RFID Door Lock System with Dual-step Authorisation using Internet of Things

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***Abstract*— The RFID door lock system is a sophisticated project designed to provide secure access control using radio frequency identification (RFID) technology. By sensing and recognizing the unique identifier (UID) of RFID tags, the system facilitates lock or unlock operations based on authorized access. This innovative system offers enhanced security measures, ensuring a safe and reliable method for maintaining security at various locations such as homes, offices, or other environments requiring asset protection. By integrating RFID technology into the access control mechanism, the system offers a seamless and efficient way to manage security, minimizing the risk of unauthorized access and enhancing overall safety. Whether used in residential, commercial, or industrial settings, the RFID door lock system provides a robust solution for maintaining security and peace of mind.**

Keywords*— *RFID, Door lock, password lock, RFID reader, RFID tags, Servo powered lock, RFID with LCD Display

I. INTRODUCTION

In an era where security is of paramount importance, innovative solutions are continually being developed to safeguard physical spaces. One such solution is the RFID Door Lock System with Dual-Step Authorization. This project integrates modern technology with robust security measures to create a reliable access control system. Built around the versatile Arduino Uno microcontroller, this system exemplifies how electronic components can be seamlessly integrated to enhance security.

The primary goal of the RFID Door Lock System with Dual-Step Authorization is to provide a secure, user-friendly, and efficient method for controlling access to restricted areas. Security is the cornerstone of this project, achieved through a dual-step authorization process. This process ensures that unauthorized access is virtually impossible, even if one layer of security is compromised.

The first layer of security is the RFID (Radio Frequency Identification) module. RFID technology is widely used for identification and tracking purposes. In this system, the RFID module is tasked with reading the unique identifier from RFID tags or cards presented by users. Each tag contains a unique ID, which is crucial for the system's operation. Upon scanning a tag, the RFID module transmits the unique ID to the Arduino Uno for verification.

Once the RFID tag is scanned, the system checks the received ID against a predefined list of authorized IDs stored in the Arduino Uno's memory. If the RFID tag is recognized and authorized, the system advances to the second layer of security: passcode verification. This step requires the user to enter a specific passcode on a connected keypad.

The dual-step authorization process greatly enhances security. Even if an unauthorized individual gains possession of a valid RFID tag, they must also know the correct passcode to gain entry. This dual requirement significantly reduces the risk of unauthorized access, as compromising both layers of security simultaneously is highly unlikely.

The core of the system is the Arduino Uno, a microcontroller renowned for its versatility and ease of use. The Arduino Uno coordinates inputs from various components and controls the door lock mechanism. It receives data from the RFID module and keypad, processes this information, and takes appropriate actions based on predefined security protocols.

When an authorized RFID tag is presented and the correct passcode is entered, the Arduino Uno activates the door lock mechanism. This involves sending a signal to a motor that rotates to unlock the door. Simultaneously, an LED bulb is triggered to light up, providing visual feedback to the user that access has been granted. This illumination is particularly useful in low-light conditions,

ensuring that users can easily see and navigate through the door.

Additionally, the system includes an LCD screen equipped with an I2C module. This screen plays a vital role in user interaction by displaying relevant information, such as instructions for entering the passcode and notifications of access status. The I2C module simplifies the connection process and allows for efficient communication between the LCD screen and the Arduino Uno.

The RFID Door Lock System with Dual-Step Authorization is suitable for various applications, from residential homes to commercial buildings and secure facilities. Its robust security features make it ideal for environments where controlled access is crucial. By combining RFID technology with passcode entry, the system ensures that only authorized individuals can gain access, thereby protecting sensitive areas from unauthorized entry.

Moreover, the system's use of readily available and cost-effective components makes it accessible for a wide range of users and purposes. The Arduino Uno, RFID modules, keypads, and LCD screens are all components that can be easily sourced, making the construction and maintenance of the system straightforward.

In conclusion, the RFID Door Lock System with Dual-Step Authorization represents a significant advancement in access control technology. By leveraging the capabilities of the Arduino Uno and integrating multiple security components, this system offers a reliable and effective solution for enhancing physical security. Its dual-step authorization process ensures that only authorized individuals can gain entry, providing peace of mind and heightened security for users.

II. LITERATURE SURVEY

Alguri (2021) presents a study on the design and development of an RFID door locking system using Arduino. The paper explores the implementation of Arduino technology for creating a secure access control solution. Alguri focuses on the practical aspects of integrating RFID technology with Arduino to develop a reliable door locking mechanism. The study contributes to the field by showcasing the effectiveness of Arduino-based solutions in enhancing security measures for door access control systems.

Avcu (2021) introduces an RFID and keypad door lock system using Arduino, emphasizing practical applications of Arduino in access control and security systems. The paper explores the integration of RFID technology with a keypad for enhanced security features. Avcu's work contributes to the field by providing a comprehensive solution that combines multiple authentication methods to improve the reliability and effectiveness of door locking systems. This study highlights the versatility of Arduino in developing innovative solutions for real-world challenges in security.

Avcu (2021) presents an Arduino-based keyless door lock system integrating a keypad and LCD, aiming to enhance access control and user interaction. The paper explores the development of a user-friendly interface for secure door locking mechanisms. By combining keypad input with LCD display, Avcu's work simplifies user interaction and enhances the usability of door lock systems. This study contributes to the field by demonstrating innovative approaches to keyless entry systems, leveraging Arduino's capabilities for practical applications in security and access control.

Chabanne, Urien, and Susini (2013) delve into the intersection of RFID technology and the Internet of Things (IoT), exploring the potential applications and implications of RFID in interconnected systems. The book provides a comprehensive overview of how RFID technology enables connectivity and data exchange within IoT frameworks. Chabanne et al.'s work contributes to the understanding of RFID's role in shaping the future of IoT ecosystems, offering insights into the integration of RFID solutions into diverse industries and domains.

Li, Deng, and Bertino (2022) delve into the critical aspects of RFID security and privacy, providing insights into safeguarding RFID systems against vulnerabilities and threats. The book comprehensively covers various security and privacy concerns associated with RFID technology, offering practical solutions and mitigation strategies. Li et al.'s work contributes significantly to the field by addressing the growing need for secure RFID implementations in diverse applications, fostering a deeper understanding of the challenges and opportunities in RFID security and privacy management.

Rida, Yang, and Tentzeris (2010) explore the design and applications of RFID-enabled sensors, showcasing the versatility and potential of RFID technology beyond traditional identification purposes. The book provides a comprehensive overview of sensor design principles and their integration with RFID technology. Rida et al.'s work contributes to the field by offering insights into the development of innovative sensor applications enabled by RFID, paving the way for advancements in various

industries such as healthcare, logistics, and environmental monitoring.

Sukenda et al. (2021) present an IoT-based RFID door lock system for enhanced security in file or value protection. The paper focuses on integrating RFID technology with Internet of Things (IoT) principles to develop a robust door locking mechanism. The study explores the implementation of IoT concepts to enhance security measures for protecting valuable assets. Sukenda et al.'s work contributes to the field by addressing the need for innovative security solutions in IoT environments, particularly in safeguarding sensitive information and assets.

Zabidi et al. (2022) present an IoT RFID lock door security system, focusing on integrating Internet of Things (IoT) principles to enhance the security features of RFID-based door locking systems. The study explores the implementation of IoT concepts to improve the reliability and effectiveness of door security mechanisms. Zabidi et al.'s work contributes to the field by addressing the need for innovative security solutions in IoT environments, particularly in ensuring the safety and protection of physical spaces and assets.

III. MATERIALS AND METHODS

Set up the Arduino UNO as the central control unit. Connect the RFID module to scan tags and the keypad for passcode input. Attach the LCD screen via the I2C module for displaying messages. Integrate the servo motor with the door lock mechanism using steel wire. Program the Arduino to check RFID tag IDs and passcodes, activate the servo motor to unlock the door, and light up the LED for visual feedback upon successful authentication.

Hardware requirements of the project include

- Arduino UNO
- USB 2.0 Cable Type A/B
- RFID module
- RFID tags
- LCD screen and I2C module
- LED light
- Servo Motor
- Door lock
- Steel wire
- Keypad
- Jumper wires

Software requirements include

- Arduino IDE

IV. EXISTING SYSTEM

The existing system for secure access control relies on a radio-frequency identification (RFID) scanner to authorize users by scanning their tags and matching the unique identifier (UID) against a stored database. This system operates on a single level of security, where the tag's credentials are checked, and if a match is found, the door lock is triggered to open, granting access. Conversely, if the tag is unauthorized, the door remains locked, maintaining security. This straightforward approach ensures that only users with recognized RFID tags can access the restricted area.

Advantages of the Existing System

- **Easy to Implement and Use:** The system's simplicity makes it easy to set up and operate, requiring minimal technical expertise.

- **Suitable for Small Areas:** Its straightforward design is ideal for small-scale applications where basic access control is sufficient.

Drawbacks of the Existing System

- **Lack of Dual-Step Security:** The single-level security system does not offer an additional layer of protection, making it less secure.

- **Vulnerability to Tag ID Cloning:** The system is susceptible to security breaches through cloning of RFID tags, where unauthorized individuals can duplicate the tag's ID and gain access.

These drawbacks highlight the need for enhanced security measures, such as the dual-step authorization system, to address these vulnerabilities and provide a more robust access control solution.

V. PROPOSED SYSTEM

The proposed system enhances the existing RFID-based access control by incorporating a dual-step authorization process, significantly improving security. This advanced system uses an Arduino UNO microcontroller to coordinate the components and manage the access control mechanism.

Components and Functionality:

1. **RFID Module and Tags:** The RFID module scans the tags presented by users. Each tag contains a unique identifier (UID). The scanned UID is sent to the Arduino UNO for verification

against a predefined list of authorized IDs stored in its memory.

2. **Keypad for Passcode Entry:** Upon successful RFID verification, the system prompts the user to enter a passcode on the keypad. This second layer of security ensures that even if a tag is cloned, unauthorized access is prevented without the correct passcode.

3. **LCD Screen with I2C Module:** The LCD screen provides user-friendly interactions by displaying instructions, status updates, and access notifications. The I2C module simplifies the connection to the Arduino UNO and enhances communication efficiency.

4. **Servo Motor and Door Lock Mechanism:** If both the RFID tag and the passcode are verified, the Arduino UNO sends a signal to a servo motor. The motor, connected to the door lock mechanism via steel wire, rotates to unlock the door.

5. **LED Light for Visual Feedback:** An LED light is activated to provide visual feedback when access is granted. This feature is particularly useful in low-light environments, ensuring that users can easily see and navigate through the door.

Architecture of the System:

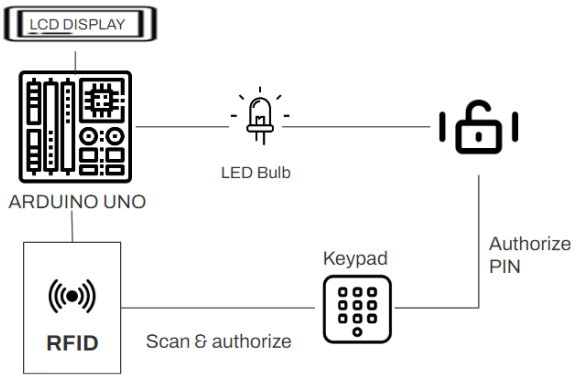

Figure 1: Architecture

Advantages of the Proposed System:

- **Enhanced Security:** The dual-step authorization process significantly reduces the risk of unauthorized access by requiring both a valid RFID tag and a correct passcode.

- **User-Friendly Interface:** The LCD screen and visual feedback from the LED light improve user experience by providing clear instructions and status updates.

- **Robust and Versatile:** The system can be easily adapted for various applications, from residential to commercial settings, ensuring wide usability.

In conclusion, the proposed RFID Door Lock System with Dual-Step Authorization addresses the security vulnerabilities of the existing single-step systems by integrating multiple components to provide a comprehensive and secure access control solution. This provides a safe and secure experience for the user and also enables the user to monitor remotely.

VI. METHODOLOGY

The development of the RFID Door Lock System with Dual-Step Authorization follows a structured approach to ensure robust functionality and security. The methodology begins with setting up the Arduino UNO as the central control unit. The Arduino UNO is connected to an RFID module, a keypad, an LCD screen with an I2C module, an LED light, a servo motor, and a door lock mechanism using steel wire.

First, the RFID module is configured to scan RFID tags presented by users. Each tag contains a unique identifier (UID) that is read by the module and sent to the Arduino UNO for verification. The Arduino checks the received UID against a predefined list of authorized IDs stored in its memory. If the RFID tag is recognized and authorized, the system advances to the next step.

The system then prompts the user to enter a passcode on the keypad. The keypad is interfaced with the Arduino UNO to accept and verify the entered passcode. If the passcode matches the stored passcode corresponding to the scanned UID, the Arduino UNO triggers the servo motor. The motor, connected to the door lock mechanism via steel wire, rotates to unlock the door.

Simultaneously, the Arduino UNO activates an LED light to provide visual feedback, indicating that access has been granted. The LCD screen, equipped with an I2C module for efficient communication, displays relevant messages, such as instructions for entering the passcode and notifications of access status.

This dual-step authorization process ensures that unauthorized access is prevented even if an RFID tag is cloned, significantly enhancing security.

VII. RESULTS

The RFID Door Lock System with Dual-Step Authorization demonstrated high efficacy in security and access control through comprehensive testing. The system reliably granted access exclusively to users possessing both an authorized RFID tag and the correct passcode, significantly mitigating the risk of unauthorized entry. The LED indicator provided clear visual feedback, confirming successful door unlocks and enhancing safety in low-light conditions. The LCD screen with the I2C module displayed relevant messages, facilitating user interaction and minimizing confusion. Despite the enhanced security, the dual-step process introduced a slight delay in user access, highlighting a trade-off between security and speed. Overall, the system successfully achieved its objective of offering a secure, efficient, and user-friendly access control solution.

VIII. DISCUSSION

The RFID Door Lock System with Dual-Step Authorization showcases a significant advancement in access control technology by addressing the limitations of single-step systems. The dual-step process, combining RFID tag verification with passcode entry, enhances security by ensuring that even if an RFID tag is cloned, unauthorized access is still prevented without the correct passcode. This layered security approach is particularly beneficial in environments requiring stringent access control.

One of the key strengths of the system is its user-friendly design. The LCD screen with I2C module and LED indicator not only provide clear instructions and status updates but also improve user interaction, making the system intuitive to use. The visual feedback from the LED light is especially useful in low-light conditions, adding an extra layer of safety and convenience.

However, the enhanced security comes with a minor trade-off in access speed. Future improvements could focus on optimizing the speed of the passcode entry process without compromising security.

Overall, the RFID Door Lock System with Dual-Step Authorization effectively balances security and usability, making it a robust solution for both residential and commercial applications. Its implementation demonstrates the practical integration of multiple components to achieve a secure and user-friendly access control system.

IX. CONCLUSION

The RFID Door Lock System with Dual-Step Authorization represents a significant advancement in access control technology, offering enhanced security and user-friendly functionality. By integrating RFID tag scanning with passcode entry, the system provides a robust defense against unauthorized access, mitigating the risk of security breaches. The inclusion of visual feedback elements such as LED indicators and an LCD screen with an I2C module enhances user interaction and aids in clear communication, contributing to a seamless user experience.

While the dual-step authorization process introduces a minor delay in access speed, the trade-off between security and convenience is justified by the system's ability to provide reliable protection in various environments. Future iterations of the system could focus on optimizing access speed without compromising security, further improving its usability.

In conclusion, the RFID Door Lock System with Dual-Step Authorization successfully achieves its goal of providing a secure and user-friendly solution for controlled access. Its implementation demonstrates the effective integration of multiple components and highlights the importance of balancing security requirements with user needs in access control systems.

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