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Smart Parcel Receiver

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Abstract

The rise of e-commerce has increased package delivery. The increased frequency of delivery increases the potential for theft, particularly in residential areas where parcels are frequently left unattended. Theft of parcels in the context of online purchasing is a major worry for both customers and e-commerce businesses. The purpose of this research is to design, develop, and evaluate a Smart Parcel Receiver. The goal of this research is to assist recipients in keeping their parcels secure during delivery. This project has used five phases in the engineering design process to complete this paper. The engineering design phase includes formulation, concept design, configuration design, parametric design, and detail design. To use this machine sender needs to contact the receiver of the parcel so that the receiver can unlock the door of the machine remotely using an app. Overall, the project achieved the study's goals. However, there is still room for development in product design and app usage.

1. Introduction

As the e-commerce industry continues to rise, there is a greater need for an efficient parcel delivery and reception system. Consumers are increasingly accustomed to buying things online, which has increased parcel shipping. The increase in deliveries provides more opportunities for theft, especially in residential areas where packages are often left unattended. Porch piracy refers to the theft of packages that are left on doorsteps or porches. Porch piracy has become a prevalent concern with the development of internet shopping and home delivery. Thieves may target parcels that have been left unattended for a lengthy period, resulting in financial losses for consumers and reputational harm for e-commerce businesses. Parcel receivers address security issues over package deliveries. Because of the increase in porch thefts, security parcel drops boxes, and smart lock systems have been developed to restrict unauthorized access to delivered parcels.

The rise in daily parcel delivery in this fast-paced environment can be attributed to the development of online purchasing platforms like Shopee, Lazada, Shein, and TikTok. Every day, courier services including Pos Laju, JnT, Skynet, DHL, and Ninja Van transport thousands of packages. According to Harian Metro, Pos Laju processes up to 770,000 shipments daily [1].

In 2021, the delivery quantity increased dramatically from 350,000 to 700,000 or 800,000 per day. Pos Malaysia group chief executive officer Syed Md Najib Syed Md Noor also said “There’s been a rapid increase in e-commerce activities, and I am happy to say that Pos Malaysia is playing a big part in supporting Malaysia’s rapidly growing Digital Economy (2). The current strength is strongly indicative of the digital transformation

occurring in the country as an increasing number of Malaysians are embracing online shopping as a new way of life, “The growth of the e-commerce platform in recent years has increased its market value to reach 28.5 billion Malaysian Ringgit” (2). This indirectly led to a rise in the postal and courier industries' earnings.

Due to the growth of online purchasing, every household will receive a minimum of one parcel delivery a day. It is customary when there is no one at home, packages or parcels of goods sent by the courier will be left outside the customer's residence. This led to many cases of theft because the parcel was left in front of the house without any security. There are a few cases that local newspapers have reported. Due to working constraints, individuals who are employed may leave the items in that exact condition for up to six hours. People will soon become worried about the shipments since they might contain something priceless or important to them.

To verify that customers worry about their parcels while they are away from home, a survey has been put into place. From the survey that was targeted towards thirty people, it shows that 70 percent of the respondents feel extremely worried about their packages if the package arrives when they’re not at home. 26.67 percent of respondents feel worried about their parcels and 3.33 percent of the respondents do not worry about their parcels. This concludes that more than 90 percent of the respondents were worried about their parcels if they received it when they were not at home

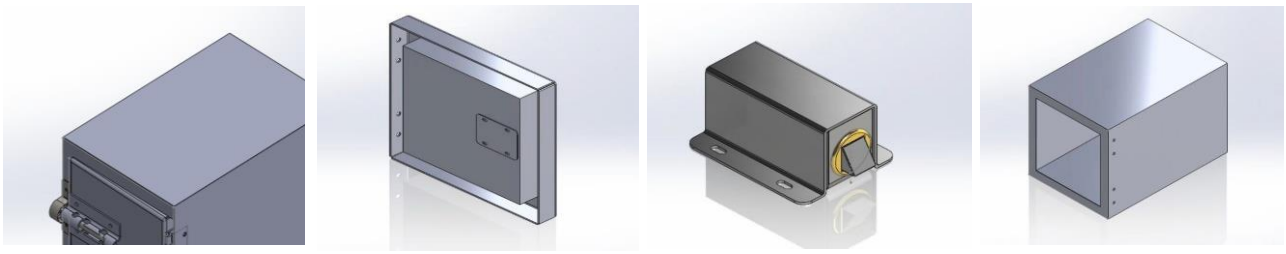
Therefore, to tackle this issue there is a need to build a machine that can receive the packages when the owner is not at home. This machine can be called a smart parcel receiver as the owner can lock and unlock the machine just by using a phone. So, when the packages arrive users can unlock the receiver and ask the courier to put it in the receiver, after that users can just lock it back. This ensures that the parcels are secure and reduces the possibility of theft.

To further prove the importance of this innovation, a survey has been conducted to hear the responses from online purchasing customers. The survey shows that over half of the participants believe that this innovation is very effective in solving parcel issues while 36.67 percent of the respondents think that this innovation is effective in solving parcel thieving problems. This concludes that all respondents agree that this innovation can solve the problem of losing parcels.

Other than that, another question has been asked to the respondents, which is: Does the innovation make the respondent's parcel safer? The survey shows that 66.67 percent of respondents strongly believe that this innovation can make their parcel safer, and 33.33 percent of respondents believe that this innovation can make their parcel safer. In conclusion, all respondents believe that this innovation can make their parcel safer. All in all, this invention is desperately needed to lessen the problem of porch piracy and thievery.

2. Methodology

This project was followed in a succession of steps. The first step is to do project planning so that the project will go smoothly. Then, a literature review of the project was completed to get a better understanding of the project. Following that a model design was created using SolidWorks to visualize the project. The components will then get selected and using the same tool which is SolidWorks the designs of these components were made. As shown in Fig. 1. After completing the design, a components selection was carried out to pick a suitable material for each component. After all the steps above are completed, the fabrication process will start. The machine will be refined until it passes the final testing. Finally, the project was finished by including the work process and results in the report.



(a) (b) (c) (d)

Fig 1 *SolidWork design for the project (a) 3D Model, (b) Door, (c) Lock, (d) Body*

As stated in the above statement about the succession of steps in this project. The Fig. 2 below will further explain about the research flow. There are two flowcharts in this project, one is the flowchart for the overall project and another one is for the coding of the system. Regarding the code flowchart, it shows how to integrate and control a device that is connected to Blynk using Arduino microcontroller. Setting up serial communication with a given baud rate for debugging or other uses comes after establishing constants and including the required libraries. After that, the Blynk connection is initialized to create a link that permits remote control and

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monitoring between the device and the Blynk server. The Blynk process is continuously run by the program's main loop to maintain the connection and manage data transmission.

The software checks if the Blynk button is active during this cycle. LEDs and motors that are linked to the system are activated when the button is pressed because all output pins are set to HIGH. The component deactivates when the button is off because all output pins are set to LOW. The Blynk interface enables remote control of the device by guaranteeing that it reacts instantly to the status of the button. This procedure never ends until the device is turned off or reset.

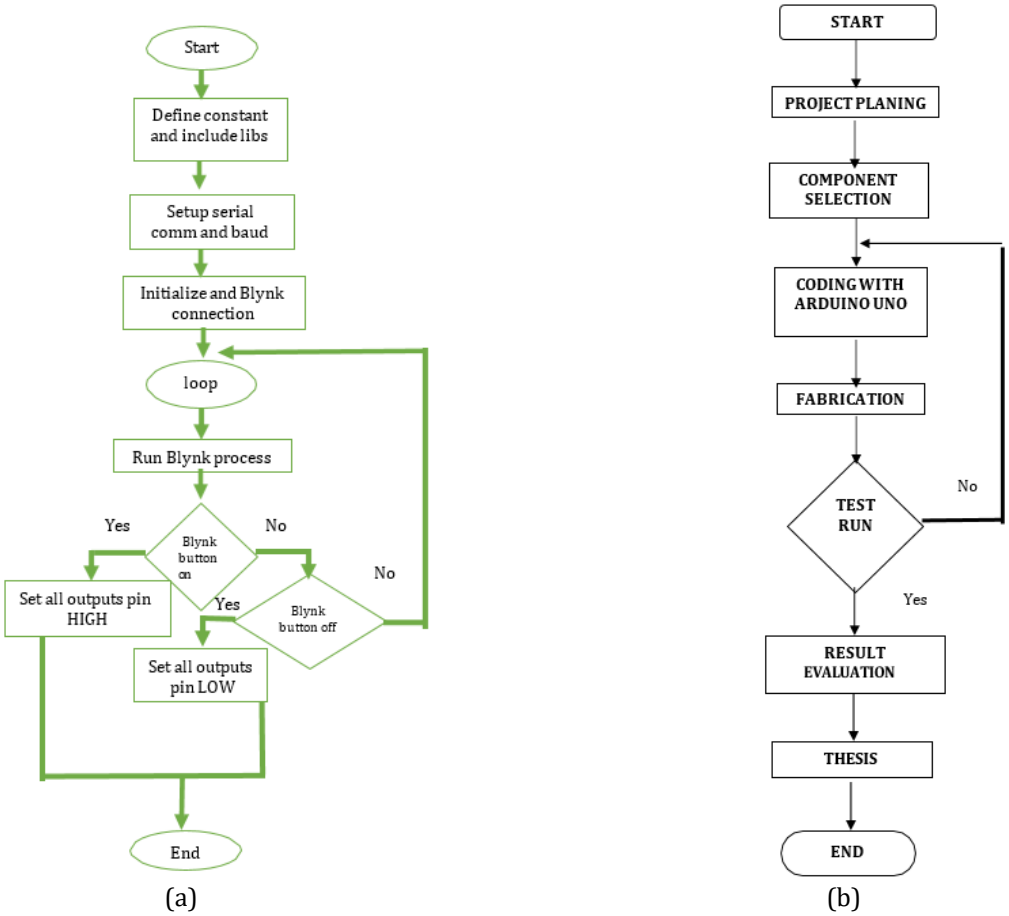

Fig 2 *Flowchart of the project, (a) flowchart for the system coding, (b) flowchart for the overall process*

Fig. 3 shows the crucial part in the coding process, which is the unlock and lock process. The Blynk app's virtual button (attached to virtual pin V0) is continually monitored by the code. The lock attached to the pins listed in the gsOut_PinArray array are activated if the button is on (V0 == 1). When these pins are linked to an off button (V0 == 0), all the locks are also off. In order to control the lock attached to the first four pins in the gsOut_PinArray, the for loop iterates over these pins.

```
//Read Blynk Button On Off, if on, running LED in sequent
if(DBlynk.read_asInt(V0) == 1)
{
  for(short i=0; i<4; i++)
  {
    digitalWrite(gsOut_PinArray[i], HIGH);

  }
}
if(DBlynk.read_asInt(V0) == 0)
{
  for(short i=0; i<4; i++)
  {
    digitalWrite(gsOut_PinArray[i], LOW);
  }
}
}
```

Fig. 3 *Coding of the system*

2.1 Materials and Sustainability Elements

The smart parcel receiver is designed to improve security, with the sustainability goal and convenience in modern package delivery systems. Aligning with SDG Goal 9: Industry, Innovation, and Infrastructure, the receiver is designed with 8 x 8 inches in size and 16 inches deep, making it small enough to fit seamlessly into residential environments while yet allowing for conventional package dimensions. Other than that, the design is also aligns with SDG Goal 12: Responsible Consumption and Production. Its modest size (8 x 8 inches with a 16-inch depth) makes it suited for a wide range of residential settings, from single-family houses to apartment complexes. The receiver's strong development, along with weather-resistant materials, ensures lifetime and low maintenance. This durability not only increases the receiver's life but also decreases the need for frequent replacements, resulting in less waste. And less money for users, aligning with SDG Goal 7: Affordable and Clean Energy.

The smart parcel receiver is designed to be powered by an advanced Internet of Things (IoT) system that manages package deliveries easily, securely, and efficiently. An Arduino Uno microcontroller is at the heart of the system, combining various features and connectivity components to ensure optimal efficiency. With a Wi-Fi module, the receiver connects to the internet and communicates with the user's smartphone through a specific mobile app. Moreover, this device is designed to be powered by a rechargeable battery, allowing for uninterrupted functioning. When not actively processing commands or sensor data, the Arduino Uno enters a low-power mode to conserve energy. This sustainable power solution not only lowers the device's carbon impact but also ensures its dependability aligning with SDG Goal 7: Affordable and Clean Energy.

For this project, the materials for the components were chosen after a thorough assessment of the literature. Therefore, for this particular project aluminium was chosen because of its sustainability element. Aluminium is a material that has high recyclable without losing its properties. Recycling aluminium requires up to 95% less energy than producing new aluminium from the ore (5). Aluminium also is resistant to corrosion and given that smart parcel boxes are often exposed to varying weather conditions, the corrosion resistance of aluminium ensures longevity and robustness. Additionally, aluminium’s lightweight nature facilitates ease of handling during installation and relocation, contributing to user convenience. The material's exceptional strength-to-weight ratio ensures that the smart parcel box remains sturdy and capable of withstanding external forces, safeguarding parcels effectively (6). Last but not least the lock. A Solenoid lock was chosen as it has energy efficient feature. It was designed to consume very low power, especially if it was powered by batteries. Solenoid locks use durable material such as metals and plastic to ensures a longer life span. The innovative aspect of solenoid lock is it implements smart lock technology using Bluetooth or Wi-Fi that allow users to control it remotely. All of these correspond with SDG Goal 12: Responsible Consumption and Production.

The decision to use screws instead of welding in the fabrication of the smart parcel receiver is based on the need for easy disassembly and repair, which supports SDG Goal 12: Responsible Consumption and Production. Screws enable components to be easily separated, facilitating recycling and replacement of parts, thereby extending the product's lifecycle and minimizing waste. This modular approach promotes a circular economy, where products are designed for reuse, refurbishment, or recycling. Additionally, rivets are chosen to provide strong, reliable joints without the high energy consumption and harmful emissions associated with welding. Riveting ensures the structural integrity of the product while allowing for partial disassembly, if necessary, further enhancing durability and repairability. This method reduces the need for frequent replacements and aligns with sustainable production practices, contributing to SDG Goal 12 by promoting eco-friendly manufacturing and responsible consumption.

3. Results and Discussion

This project consisted of three parts which is the frame, system and the lock. At the end of the project, the frame of the machine was built successfully as intended based on design. However, a few adjustments have been made during the fabrication process to accommodate some unexpected changes. The next part is the system. Through many tries and errors, the system of this project finally can function well based on IoT (internet of things) concept. Arduino Uno motherboard can successfully connect to the Blynk IoT app from a series of coding that has been made. The system managed to function as intended to initiate the lock and unlock action for the machine by using a smartphone. Finally, the solenoid lock, at the end of the project, the solenoid lock was successfully connected to the circuit and Arduino Uno motherboard to achieve the objective of fabricating a smart parcel receiver. Fig. 4 below shows the workflow of the machine.

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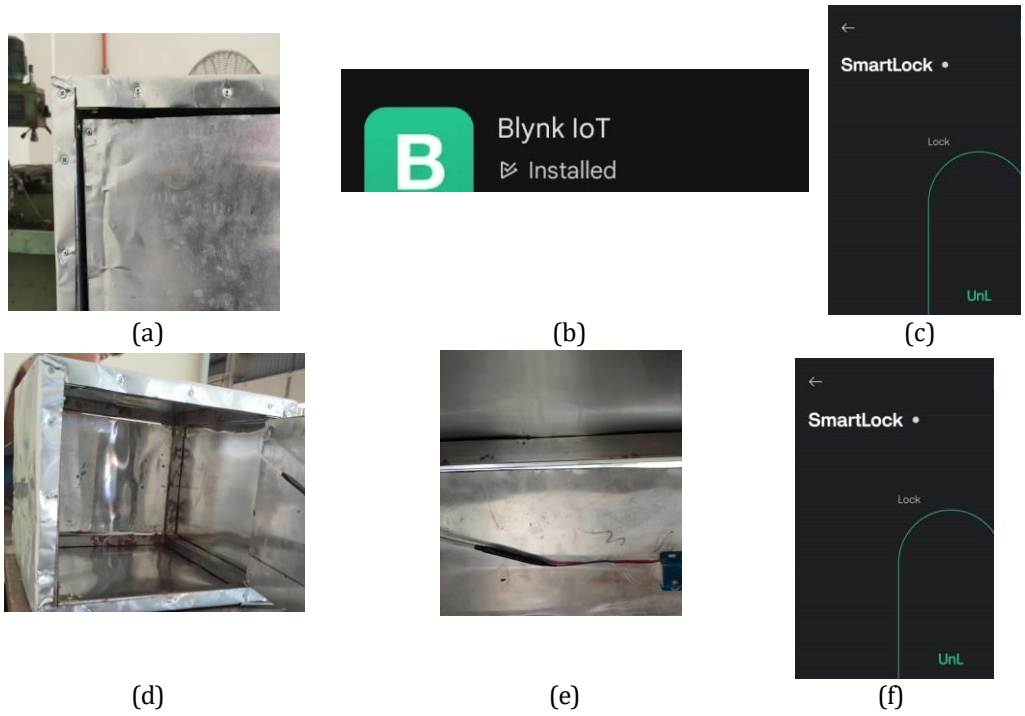

Fig.4 *Workflow of smart parcel receiver(a) the parcel arrives (b) Open Blynk app (c) Unlock the door (d) The door opened (e) Closed the door (f) lock the door*

4. Data Discussion

This section discusses the performance evaluation of the smart parcel receiver's solenoid lock system and battery management. The analysis focuses on the success rates of unlocking and locking operations, identifies potential causes of performance discrepancies, and highlights the results of real-world battery life testing to ensure system reliability and user satisfaction.

Table 1 *Frequency of unlock and lock*

Action	Frequency
Unlock	18/20
Lock	17/20

The disparity in success rates between unlocking and locking actions as in Table 1, with unlocking succeeding 18 out of 20 times and locking only 17 out of 20 times, can be attributed to a few key issues. First, loose or improperly connected wires within the solenoid lock system can disrupt the electrical signals necessary for the locking mechanism to function properly, causing intermittent failures during locking. Additionally, a low battery level can compromise the solenoid lock's performance, as insufficient power can hinder its ability to generate the necessary magnetic force to engage the lock effectively. To address these issues, it is essential to conduct regular inspections and maintenance to ensure all components, including wiring and power sources, are securely connected and functioning optimally. Implementing battery monitoring systems and recalibrating the system's operational parameters to ensure equitable power distribution between locking and unlocking actions can also help achieve a more balanced success rate and enhance the overall reliability of the solenoid lock system.

To ensure the battery life and power supply of our smart parcel receiver are reliable in real-world usage, we conducted extensive testing. Our focus was on evaluating how well the device performs over time without frequent recharging. During testing, we simulated continuous operation and monitored power consumption and performance. The results were impressive: the smart parcel receiver maintained a battery life of one to one and a half months without needing a recharge. This demonstrates the effectiveness of our power management system and the quality of the battery technology we use. To keep this high level of performance, we recommend ongoing optimization of power management algorithms and using energy-efficient components. Additionally, features like low-power standby modes and intelligent battery monitoring systems can further improve battery life and reliability, ensuring the device works seamlessly and keeps users satisfied over extended periods.

5. Conclusion

Overall, the smart parcel receiver is a promising and practical solution for addressing delivery tracking and parcel security issues. It incorporates advanced technology such as locks to effectively deter parcel theft. This not only provides peace of mind for senders and recipients but also improves accountability and transparency in the logistics process. The performance of the smart parcel receiver aligns well with the growing demands of our interconnected society. As e-commerce continues to expand and online shopping becomes more prevalent in our daily lives, there is an increasing need for solutions that ensure safe and reliable package delivery. By safeguarding parcels against theft, this device enhances the overall customer experience and offers added convenience through its monitoring capabilities.

Furthermore, the implementation of smart parcel receivers could potentially transform last-mile delivery dynamics by reducing instances of misplaced or stolen items and boosting public trust in the e-commerce industry. It represents a proactive approach towards addressing challenges in the logistics and delivery sector using technological advancements. By integrating smart parcel receivers, several key benefits can be realized. Firstly, they help prevent parcel theft through integrated locking mechanisms, ensuring that deliveries remain secure until they are retrieved by the rightful recipient. Secondly, real-time tracking provides enhanced visibility on the delivery status, allowing both customers and delivery personnel to monitor shipments more effectively. Additionally, the use of smart parcel receivers promotes improved accountability and transparency in the logistics process, reducing errors and misplacements.

Moreover, these receivers enhance the overall customer experience by providing peace of mind and greater convenience, minimizing the stress associated with missed or stolen deliveries. Ultimately, their adoption could have a positive impact on last-mile delivery efficiency and strengthen public trust in e-commerce services. As a further recommendation for this project, incorporating a small CCTV camera to supervise the parcel area could add an extra layer of security, ensuring continuous monitoring and deterring potential theft or tampering.

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Author Contribution

The authors confirm contribution to the paper as follows: ***design***: yeo yong jia; ***IoT system*** : nur solehah mohd ariffin; ***fabrication process***: phua zhi heng, yeo yong jia, nur solehah mohd ariffin; ***data collection***: nur solehah mohd ariffin; ***analysis and interpretation of results***: Yeo Yong Jia, Phua Zhi Heng. All authors reviewed the results and approved the final version of the manuscript.

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