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Cloud-Controlled Parcel Storage Box with User Image Capturing

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Abstract: Nowadays, the pandemic COVID-19 has caused people mostly work from home and spend less time staying at the office to avoid close contact with other people. This causes difficulty in parcel delivery when there is no worker at the office. Thus, a cloud-controlled parcel storage box with user image capture is designed to overcome the problem. The box is implemented with the technology of a door lock system and motion alert system by using the microcontroller NodeMCU ESP8266, ESP32-CAM and the Blynk IoT platform. The box is allowed to be controlled by using the Blynk and the vision image will be taken when motion is detected. The time response for the solenoid door lock and magnetic door sensor is less than 1 second. The percentage to obtain a clear vision image is 70% and the average time taken for ESP32-CAM to send the image to telegram is 5.64 seconds. This project contributes to the parcel delivery system to easily pick up and drop off the parcel. In the future, it is recommended to implement a face recognition or face detection system to allow the door to open automatically.

Keywords: Door Lock System, Motion Alert System, Blynk, NodeMCU ESP8266

1. Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. This COVID-19 pandemic has hit the global at a colossal scale. According to World Health Organization (WHO), there have been more than 242 million confirmed cases in worldwide. When an infected person coughs, sneezes, speaks, sings, or breathes, the virus spreads in microscopic liquid particles from their mouth or nose

Pandemic COVID-19 had made the Internet of Things (IoT) more into our daily life in order to avoid the spread of COVID-19. Kevin Ashton initially coined the phrase "Internet of Things" (IoT) in

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a presentation regarding Procter & Gamble's implementation of radio-frequency identification (RFID) for supply chain management [1]. IoT is a cutting-edge technology that can connect all smart things in a network without requiring any human interactions [2]. The NodeMCU Development board is featured with Wi-Fi capability, analog pin, digital pins and serial communication protocols in order to build the IoT [3].

Due to the pandemic COVID-19, people mostly work from home and they spend less time staying at the office to avoid close contact with other people. This causes difficulty in parcel delivery when there is no worker at the office. Therefore, a cloud-controlled parcel storage box with user image capturing is designed for this project.

The main objective of the project is to design a cloud-controlled parcel storage box with user image capturing. The sub-objectives are to design and install the electronics and mechanical control of the cloud-controlled storage box. Besides, the mobile phone dashboard is developed and to assess and test the functionality of the cloud-controlled storage box. The expected outcome is the parcel storage box is allowed to be controlled by using the Blynk and the vision image will be taken when someone is open the door.

2. Materials and Methods

This section will present the methodology used to develop the cloud-controlled parcel storage box. The first subsection presents the materials that were used to develop the system. The second subsection presents the methods which can be described by using the block diagram, circuit diagram and flowchart of the developed system.

2.1 Materials

The materials that are required for the working of the proposed system are as follows:

i. NodeMCU ESP8266: NodeMCU can be programmed in Arduino IDE. It is simple and convenient to use as the programming to NodeMCU is similar to Arduino. It has firmware that operates on ESP8266 Wi-fi Soc from Espressif System [4]-[5].

ii. ESP32-CAM: The ESP32-CAM is a camera module that works with the ESP32-S chip. It has an OV2640 camera, many GPIOs for connecting peripherals, and a micro SD card slot. It has two power pins which are 3.3v and 5v but in the majority of situations, a 5v pin is used [6].

iii. Solenoid Door Lock: The solenoid door lock is a key that is moved by an electric current, either 12 VDC or 24 VAC, and it is regulated by a Door Access Control System [7].

iv. Single Channel 5V Relay: The relay module acts as a switch to turn the circuitry on and off. They are in charge of ensuring that each piece of equipment receives the proper voltage. When several circuits must be controlled by a single signal, this is advantageous [8].

v. PIR sensor module (HC-SR501): PIR stands for passive infrared, and these sensor modules are utilized to detect the presence or movement of any person within a 5 to 10-meter range [8].

vi. FTDI Programmer: Helps the ESP32-CAM in uploading the program [5].

vii. Blynk: Blynk has a wide range of widgets that work with most real-time applications, as well as superb data visualisation, many widgets, low latency, and app-based functionality, a modest one-time price for feeds, and remarkable average latency, update time, and throughput [9].

viii. Telegram: Telegram is one of the cloud-based messaging applications that work over the web.[8] Besides, the telegram has a high level of security and it can send and receive messages by using a Wi-Fi connection or mobile data allowance [10].

2.2 Methods

The block diagram of the cloud-controlled parcel storage box is shown in Figure 1. The microcontroller will act as the head of this system, thus NodeMCU ESP8266 is selected. Besides, the magnetic door sensor will generate a signal to the microcontroller NodeMCU ESP8266 if receive any input. The microcontroller NodeMCU ESP8266 will link to the Blynk application for cloud control via Wi-Fi. Any signal that sends from the Blynk will receive by the NodeMCU ESP8266 and processed. The output of NodeMCU ESP8266 will goes to the relay module and go to the solenoid door lock. The PIR motion sensor is connected to the ESP32-CAM for motion detection to take the vision image. The vision image will send and store in the cloud chat of the telegram.

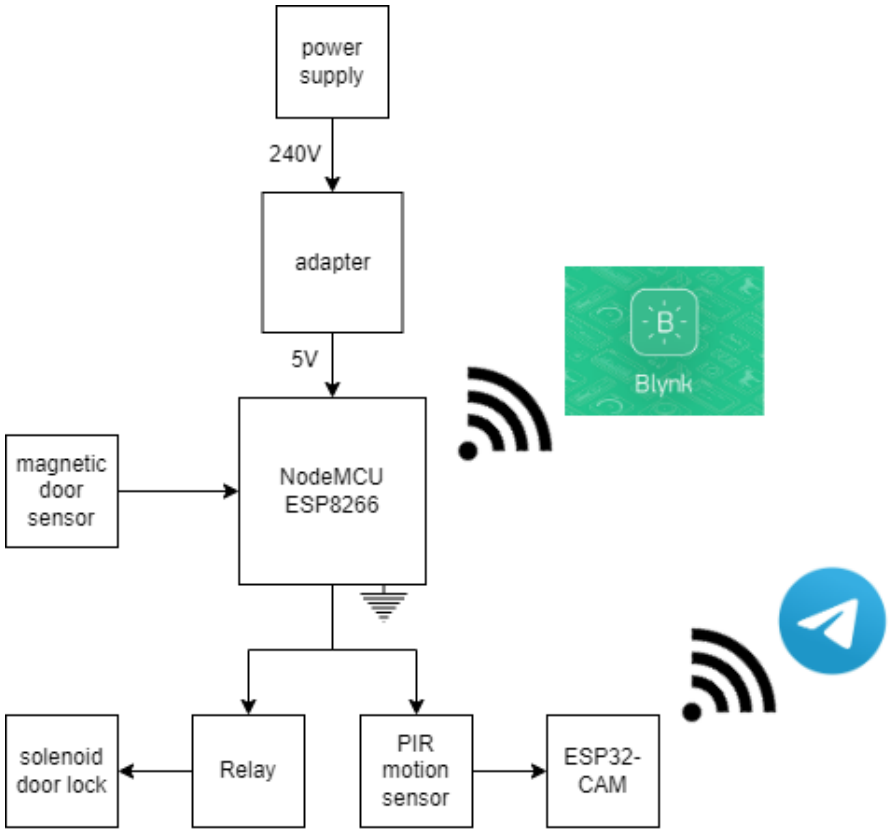

Figure 1: Block diagram of the system

The circuit diagram of the system is shown in Figure 2. The input pin of the relay module is connected to the D5 pin of the NodeMCU ESP8266 to receive the signal to turn on the relay module. The positive part of the solenoid door lock is connected to the common (COM) of the relay module whereas the negative part is connected to the 12V power supply. Besides, the door magnetic sensor is connected to the D8 pin of the NodeMCU ESP8266 and the 3V. For the connection between ESP32-CAM and PIR motion sensor, the output of the PIR motion sensor is connected to the GPIO13 of the ESP32-CAM.

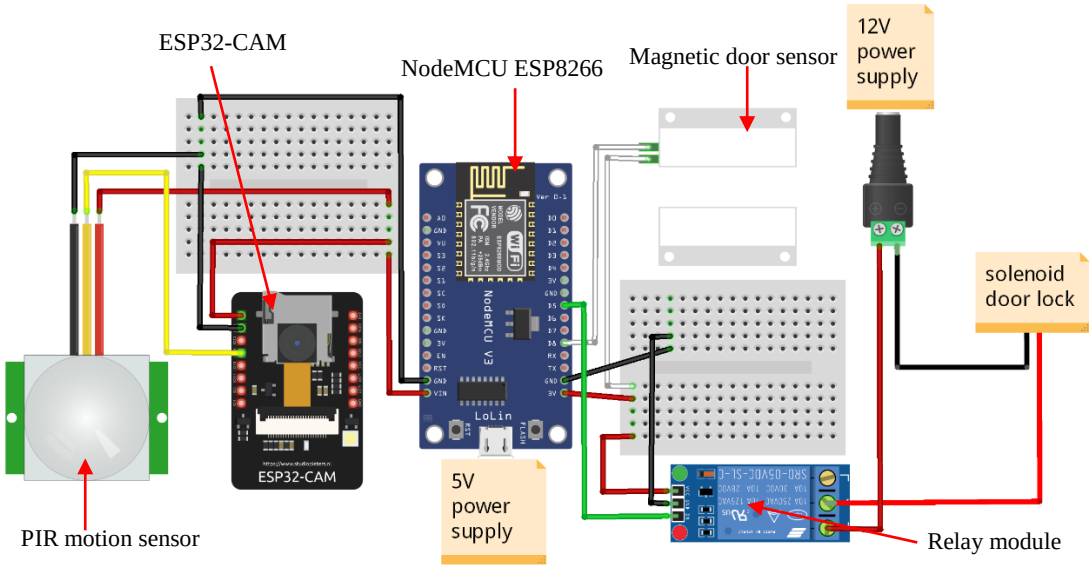

Figure 2: Circuit diagram of the system

The flowchart of the system flow is shown in Figure 3. Firstly, the system will detect if is it connected to Wi-Fi, and it will notify the owner if it is not connected. Next, the system will check whether receive the signal from Blynk for opening the door or opening the image. If the open door command is given, the door will be opened and the vision image will be taken if any motion is detected and sent and stored in telegram. If the open image command is given, it will directly open the telegram to view the image that had been saved.

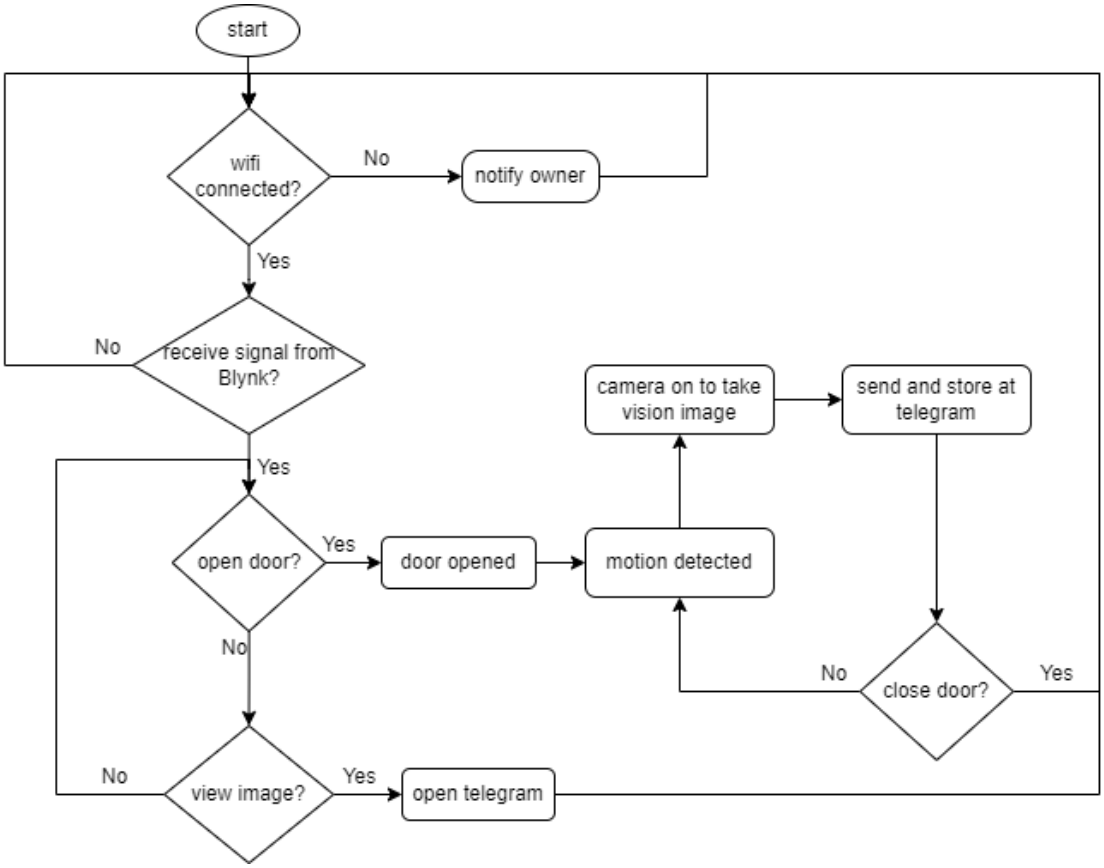

Figure 3: Flowchart of the system

3. Results and Discussion

The results that have been obtained are discussed in this section. The door lock system and the motion alert system that is implemented on the storage box are discussed.

3.1 Door lock system

The door lock system had been successfully developed by the combination of solenoid door lock, relay module, NodeMCU ESP8266 and magnetic door sensor as shown in Figure 4. Besides, the Blynk is successful to control to lock and unlocking the door and receiving the signal from the magnetic door sensor to show that the door situation currently is open or close. The result for the different situation for the door lock is shown in this section.

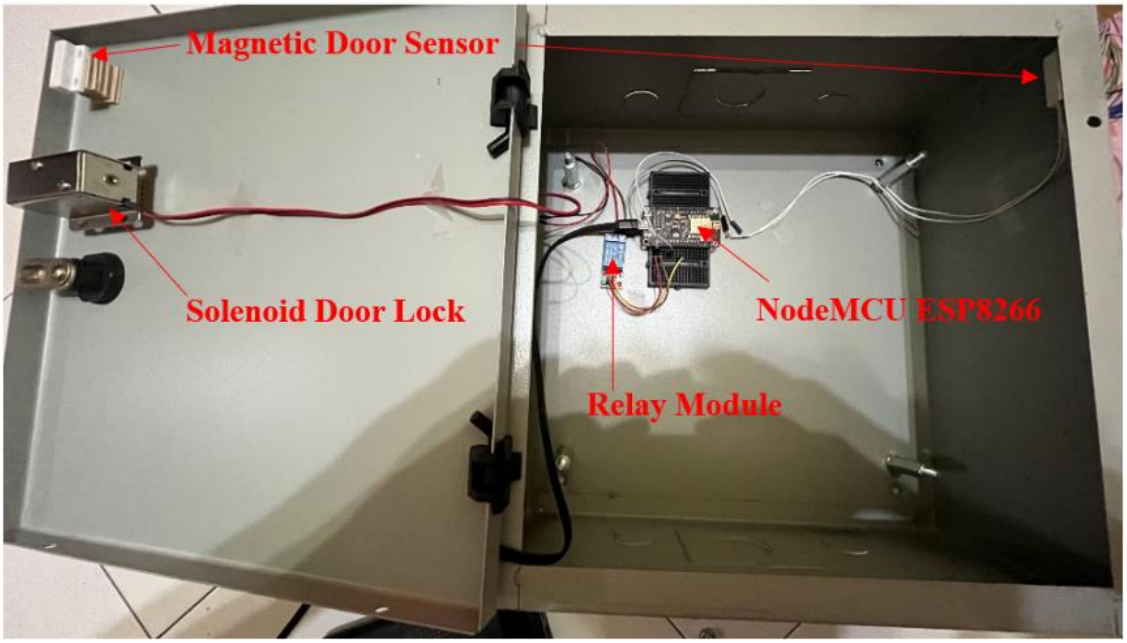

Figure 4: Interface of the door lock system

The first situation is when the door is locked, the interface of the Blynk for web and the mobile dashboard had shown that the solenoid door lock is locked and the magnetic door sensor is still stuck together to show the door currently is in shut position in Figure 5 and Figure 6.

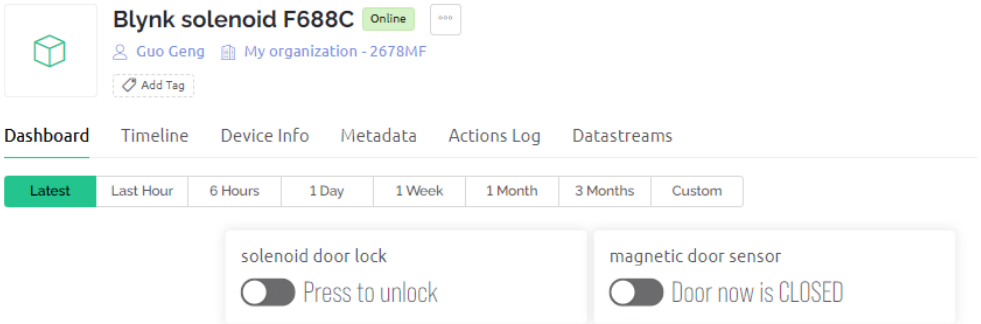

Figure 5: Interface of Blynk when door is locked at web dashboard

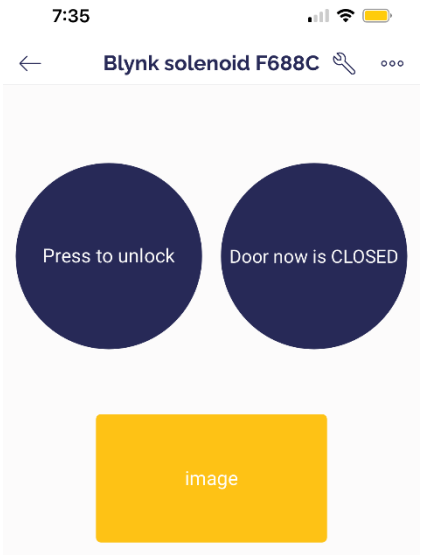

Figure 6: Interface of Blynk when door is locked at mobile dashboard

The second situation is when the door is unlocked but the door is still in the shut position. The interface of the Blynk for web and the mobile dashboard had shown that the solenoid door lock is unlocked but the door sensor is still stuck together to show the door currently is in the shut position in Figure 7 and Figure 8.

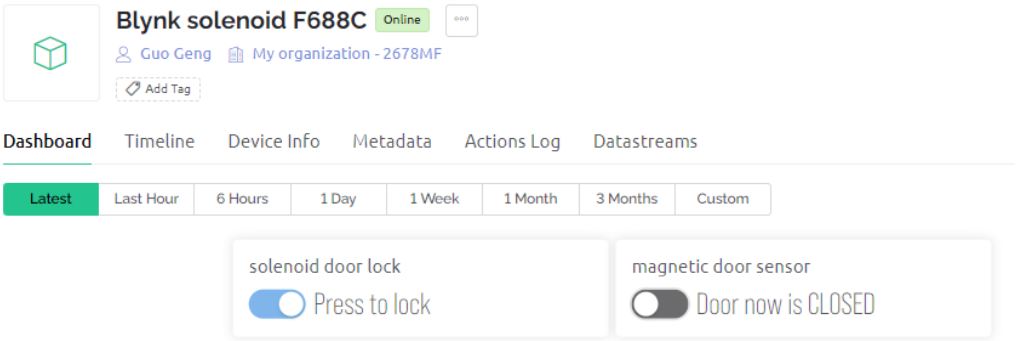

Figure 7: Interface of Blynk when door is unlocked but door still in shut position at web dashboard

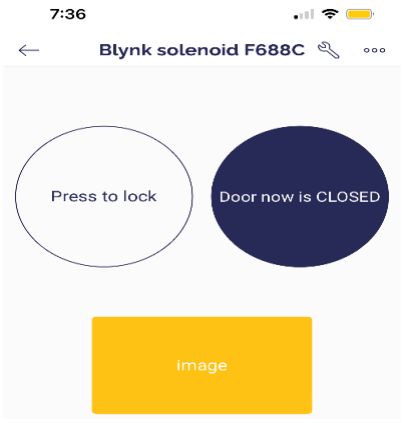

Figure 8: Interface of Blynk when the door is unlocked but the door still in shut position at the mobile dashboard

The third situation is when door is fully opened, the interface of the Blynk for web and the mobile dashboard had shown that the solenoid door lock is unlocked and the magnetic door sensor is separated to show the door currently fully opened in Figure 9 and Figure 10.

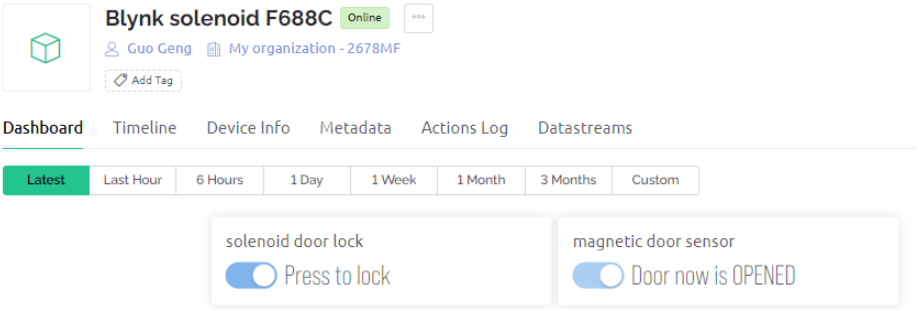

Figure 9: Interface of Blynk when door is fully opened at web dashboard

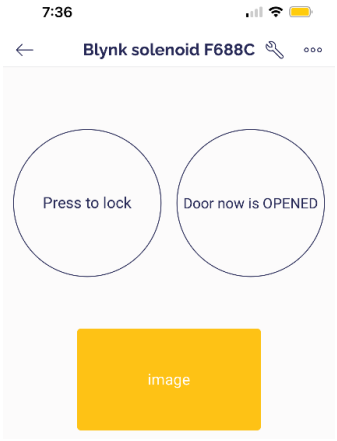

Figure 10: Interface of Blynk when door is fully opened at mobile dashboard

The result of the time response for solenoid door locks and the magnetic door locks is shown in Table 1 and Table 2. The time response indicates the length of time taken for the system to give a response. From the results, it can be analysed that the time response for the solenoid door lock and magnetic door sensor is less than 1 second. This shows that it is almost synchronised and no delay in the system.

Table 1: Time response for the solenoid door lock

No.	Action	Time response, s
1.	Lock the door	Less than 1s
2.	Unlock the door	Less than 1s
3.	Lock the door	Less than 1s
4.	Unlock the door	Less than 1s
5.	Lock the door	Less than 1s

Table 2: Time response for magnetic door sensor

No.	Action	Time response, s
1.	Close the door	Less than 1s
2.	Open the door	Less than 1s
3.	Close the door	Less than 1s
4.	Open the door	Less than 1s
5.	Close the door	Less than 1s

3.2 Motion alert system

The motion alert system is implemented in this parcel storage box as shown in Figure 11. For the motion alert system, when there is any motion detected by the PIR motion sensor, the ESP32-CAM will take the vision image and send to the cloud chat of the telegram.

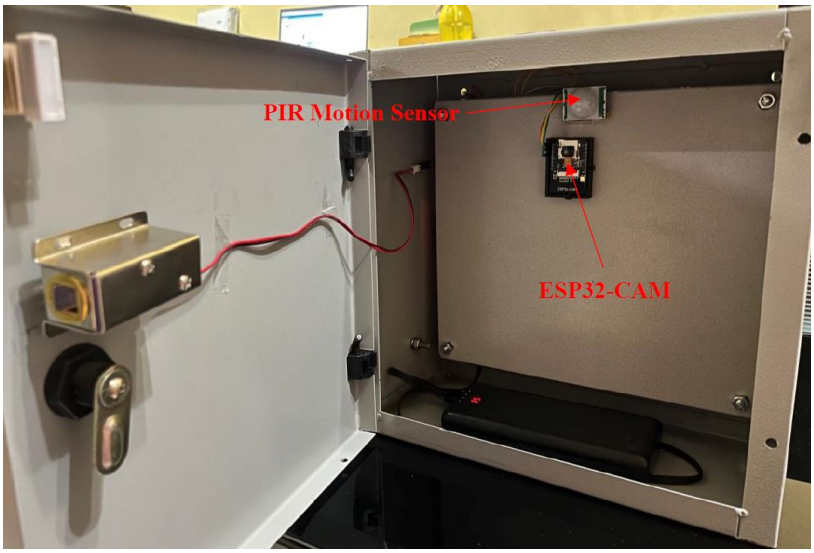

Figure 11: Interface of the motion alert system

The result of total percentage to obtains the clear vision image is shown in Table 3. The total percentage of clear vision images obtained is 70% by calculating the sum of clear vision images over the total images taken. It can be analysed that an average of 2 vision images can be taken for 10 seconds. Besides, there are 30% to obtain a not clear vision image such as totally in black or cannot focus. This is because when the solenoid door lock is unlocked, there have a chance to trigger the PIR motion sensor and trigger the ESP32-CAM to capture the image before the door is fully opened. In addition, the vision image might be in total black because when closing the door, it will trigger the PIR motion sensor and the ESP32-CAM will capture the image after the door is closed.

Table 3: Total percentage to obtain the clear vision image

No.	Number of clear vision image	Number of not clear vision image	Total percentage of clear vision image
1.	2	0	70%
2.	1	1	
3.	1	1	
4.	2	0	
5.	1	1	
Total:	7	3	

The result of time taken for ESP32-CAM to send the image to telegram is shown in Table 4. It can be analysed that the average time taken for ESP32-CAM to send the image to telegram is 5.64 seconds. The time taken to send an image varies due to unforeseen situations such as Wi-Fi stability. If the Wi-Fi is not stable or less signal, the time taken for ESP32-CAM to send the image to the telegram will become longer.

Table 4: Time taken for ESP32-CAM to send the image to telegram

No.	Time taken for the ESP32-CAM to send the image to telegram, s
1.	6.2s
2.	5.6s
3.	5.8s
4.	5.8s
5.	4.8s

4. Conclusion

In conclusion, the cloud-controlled parcel storage box with user image capturing is well-designed. The technology implemented in this project which is the door lock system and motion alert system is successfully developed. The door lock system can be controlled by using the Blynk to lock or unlock the door. The time response for the solenoid door lock and magnetic door sensor is less than 1-second shows that it is almost synchronised at the same time. For the motion alert system, the vision image is taken when the motion is detected. The percentage to obtain the clear vision image is 70% and the average time taken for ESP32-CAM to send the image to telegram is 5.64 seconds. However, there is an obvious limitation of this system, which cannot open the door automatically by detecting the face. Thus, in the future, it is recommended to implement a face recognition or face detection system to allow the door to open automatically.

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