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Design of Parcel Box Using RFID Technology with Arduino

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Abstract

In this era of growing online shopping, secure and efficient delivery systems are very important. This paper presents the design and implementation of a parcel box that uses RFID (Radio Frequency Identification) technology combined with an Arduino microcontroller. The primary objective is to build a security system by using RFID module. The core components of the system include an RFID reader, a 4x4 matrix membrane keypad, a red and a green LED, a solenoid door lock, and a 5V relay module, all controlled by an Arduino board. Each authorized user is provided with unique RFID tag. When an authorized tag is scanned, the Arduino verifies the tag and triggers the green LED, indicating successful authentication, and unlocks the parcel box via the solenoid lock controlled by the relay module. If an unauthorized tag is detected, the red LED lights up, and the box remains locked. Additionally, the 4x4 matrix membrane keypad allows users to enter a personal identification number (PIN) for an added layer of security. This dual-factor authentication mechanism ensures that only authorized users can access the parcel box, leading to greater security. The proposed design provides a low-cost and scalable solution for secure parcel handling, addressing common issues like package theft and missed deliveries. Experimental results show that the system is reliable and effective, making it suitable for residential uses. This parcel box design aims to enhance the security and efficiency of the last-mile delivery process, meeting the demands of modern e-commerce.

1. Introduction

E-commerce's exponential growth has transformed people's shopping habits, resulting in a significant increase in parcel deliveries [1]. However, the increase in online shopping has brought about challenges, particularly in ensuring the security and convenience of parcel delivery and retrieval [2]. Package theft, missed deliveries, and unauthorized access are all common issues that traditional delivery methods fail to address. As a result, there is a critical need for innovative solutions that can improve the security and efficiency of last-mile delivery.

This paper investigates the design and implementation of a parcel box using RFID (Radio Frequency Identification) technology combined with an Arduino microcontroller. The primary aim of this design is to provide a secure and user-friendly system for parcel deliveries. The proposed system, which includes an RFID reader, a 4x4 matrix membrane keypad, a red and a green LED, a solenoid door lock, and a 5V relay module, ensures that only authorized users can access delivered parcels.

This parcel box's core is RFID technology, which makes it easy for authorized users to identify quickly and securely [3]. Every user has an RFID tag that is specific to them, and the Arduino microcontroller can validate the tag and unlock the parcel box by scanning it. A 4x4 matrix membrane keypad is integrated to increase security even further, requiring users to enter a personal identification number (PIN) as an extra authentication step [4]. Visual indicators, such as red and green LEDs, provide clear feedback on the authentication status and state of the lock mechanism.

The design of this smart parcel box provides a cost-effective, scalable solution to the common problems of package theft and missed deliveries [5]. This system improves delivery security and reliability by ensuring that only authorized individuals have access to the parcels. This introduction sets the stage for a thorough examination of the smart parcel box's design, implementation, and evaluation using RFID technology and Arduino, emphasizing its potential to transform parcel delivery in residential settings [6].

2. Materials and Methodology

2.1 Materials

The materials that used for the Parcel Box are listed as below:

- Arduino Uno R3
- RC522 RFID Module
- 4x4 Matrix Membrane Keypad
- 5V One Channel Relay Module
- 12V Solenoid Lock
- Red and Green LED
- Buzzer
- Jumper Wire Male To Male
- Jumper Wire Female To Female
- Jumper Wire Female To Male.

2.1.1 Arduino Uno R3

Arduino is a microcontroller board that has datasheet based on Atmega328P. It has 14 pins digits input/output which are 6 used PMW output, 6 Analog input, 16Mhz quartz crystal, USB connection, power jack and reset button. Pin 0 and Pin 1 are used to receive the transmitted serial data. Pin 2 and Pin 3 are external interrupts which can be configured to trigger an interrupt at the low value or at the changing value. Pin 3,5,6,9,10 and 11 provide 8-bit PMW. Output 15 with the Analog function. Pins 11,12 and 13 support communication by using the library.

2.1.2 RC522 RFID Module

RC522 RFID module are used as security system in this project. When the tag is brought close to the reader, the reader generates an electromagnetic field. This causes electrons to move through the tag's antenna and subsequently powers the chip. The chip then responds by sending its stored information back to the reader in the form of another radio signal. This is called a backscatter. The reader detects and interprets this backscatter and sends the data to Arduino. The module's operating voltage ranges from 2.5 to 3.3V, but the good news is that the logic pins are 5-volt tolerant, so can easily connect it to and without using a logic level converter.

2.1.3 4x4 Matrix Membrane Keypad

The 4x4 matrix keypad is a simple mechanism that is similar to the numeric input on your computer keyboard, except for an additional '*,' '#', and four other additional buttons that can be used for various functions in the application.

2.1.4 5V One Channel Relay Module

The Single Channel Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontrollers such as Arduino, ESP and more. The relays terminal (COM, NO and NC) is being brought out with screw terminal. It also comes with an LED to indicate the status of relay.

2.1.5 Methodology

At here has the details explanation of methodology that is being used to make this parcel box using RFID technology with Arduino system complete and working well. All the methods and step involved during the

Multidisciplinary Applied Research and Innovation Vol. 7 No. 2 (2026) p. 49-54

designing concept, market surveying, concept sketching idea has been clarified in this part. It also covered the process involved while setting up design hardware while completing the project.

2.1.6 Flow Chart

Fig. 1 shows the flowchart outlines the process for accessing the parcel box system, which allows ususerso choose between RFID technology and PIN entry system for authentication. Firstly, the parcel will be placed inside the parcel box. At this point, the user has the option to authenticate either by scanning their RFID tag or by entering their PIN on the keypad.

If the user chooses the RFID authentication path, they scan their RFID tag on the RFID reader surface. The system then checks whether the scanned tag is authorized. If the tag is not authorized, the system triggers a buzzer and red LED to indicate an unauthorized access attempt, and the process terminates. However, if the RFID tag is authorized, the system proceeds by turning on the green LED and unlocking the parcel box, allowing the user to retrieve their parcel.

Alternatively, if the user chooses for the PIN authentication path, they enter their PIN on the keypad. The system verifies the entered PIN. If the PIN is incorrect, the system activates the buzzer and red LED to signal a failed authentication attempt. If the PIN is correct, the system turns on the green LED and unlocks the parcel box, enabling the user to access their parcel.

In both authentication paths, upon successful verification, the green LED is turned on to indicate that the authentication was successful. The solenoid door lock is then activated, unlocking the parcel box and allowing the user to retrieve their parcel

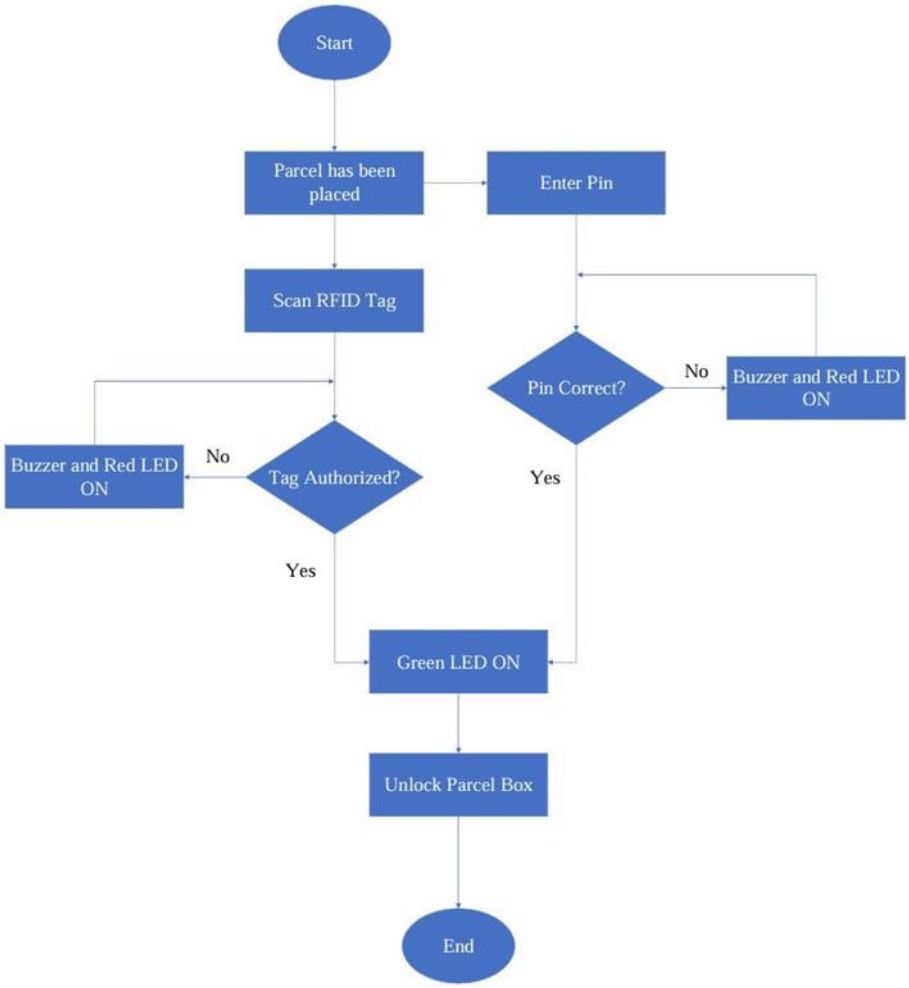

Fig. 1 *Flowchart*

3. Result and Discussion

3.1 Result

Fig. 2 and Fig. 3 show the prototype of the parcel box was successfully designed, while the obtained result is shown as in Table 1 below, which indicates the RFID reader accurately identified authorized tags, and the keypad successfully validated the correct PIN.

Fig. 2 *Prototype (front view)*

Fig. 3 *Prototype (top view)*

Based on Table 1, the results obtained are correct where the solenoid unlocked and received 12V, green LED is on, and the buzzer does not sound if the password entered is correct and the RFID tag used is also correct.

While in the opposite, if the password entered is incorrect and the RFID tag used is also incorrect, solenoid lock is still locked and there is no voltage flow through it, red LED is on, and the buzzer generated a sound.

Table 1 *Testing results*

Item	Correct					Incorrect				
	Solenoid Lock	Volt	Red LED	Green LED	Buzzer	Solenoid Lock	Volt	Red LED	Green LED	Buzzer
RFID	Unlock	12V	×	✓	×	Lock	0V	✓	×	✓
Keypad	Unlock	12V	×	✓	×	Lock	0V	✓	×	✓

3.2 Discussion

The parcel box prototype's development and testing provide several key insights into its functionality and potential applications. The dual authentication system, which combines RFID technology with a keypad, offers a strong security mechanism. Users can choose between scanning an RFID tag and entering a PIN, which significantly reduces the risk of unauthorized access. This adaptability improves the user experience by catering to varying preferences and security requirements.

The presence of visual and audio feedback mechanisms, such as red and green LEDs and a buzzer, plays an important role in guiding users through the authentication process. These indicators provide immediate and clear feedback on the status of authentication attempts, keeping users informed about successful and unsuccessful access attempts. This feature not only improves the system's reliability, but it also makes it easier to use.

Throughout the testing phase, the prototype demonstrated high reliability. The RFID reader consistently identified authorized tags, and the keypad accurately registered PIN entries. The solenoid door lock worked smoothly, allowing the parcel box to be locked and unlocked securely and reliably. These results show that the system can effectively secure parcels while also providing a dependable user experience.

The anti-fishing feature is a key addition to the design, preventing unauthorized attempts to retrieve parcels by inserting tools or hands into the box. This feature is critical for ensuring the security system's integrity because it addresses a common vulnerability in traditional parcel boxes. The anti-fishing mechanism ensures that only those who have successfully authenticated via RFID or PIN entry have access to the contents, significantly improving the security of the smart parcel box.

4. Conclusion

In conclusion, the parcel box prototype provides a practical and innovative solution to the challenges of secure parcel delivery and retrieval. Its dual authentication system, along with anti-fishing features and clear user feedback, make it an important addition to modern delivery systems. For further enhance the reliability and security of the parcel box, several improvements can be considered. Incorporate solar panels to make the system energy efficient and suitable for outdoor installations without access to power outlets. Additionally, develop a mobile app to allow users to receive notifications and remotely unlock the parcel box.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Jason Teo Chang Cheng, Mohd Sabani bin Mohd;* ***data collection:*** *Jason Teo Chang Cheng;* ***analysis and interpretation of results:*** *Jason Teo Chang Cheng, Mohd Sabani bin Mohd;* ***draft manuscript preparation:*** *Jason Teo Chang Cheng. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] S. Anderson, "*E-commerce: Growth and Opportunities*," J. Internet Commerce, vol. 16, no. 2, pp. 101–115, 2017.
[2] J. Smith and T. Brown, "*Parcel Delivery Security: Challenges and Solutions*," Secur. J., vol. 31, no. 4, pp. 415–431, 2018.
[3] RFID Journal, "*RFID Technology Basics*," 2020, Available: https://www.rfidjournal.com/rfid-basics.
[4] M. Stanley and A. Brevig, "*Keypad Library for Arduino*," n.d., Available: https://playground.arduino.cc/Code/Keypad/.
[5] M. Harris, "*Smart Parcel Lockers: A Review of Current Systems and Future Prospects*," Logistics & Transp. Rev., vol. 57, pp. 43–58, 2021.
[6] R. Kumar and M. Singh, "*Smart Home Technologies and Their Applications*," Int. J. Smart Home, vol. 13, no. 3, pp. 1–12, 2019.