

## S-Parcel Mailbox With Printed Delivery Receipt

**Roslinda binti Mohd Sidek<sup>1\*</sup>, Wan Haslinda binti Wan Mohamad<sup>1</sup>**

<sup>1</sup> Department of Electrical Engineering, Politeknik Sultan Mizan Zainal Abidin, 23000 Dungun, Terengganu

**\*Corresponding author E-mail:** roslinda@psmza.edu.my

### Abstract

S-Parcel Mailbox With Printed Delivery Receipt is designed due to the drastic increase in e-commerce activities has turned daily parcel delivery and reception into a logistical challenge. This project presents to overcome a primary issue in delivery such as the failure of a secure drop-off when the recipient is not present. This typically leads to the packages being left in insecure locations to chance theft or damage or returned to the hub, causing inconvenience to both the recipient and delivery personnel. The main objective of this project is to devise a secure and convenient parcel mailbox prototype with a receipt-generating machine for proof of delivery and attach a notification indicator such as indicator lamp and LCD display to notify the owner. It includes a security features to open this mailbox securely with a secret code to prevent tampering. With it, a functional prototype was effectively built. It is able to print a delivery receipt for delivery staff after the package has been deposited into the parcel box, display the status on an LCD display during detection of the package in the parcel box, and safeguard its contents through the security code system. The contribution of the project is a concrete solution that improves the security and efficiency of the delivery process in the last mile, reduces the risk of package loss, and makes the process more efficient for all parties involved.

**Key Words:** Mailbox, Receipt, Delivery, Package, LCD, Secret Code

### 1.0 Introduction

The rapid growth of e-commerce has had a profound impact on urban areas, especially in the last-mile delivery phase. A literature review by Viu-Roig et al. (2020) explained how this increase in volume in delivery has led to many problems such as traffic congestion and calls for more efficient and safer delivery solutions. As a countermeasure to the concerns mentioned above, the development of smart mailbox systems has been an ongoing research and development activity.

There are several local and international studies investigating the creation of smart mailbox prototypes with different platforms and features. For instance, Az-Zahra and Ahmad (2022) managed to create a smart mailbox based on Arduino with the feature to send user notification through an SMS system. At the same time, ongoing efforts for more sophisticated security features were presented by Sokullu et al. (2020) created a multifunctional smart mailbox with biometric access control through facial recognition and fingerprint scanning. Their intricate system is built on a hybrid design which integrates Arduino in conjunction with Raspberry Pi to perform high-level image processing workloads. Even though these works, from rudimentary SMS alert systems to complex biometric systems, demonstrate the practicality and comprehensive research interest on smart mailboxes, their main concern still revolves around enhancing security as well as alerting capabilities for users.

Security is a critical part of the design of these systems. Most importantly, a reliable and secure locking mechanism is required. A comprehensive review of security locking systems has been provided by Sai et al. (2024), based on which the locking mechanisms have been chosen for this project. Apart from that, the capability to provide information to the user is also necessary. Research like Islam et al.'s (2024) IoT-based wireless electronic notice board demonstrates an example of the sending and receiving of information remotely through internet technology that points toward possible future integration for mailbox systems.

However, one thing that remains underestimated in most of the recent research is the existence of confirmation or proof of delivery to the sender. Herein lies the key research gap. Kedia et al.'s (2024) research has already established elaborately that it is feasible and most appropriate to design and develop a mini Arduino-based thermal printer and is most applicable

for applications like printing receipts. It involves their work on the hardware aspect, programming in Adafruit libraries, and showcases its potential use in numerous mobile applications.

Therefore, combining these findings, this literature review discovered that although smart mailbox technology, notification systems, and mini printers have all been around individually, there is tremendous opportunity for innovation to bring all these components together into an integrated system. It is the intention of this project to bridge this gap by creating a S-Parcel Mailbox With Printed Delivery Receipt which, although secure and communicative to the recipients, gives rightful evidence of delivery in the form of a tangible receipt to the courier or sender, an aspect that has not been emphasized yet in the literature.

## **2.0 Materials and Methods**

Components selection and methodological approach to the project development are crucial considerations for ensuring the success of the proposed project. The components given below were chosen and methodology has been adopted to develop and design this S-Parcel Mailbox With Printed Delivery Receipt prototype. A block diagram was developed to visualize the interaction between each of the major components.

### **2.1 Materials**

Figure 1 shows a block diagram of the chosen components for the developing of this project which consists of three main interconnected parts, which are Input, Processor and Output. The components and their roles in this project include:

#### **2.1.1 INPUT Part**

This is where the system receives data or instructions from the external world. There are two major input devices:

- i. IR Sensor: As an input that detect the presence of an object passing through it.
- ii. Keypad 4x4 Module: As an input device to enable the user to enter a passcode for unlocking the security door.

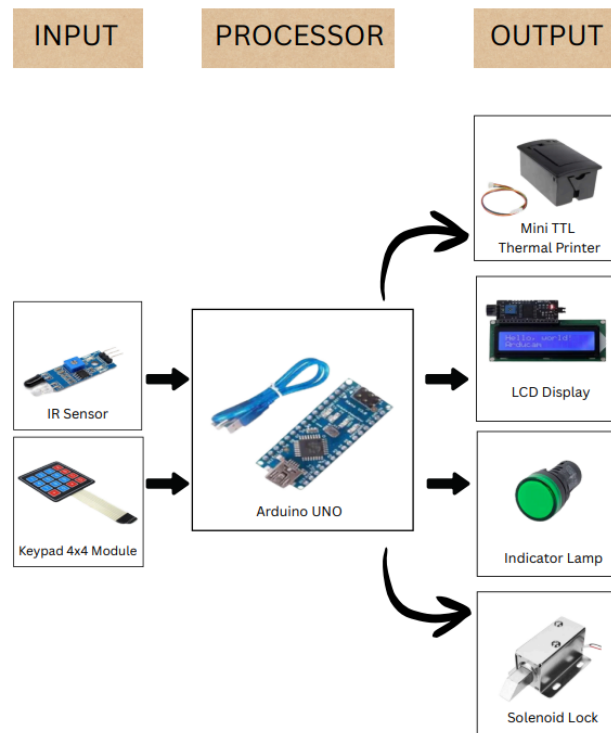
#### **2.1.2 PROCESSOR Part**

All inputs from the INPUT section will be routed to the Arduino Uno, which is the processing unit of the system. It accepts input from the IR sensor and keypad, operates the lock mechanism and sends output to be shown on the LCD display and lamp indicator, and printed out the receipt by the thermal printer.

#### **2.1.3 OUTPUT Part**

When a decision is made, the Arduino Uno will instruct the output devices to generate a physical action. There are four main output devices:

- i. Indicator lamp: As an output device to show the light to notify the user.
- ii. Liquid Crystal Display (LCD Display): The LCD display serves as an output interface to provide basic notifications to the user.
- iii. Thermal Mini Printer: This is a new functionality that prints legitimate receipts as delivery proof to the courier or sender. The printer employs thermal heat technology in order to create prints on heat-treated paper.
- iv. Lock Mechanism (Solenoid Lock): A solenoid lock is employed as a physical actuator for locking and unlocking the door of the parcel mailbox automatically according to instructions from the Arduino Uno and validation of the passcode entry.



**Figure 1:** Materials block diagram of the project

## 2.2 Methodology

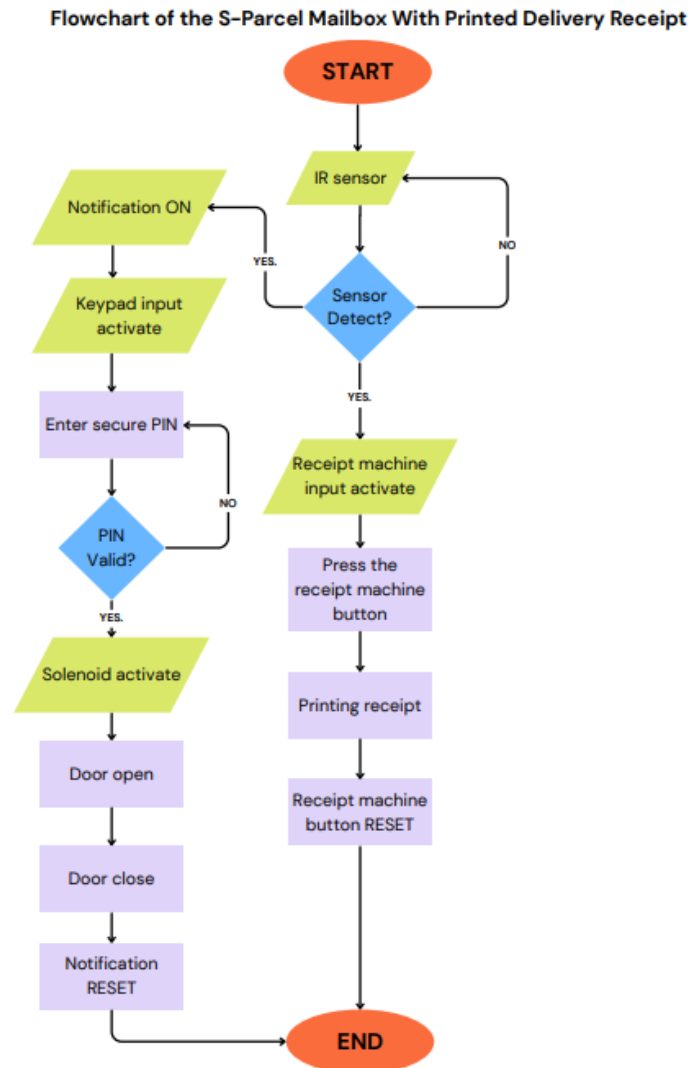
Figure 2 shows the flow chart of functional and operational for this project. This flowchart describes the two major processes performed for the S-Parcel Mailbox With Printed Delivery Receipt, which is the parcel collection process (path on the left) and the process of the courier getting a receipt (path on the right).

The process starts when an IR sensor detects object on the package delivery route of the mailbox. If object is detected, two logical routes will be triggered by the system.

For the courier (Right Path), the receipt machine system will be activated. The courier must press the button on the receipt machine, and the receipt machine will issue a receipt as a confirmation of delivery. Once this is completed, the button on the receipt machine is reset, and the courier's process is complete.

For the User (Left Path), the notifications will be activated, and the keypad will be available for input. The user will have to enter the valid PIN number. When the correct PIN is entered, the solenoid lock will be energized to open the door. When the user opens and then closes the door, the notice system will be reset, and pickup is complete.

In conclusion, this flowchart illustrates how the system reacts to the presence of an object by offering two main functions, opening the security using the correct PIN and giving a confirmation receipt upon pressing the button.



**Figure 2:** Flowchart of S-Parcel Mailbox With Printed Delivery Receipt operation

### 3.0 Results and Discussions

Upon completion of the system integration activity, a sequence of tests was conducted to verify the performance of each component and the overall system. Based on the test results attained, the S-Parcel Mailbox With Printed Delivery Receipt prototype has been successfully constructed and performs as expected.

#### 3.1 Result

Test results confirm that this prototype solution addresses security and proof of delivery deficits in the parcels delivery system adequately. Utilization of electronic keys combined with physical proof of receipt provides a two-way solution that satisfies both the recipient and the courier.

**Table 1:** Operational results for S-Parcel Mailbox With Printed Delivery Receipt prototype

| Input                    | Output                   | Status   | Action                                | Description                                               |
|--------------------------|--------------------------|----------|---------------------------------------|-----------------------------------------------------------|
| IR Sensor                | Mini Thermal Printer     | Activate | Allow the printer button to be pushed | IR sensor detects object passing through it               |
|                          |                          | ON       | Printing the receipt                  | Printed receipt issued once the printer button was pushed |
|                          |                          | RESET    | The printer button cannot be pushed   | Printer will be RESET once the printed receipt issued.    |
|                          | Notification Indicator   | ON       | The indicator lamp light on           | IR sensor detects object passing through it               |
|                          | Notification LCD display | ON       | Display message notification          | IR sensor detects object passing through it               |
|                          |                          |          |                                       | Correct PIN entry                                         |
| PIN entry through keypad | Solenoid Lock            | Activate | Release the door lock                 |                                                           |
|                          | Notification Indicator   | RESET    | The indicator lamp light off          | Security door turn closed                                 |
|                          | Notification LCD display | RESET    | Display message notification OFF      | Security door turn closed                                 |

Table 1 shows a summary of the results of the functional tests that were run on the prototype. It indicates how each input, which is action by PIN or sensor leads to a certain output and action on the various components.

## 3.2 Analysis and discussion

### 3.2.1 Delivery process, triggered by IR Sensor.

Once the IR Sensor has detected an object, it triggers three systems at once.

#### a. Receipt System.

The printer button is enabled, which can now be pressed. When pressed, it prints a receipt and resets the printer system.

#### b. Notification Lamp System.

The indicator lamp will illuminate as a visual notification signal.

#### c. Notification LCD System.

The LCD screen will be lit up to show a notification message.

This shows that the IR Sensor is the sole sensor which triggers the system for delivery and notification modes. The reasoning is correctly established where an individual input triggers various outputs simultaneously to notify the new status of the mailbox.

### 3.2.2 Pick-up Process, triggered by keypad.

Once the correct PIN has been entered via the keypad, the system shall respond with lock system. The solenoid lock is activated to open the door lock so that the user can pick up the package. Once the door is closed, the system will know this action and automatically reset notification. Both indicator light and message display on the LCD will be disabled.

This process demonstrates that the security system and reset system are running perfectly well. Correct PIN insertion grants access, and the smart closure of the door returns the system to idle mode in readiness for the next delivery. This is an economical feature.

This output table verifies that the S-Parcel Mailbox With Printed Delivery Receipt prototype in Figure 3 behaves as expected. Each input produces a correct and logical output. The system shows an effective sensor, keypad with a PIN, and output device such as receipt printer, indicator lamp, LCD and solenoid lock are integrated.



**Figure 3:** S-Parcel Mailbox With Printed Delivery Receipt prototype

## 4.0 Conclusion

The project has been successful and meets its primary goal of designing and developing an operational S-Parcel Mailbox With Printed Delivery Receipt prototype. The prototype is successful in combining several important elements in an attempt to devise a safe and efficient system.

A locking mechanism with an access code has been implemented to great success, providing a functional layer of security to safeguard the parcel. The LCD screen and indicator lamp are also a clear and immediate medium of notification to the user. But perhaps the greatest contribution of this project is getting the mini thermal printer to work in order to provide a physical receipt as proof of delivery to the courier or sender. This new functionality accurately addresses the missing link in the literature review of the current smart mailbox studies, which concentrated mainly on recipient notifications. Therefore, this project demonstrated the viability of an end-to-end solution that protects the interests and gives confidence to both the courier and the recipient.

To further the possibility and usability of this S-Parcel Mailbox With Printed Delivery Receipt in the future, several enhancements can be made based on existing technology that

has already been researched like IoT Integration and Real-Time Notifications and adding Cameras for Visual Verification.

### Acknowledgement

Our sincere gratitude to all lecturers of the Electrical Engineering Department, Sultan Mizan Zainal Abidin Polytechnic who have been involved in the development of this S-Parcel Mailbox with Printed Delivery Receipt project. All cooperation rendered is well appreciated.

### References

- Az-Zahra, A., & Ahmad, S. A. (2022). *Smart mailbox with notification system* [Diploma project report, Universiti Teknologi MARA]. UiTM Institutional Repository.
- Islam, M. S., Kafi, A. B. M. A., Hossain, M. S., Sultana, S., & Faruque, M. R. I. (2024). Wireless electronic notice board system using IOT. In *2024 5<sup>th</sup> International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST)*. IEEE.
- Kedia, A. K., Anand, B., Bansal, K., Pavithra, G., & Manjunath, T. C. (2024). Design & development of an Arduino-based thermal-mini printer. *Grenze International Journal of Engineering and Technology*, 6785–6790.
- Sai, K. N., Sunil, T. D., & Eshwarappa, M. N. (2024). A comprehensive review of door lock security systems. *International Journal of Computer & Communication Networks*, 5(1), 12–17.
- Sokullu, R., Akin, Ö., & Aslan, E. (2020). Face Recognition Based Multifunction Smart Mailbox. In *2020 7th International Conference on Energy Efficiency and Agricultural Engineering (EE&AE)* (pp. 1-5). IEEE.
- Viu-Roig, M., & Alvarez-Palau, E. J. (2020). The Impact of E-Commerce-Related Last-Mile Logistics on Cities: A Systematic Literature Review. *Sustainability*, 12(16), 6492. <https://doi.org/10.3390/su121664>