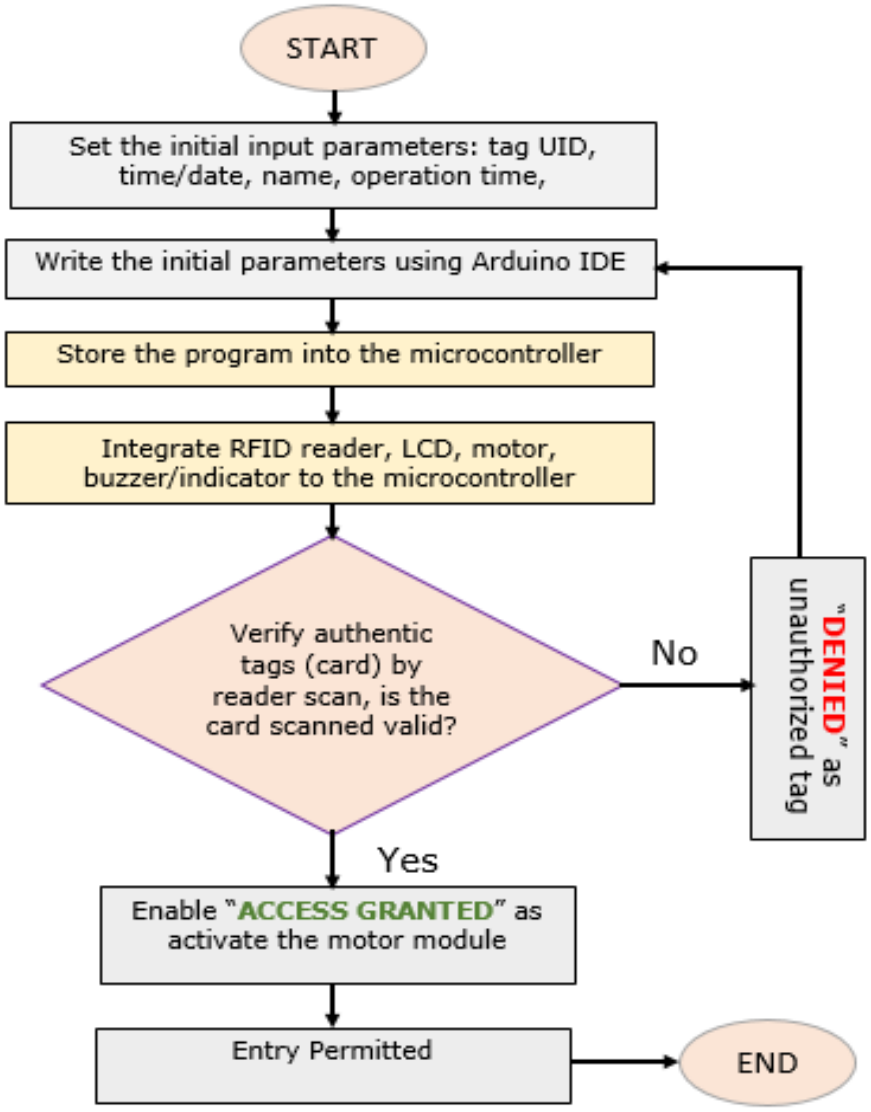

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Figure 2. System Design Flowchart

3.2. Materials :

RFID-IoT integrated system holds great promise as a smart technology solution, it relies on the seamless combination of essential components to function effectively. These components work together as a unified system to achieve the intended objectives. Key elements include RFID readers, tags, identification cards, Wi-Fi-enabled modules such as ESP32 and ESP8266, cloud platforms like ThingSpeak and Firebase, a reliable power source, and a supporting mobile or web application.

3.3. Data and Information

Typically, RFID and IoT technologies generally rely on data collection, monitoring, and tracking to bring the proposed framework to life. As such, key system-level metrics include verification time, accuracy of participation record, and the ability to detect unauthorized access. On the user's side, important data points involve enrolment details and authentication processes. To achieve the proposed model, the design flow of how the system be configured, coding, and assess as shown in Figure 2.

3.4. Working Principle

The entrance authentication system is initiated upon scanning a tag and verifying its authenticity. If the card is recognized and stored within the database, the controller transmits an activation signal to the motor control unit. Consequently, the LCD displays "Access Granted" while the green LED flashes. In contrast, if the card is unregistered, the system triggers the buzzer along with the red LED, while the LCD shows "Access Denied" at 0.5-second intervals, repeated twice. For valid authentication, the servo motor rotates to lift the micro-barrier arm, which remains open for 2 seconds before returning to its closed state. This sequence is repeated for each subsequent registered tag presented in the queue. However, if an unauthorized card is scanned repeatedly, the buzzer activates continuously for approximately 3 seconds, signaling a potential intrusion attempt, while the LCD consistently displays **"**Access Denied**."** The operational flow of the system is illustrated in Figure 3.

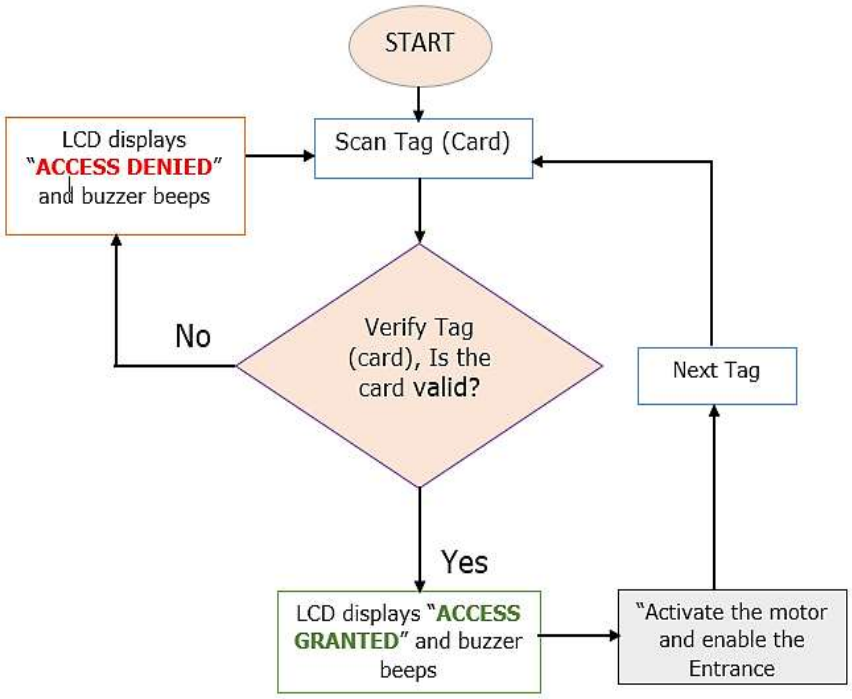

Figure 3. Working Principle of developed System

4. RESULTS AND DISCUSSION

This study presents an RFID-based system designed to provide an authentication platform for student examinations and other assessments. The aim is to simplify the verification process during exams and practical sessions. The system consists of three main components: the RFID modules, microcontroller, and the motor control circuitry. As shown in Figure 4, is the proposed developed system. The system operates, when a student presents hi/her RFID tag and scan the reader at the entrance of an examination hall or assessment room, the RFID reader determines the validity of the presented card or otherwise. If the tag (card) is valid, then tag's unique code is used to retrieve the student's information from the database, and hence displayed on an LCD screen, and equally trigger the buzzer as well. Consequently, the controller compares the stored tag's information, if the validity confirmed, it trigger the servo-motor then granted access to the entrance. Otherwise, no activation occurs, and entry is denied.

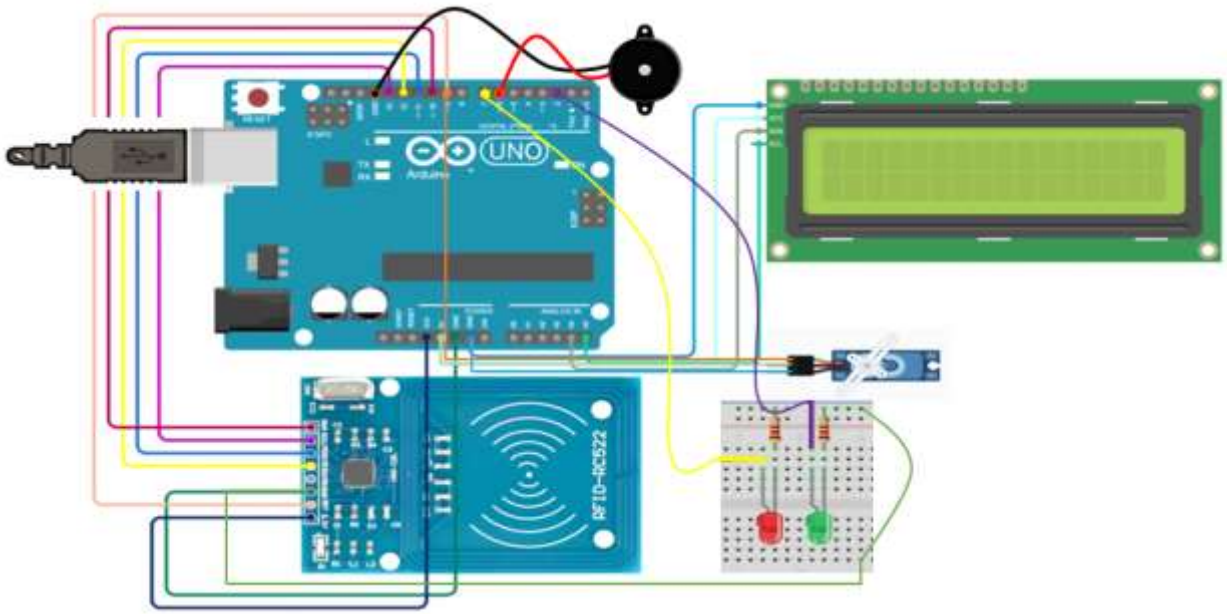

Figure 4. Proposed Design Circuitry

5. CONCLUSION

The RFID-based system is an emerging technology with wide-ranging applications, integrating key components such as tags, readers, and microcontroller units. It provides an effective and streamlined authentication process for students participating in examinations and assessments setting. In this work, a RFID-based system is developed to offers secured authentication during examination setting that enables access to the registered or the authorized students into the examination or other academic setting as decided. The design is capable of capturing essential students information that include, primary ID, Name, Date, Level, and the verification time. The system simulated and developed using 50 RFID tags, each configured with a unique identification numbers. Student information was captured and programmed through the Arduino IDE platform, then stored in the microcontroller. A servo motor was integrated to control access, allowing entry only upon successful card verification. Thus, proposed model is well-suited for examination settings, and can be equally applied across various fields where authentication and verification are critical, providing a scalable foundation for broader applications. Moreover, the system offers flexibility for future integration with additional entry methods such as face recognition and biometric authentication

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