Paracel Guard: Smart Delivery Solution

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Abstract - Parcel Guard is a smart delivery box solution designed to securely receive parcels when no one is available at home There are a lot of problems with internet shopping, missed deliveries, and package theft. User Parcel Guard addressed this by using a combination of IoT and embedded systems, allowing authorized household members to remotely control a secure, weather-resistant delivery box via a smartphone app Blynk. When a delivery person arrives, they contact the homeowner, who can then remotely unlock the box, allowing the package to be placed securely inside the compartment one of the box. The system leverages a Raspberry Pi Model 4 as the main controller, which manages the communication between the microcontroller for Wi-Fi connectivity and the smartphone app. A servomotor lock ensures that the box remains securely closed until the owner locks or unlocks it via the Blynk app. Upon a successful parcel deposit, the system sends a real-time notification to the owner, providing confirmation of delivery and enabling them to lock the box again for added security. This seamless solution allows the user to retrieve their parcel at their convenience, offering peace of mind by integrating the IoT, cloud connectivity, and mobile-based remote control for a secure and flexible delivery experience.

Keywords— IoT, Smartphone app, Smart Delivery box

I. INTRODUCTION

This initiative focuses on creating an intelligent IoT-enabled system for managing parcels and ensuring their secure delivery and storage. By incorporating cutting-edge sensors, instant notifications, a smartphone application, and secure access features, we addressed the shortcomings highlighted in previous studies, providing a smooth experience for both delivery staff and recipients. This system significantly minimizes theft and loss incidents while enhancing the overall efficiency of parcel management. Furthermore, this system is purposefully simple to use, making it accessible to a wide range of users, including huge apartment complexes and single households. Its shape lets it fit a lot of different size of delivery requirements and settings, thereby facilitating easy integration into existing systems. This project aims to design a smart, IoT-enabled parcel management system that makes sure the delivery is safe and storage of packages. By integrating advanced sensors, real-time notifications, and secure access mechanisms, It also offers a seamless experience for both the buyer and the delivery staff. Unlike conventional mailboxes or drop-off points, this system offers intelligent features that enhance system responsiveness and user interactivity. As soon as a parcel is delivered, the personnel can open the door of box from the smartphone itself using the software application when they are not physically willing to accept the package. The lock remains closed until authenticated access is permitted, making certain that the package cannot be tampered with by unauthorized users. Additionally, delivery personnel can follow a guided process to deposit packages efficiently, reducing confusion and manual errors. Beyond its technical sophistication, Parcel Guard stands out for its modular and scalable design. It can be modified to fit a variety of locations, including single-family homes, multi-story apartment buildings, and even large parcel traffic businesses. There system[1] proposes a basic parcel receiving box that lacks an appropriate locking mechanism. The parcel was easily retrievable from the box by anyone. However, inside this System, supplied the lock system, which is managed by consumer who guarantees the box and package's security inside of it. The YOLOv5 model in order to identify the parcel was used in box detection and position

estimation research. This model is currently being used in numerous investigations due to its superior object recognition capabilities and speed compared to earlier models. A box with a barcode sticker has been proposed [2]. The driver for the courier company is asked to assist in enhancing the company's operations by writing something on the inside of the package to scan as evidence that he completed the delivery. Of course, though Since that same barcode appears again, it actually isn't proof. There are certain instances, like food home delivery [5] where the online retailer and their consumer schedule a delivery window in advance, but even in this scenario, there's no guarantee the customer will be home at the appointed time. This isn't usually the case with house delivery, though. The rationale is that this delivery schedule in advance time slots with consumers would raise the carriers' fleet operation's rigidity, resulting in an extremely costly delivery system for carriers as well as merchants. The Internet of Things (IoT) will be able to integrate a wide range of diverse and heterogeneous end systems in a transparent and seamless manner, while also granting open access to specific data subsets for the creation of an IoT-powered Smart Freight Box that automates parcel delivery collection [6]. Our houses are becoming safer, smarter, and more connected thanks to networked gadgets, which also improve playtime and security [7].   In the Smart Parcel Receiving System, [8] The rise of online shopping has brought several challenges for customers that aren't typically encountered in traditional retail. One significant issue is managing parcel deliveries when no one is home. This paper presents the Smart Parcel Receiving System, which leverages advancements in GSM technology to address the problem of missed deliveries. This system offers a intelligent and safe solution for parcel delivery, allowing customers to monitor and control it from their smartphones. The goal is to create a Smart Parcel Receiving System capable of verifying and accepting deliveries, while also notifying both customers and e-retailers about the parcel status. In Low cost Parcel Box designed by [9] proposed a low- intelligent package delivery mechanism that will be put in place at each residence with enhanced security. The Arduino Mega 2560 is used to regulate every aspect of the system's

development. The system is started when couriers send the parcel's providing the customer with a tracking number using programs to obtain the password. For security purpose, password is given as soon as the courier's message is the courier's message is the same as the the user-specified message. RFID technology utilization in logistics center's to enhance courier businesses' operations, [10] The creation of a cost-effective digital control method for a dynamic event in the logistics services sector determines how change is implemented and the best solutions are sought.RFID is an automatic system of identifier that could be used to locate facilities insido by means of waves of radio without interference that is used to scan the parcel and process the delivery further with proper security by using OTP. This system defines [11] defines all of the terms from 'Intelligent Parcel Receiving Box' to understand the meaning in this context of study. While "intelligence" refers to the capacity to learn, comprehend, and form reasonable judgments or ideas, "intelligent" people are able to pick things up quickly. 'Parcel' simply means the package. Hence, 'Intelligent Parcel Receiving Box' in this theme straightforwardly means the package that the postal worker will deliver to the recipient to the intelligent box situated at their house. Letter boxes are often utilized by the societies, mainly to post letters. Instead of functioning as a conventional mailbox, the box will function as a smart box. A smart mailbox system can send and obtain information by itself to users

I. METHODOLOGY

An IoT-based method was devised to facilitate secure parcel deliveries in the absence of homeowners. The system design incorporates a Raspberry Pi Model 4, ESP32 microcontroller, servo motor functioning as a lock, ultrasonic sensor, Web camera, keypad, and LCD display. These components are related through the Blynk IoT platform, allowing real-time monitoring and management. The locking mechanism was operated by a servo motor, while a Raspberry Pi camera was

utilized for surveillance. Users can use the Blynk app to display the OTP on an LCD and manage the system. Internet connectivity is essential to OTP generation and real-time monitoring. In Low cost Parcel Box designed [3] suggested a smart parcel box system that is inexpensive that will be positioned at individual homes with increased protection. They used Arduino Mega 2560 to manage every procedure in the developed system. Application of RFID technologies in logistics centre's to improving operations of courier firms, Beata, Skowron-Grabowska Czestochowa, Poland Tomasz Szczepanik, Czestochowa, [4] Creation of an economical digital control method for a dynamic occurring on the logistics services industry Assess the change's implementation and the pursuit of the best answers. contemporary logistics facilities that are adapted to the requirements, Contemporary technologies from courier services that prioritize delivery speed and service quality has helped address the stated need.

Hardware Setup and Component Integration

The system is built using utilizing a mix of embedded hardware devices:

- Raspberry Pi Model 4 serves as the primary processing unit, handling high-level operations including camera interfacing, network communication, and user interaction.
- ESP32 microcontroller is used to control lower-level functions like locking mechanisms and sensor data processing.
- Servo Motor acts as a smart locking unit, which which either opens or shuts the parcel box based on OTP validation and delivery confirmation.

- Ultrasonic Sensor is integrated to detect the presence of a parcel inside the box, enhancing security by validating package placement.
- Web Camera is interfaced with Raspberry Pi to provide live video streaming for surveillance purposes, giving the user real-time visual confirmation of deliveries.
- Keypad is provided for receiving the parcel after providing the generic password
- LCD Display is used to show the OTP to the delivery agent or display system status messages.

ARCHITECTURE
Block Diagram
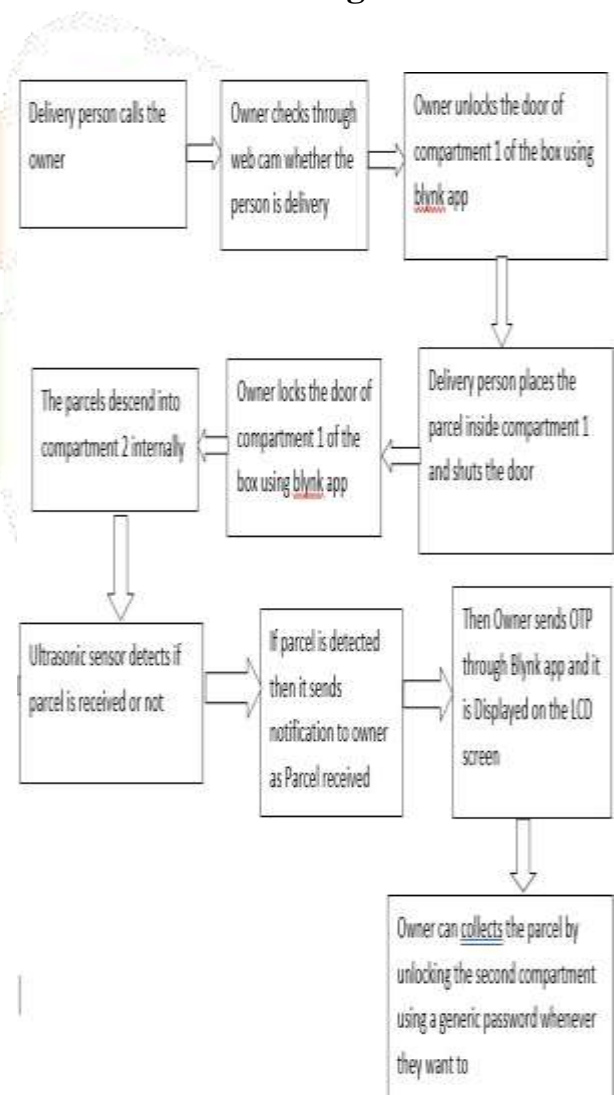
The architecture of the Parcel Guard system is structured around a hybrid framework that seamlessly integrates embedded systems with Internet of Things (IoT) technologies. This dual-layered architecture ensures both on-site security and remote accessibility, offering a reliable and scalable solution for modern parcel delivery challenges.

Fundamentally, the system is made up of the two functional domains: the embedded module and the IoT-based module. Each domain handles distinct responsibilities that together form a cohesive parcel management ecosystem.

Flowchart
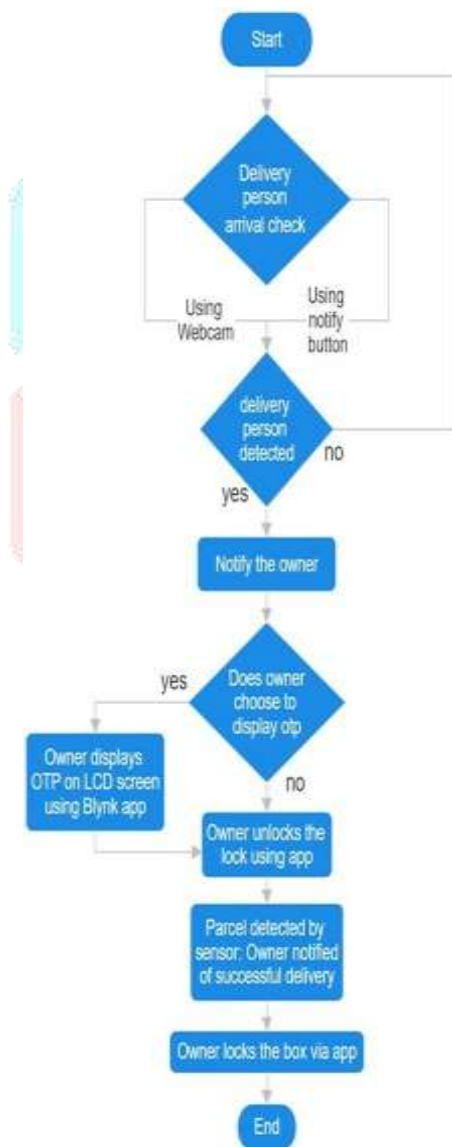
Step-by-Step Breakdown of the Process

1. Delivery Person Calls the Owner
The process begins when the delivery personnel arrives at the recipient's address. At this stage, they must initiate communication with the owner to notify them of the package arrival. This communication is crucial as it ensures that the make certain the recipient gets the delivery and is able to interact with the system remotely if required.

2. Owner Verifies the Delivery Person Using a Webcam
To maintain stringent security protocols, the system incorporates a webcam-based verification mechanism. The owner uses the webcam to confirm the prior to the delivery person's identity proceeding with further steps. This protect against unapproved users attempting to access the parcel storage unit. If the verification fails, the delivery process does not proceed.

3. Unlocking the First Compartment Using the Blynk App
Once the delivery person is successfully verified, the owner uses the Blynk application to remotely unlock Compartment 1. The Blynk app acts as the central control interface, allowing users to manage their parcel deliveries efficiently. This remote unlocking feature provides a seamless contactless interaction, reducing the need for direct physical involvement while ensuring security.

4. Placement of the Parcel in Compartment 1
After gaining access to Compartment 1, the delivery personnel places the package inside and securely closes the door. This compartment serves as the initial storage unit, ensuring that the package is deposited safely before proceeding to further security procedures.

5. Internal Transfer of Parcel to Compartment 2 to provide an additional degree of security access. ,The system is configured to operate automatically transfer the parcel from the first to the second compartment. This internal transfer mechanism ensures that the package is isolated from external access, thereby preventing tampering or

unauthorized removal before the owner retrieves it.

6. Parcel Detection Using an Ultrasonic Sensor

Once the package is internally transferred, the system activates ultrasonic sensors to confirm the successful placement of the parcel in Compartment 2. Ultrasonic sensors are highly effective in detecting objects within enclosed spaces, ensuring that the package reaches its final storage destination.

If the sensor fails to detect the parcel, the system flags an error, prompting corrective actions to be taken.

7. Notification Sent to the Owner

Upon successful detection of the parcel, the system automatically generates a real-time notification and sends it to the owner. This notification informs the recipient that the package has been securely stored, eliminating uncertainty regarding its status.

This This characteristic guarantees that the recipient is always updated on parcel movements, improving user convenience and transparency.

8. OTP Displayed on the LCD Screen

To restrict unauthorized access, the system utilizes One-Time Password (OTP) authentication. Following parcel confirmation, an OTP is displayed on the LCD screen, which is generated through the Blynk app.

9. Locking the First Compartment Using the Blynk App

After successfully transferring the package and displaying the OTP, the owner initiates the locking procedure for Compartment 1 using the Blynk app. This action ensures that the outer compartment remains inaccessible, further securing the package against external interference.

10. Owner Retrieves Parcel Using a Generic Password

When the owner is ready to collect the package, they unlock Compartment 2 using a generic password instead of the OTP. This system allows for controlled access, ensuring that retrieval is smooth and secure. The generic password feature allows the user flexibility in accessing their parcel while still maintaining security standards.

CONCLUSION

The Parcel Guard Smart Delivery Box project presents an efficient remedy to the challenges of secure parcel delivery in the growing e-commerce landscape. By utilizing IoT technology and real-time notifications, the

system allows for safe parcel deposits even when recipients are not at home. This innovation significantly reduces the risks of Delivery delays and theft, enhancing convenience for users.
Additionally, the project addresses operational inefficiencies faced by delivery services by ensuring that parcels can be securely stored at any time. The Smart Delivery Box not only improves the delivery process but also positions itself as a reliable and scalable solution for modern households, helping to create a more effective and safe e-commerce model.

II. SCOPE

Parcel Guard's future plans involve incorporating additional security measures such as facial recognition, tamper alerts, and live camera surveillance. To improve management, enhancements include AI-driven parcel identification, cloud-based storage, and predictive tracking. The system may also accommodate lockers with multiple compartments, temperature-regulated storage, and smooth integration with online shopping platforms. Utilizing solar energy, energy-saving components, and blockchain technology for secure delivery records can increase reliability and sustainability. These improvements aim to boost the security, efficiency, and user-friendliness of the smart-parcel delivery experience.

III. RESULT

The implementation of the Parcel Guard smart delivery box has led to several significant achievements. First, it has enhanced security for unattended deliveries by providing a locked compartment that minimizes the risk of parcel theft or tampering. Homeowners benefit from flexible and convenient access control, as they can monitor and manage the box remotely through the Blynk app, allowing real-time unlocking and locking from any location. Additionally, the system employs an efficient OTP-based access mechanism for parcel owner ensuring that only authorized person can access the delivery compartment.

Parcel Guard also supports secure parcel transfer between compartments, adding another layer of security and preventing unauthorized access. Homeowners receive real-time notifications of parcel deliveries, keeping them updated on delivery status without needing to be present. This feature, combined with remote control and OTP-based access, reduces the incidence of missed deliveries, eliminating the need for rescheduling and enhancing efficiency. Overall, the Parcel Guard system has improved the user experience by offering a convenient, safe, and dependable solution for handling unattended deliveries, giving homeowners comfort and knowledge and greater control over their deliveries.

Enhancement of Security for Unattended Deliveries

Security is the most crucial element of any delivery system, and Parcel Guard excels in this regard by implementing compartmentalized storage and controlled access mechanisms. Unlike conventional drop-off deliveries where packages are left exposed to external threats, this system ensures that parcels remain protected within a locked storage unit. The dual-compartment structure enables automated internal transfer, which prevents unauthorized access by separating the initial drop-off location from the final retrieval compartment. This mechanism effectively eliminates the risk of theft and ensures that packages cannot be accessed until verified by the rightful recipient

Functionality of remote control and Smart Home Integration

One of the principal benefits of Parcel Guard is its capability of remote control, which allows users to monitor and manage deliveries through the Blynk app. This feature ensures that homeowners can interact with their parcel storage system from any location, reducing dependency on manual access while providing flexibility in parcel management. Traditional delivery systems often require recipients to be in the flesh at the time of drop-off, increasing the likelihood of missed deliveries. Parcel Guard eliminates this limitation by enabling users to remotely unlock and secure their parcel box, ensuring that deliveries are successfully completed regardless of their availability.

Another distinctive aspect of Parcel Guard is its ability to transfer parcels between compartments, reinforcing security by ensuring that deliveries remain protected until retrieval. In conventional delivery systems, parcels are left in accessible areas, making them susceptible to unauthorized handling. Parcel Guard introduces an internal transfer mechanism, where packages are first deposited in Compartment 1 before being automatically moved to Compartment 2.
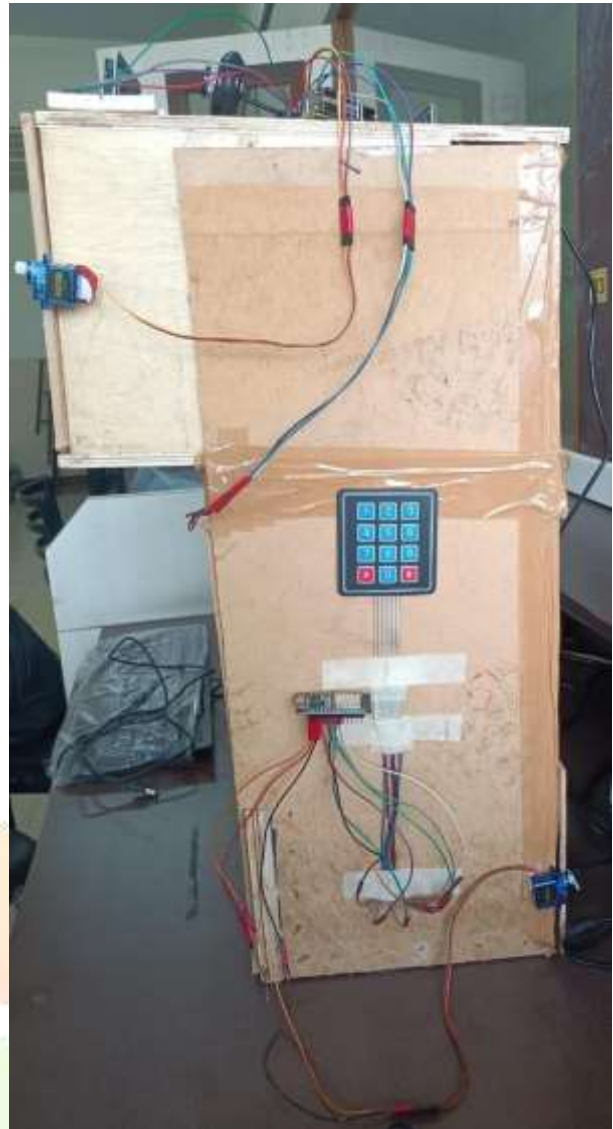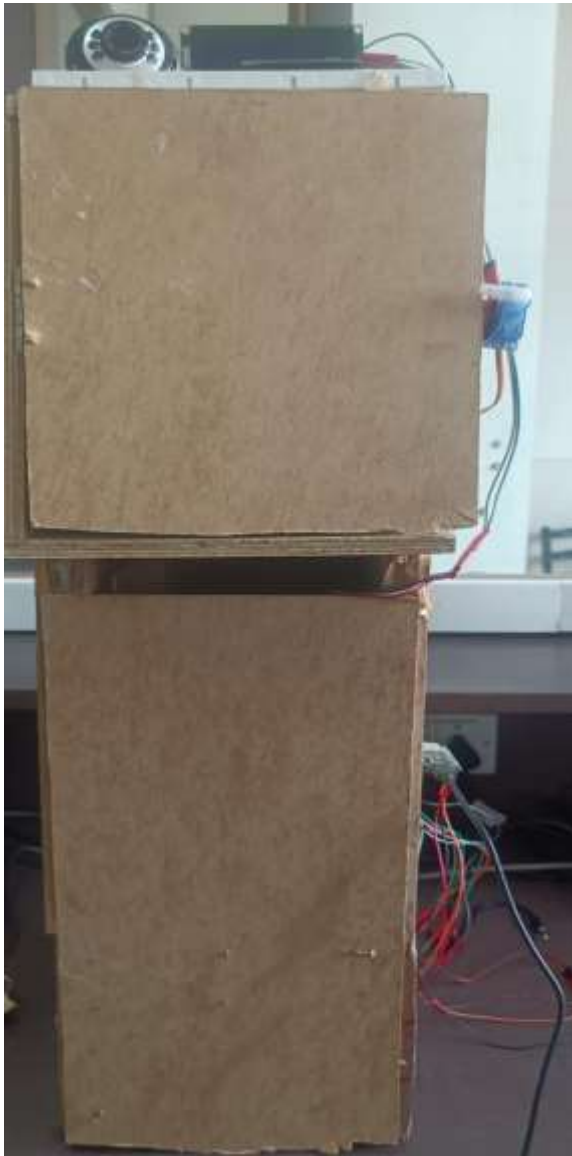
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