A Remote Control Delivery Vehicle

It Based on the Background of the Post–epidemic Era, Helping to Block the Transmission of Virus in People.

Word count : 4547

Introduction

In the wake of the overwhelming impact of COVID -19, which has confirmed over 769 million cases and nearly 7 million fatalities worldwide by August 2023(WHO), societal norms and practices have undergone profound shifts. One critical change is that governments have taken various restricting measures including stay at home orders. Due to the possible infection risk when leaving the home or the fact that several thousand people are quarantined at home, the demand for home delivery of groceries increased heavily since the end of February 2020. (S. Kapser,2021). But this convenience has not been without its risks, the latent danger of human-to-human transmission during the final hand-off of deliveries persists. Here's my proposed solution to this: an automated delivery vehicle (ADV), meticulously designed using 3D modeling and enhanced with cutting -edge electronics. With features like remote unlocking and Wi-Fi controls, this vehicle is not merely an innovation but a necessity in our current reality. As S. Kapser suggests, the benefits of ADVs are manifold; they operate without direct human intervention, significantly reducing the risk of viral spread. The focus of this research is the development of an automated delivery vehicle (ADV), a model car, conceptualized using 3D modeling and printing. Outfitted with a remote control unlock system and Wi-Fi remote controls, realized through intricate programming and advanced electronic components, this vehicle represents the vanguard of safe and efficient delivery systems. Together, we shall explore a future where safety and efficiency in deliveries are paramount.

Literature Review

In the wake of global health crises, the quest for contactless solutions has been a recurring theme in recent literature. The seismic upheaval caused by the COVID -19 pandemic, with over 769 million cases worldwide by August 2023 (WHO, 2023), has sent ripples through various sectors. Many establishments faced closures, while others, like supermarkets or restaurants, grappled with skyrocketing demand for home deliveries. This surge in demand underscored the conundrum: the ever-present risk of human -to -human infection during final delivery (S. Kapser,2021).

Since the pressure has amplified to develop mechanisms that can ensure safety and reduce person -to -person transmission , the importance of autonomous delivery vehicles (ADVs) emerges. Viewed from a logistician's lens, these vehicles, devoid of human intervention during drop -off, metamorphose the delivery dynamics. S. Kapser suggests,the advantages of ADVs are significant :they could operate by remote control system which significantly reducing the risk of viral spread.

Meanwhile, the risk of such viral transmission is also widespread in the medical field.

Building upon this narrative is the brainchild of S. G. Dastidar et al. (2022) - the Remotely Operated Vehicle (ROV). Tailored for hazardous environs, this semi-autonomous creation, complete with webcam and sensors, bridges the gap between safety and efficiency. Trials within infectious disease wards manifest its proficiency in executing deliveries, remotely maneuvered by healthcare personnel (S. G. Dastidar et al., 2022).

Commercial ventures, NURO and STARSHIP TECHNOLOGY, have also steered their prowess in this direction. Starship's robots, a harbinger of autonomous delivery services, have been embedded within campuses, revolutionizing the delivery landscape by offering on-demand services through an app (Starship Technology, 2018). NURO, on the other hand, flaunts its custom-built vehicles tailored for neighborhood deliveries. Their design paradigm prioritizes safety, with features such as 360° and thermal cameras, lidar, radar, and a redundant collision prevention system (NURO,2023).



Fig 1. Image showing the newest -generation autonomous vehicle from NURO

In conclusion, the post-epidemic world the focus has shifted towards minimizing human contact which offers a unique opportunity for ADVs. The burgeoning literature on ADVs reflects this paradigm shift, underscoring the role of technology in navigating this new normal. Through advancements in remote-controlled vehicles and the contributions of pioneering companies, the narrative towards a safer, contactless delivery future is being carved.

Methodology

1.Secondary Research

In this part, my aim is to explore and synthesize existing literature regarding the potential of autonomous delivery vehicles (ADVs) in reducing human contact, especially in the context of the post-epidemic era.

I use scholarly databases such as Google Scholar, PubMed, ScienceDirect, and IEEE Xplore to gather peer-reviewed articles and journals. I also use some investigated reports from WHO as my data support.

Here is some of my search strategy:

- Key words: Used search terms including "autonomous delivery vehicles", "remote control

vehicles", "virus transmission", "pandemic delivery solutions", etc.

- Timeframe: Focused on literature published from 2019 to 2023 to capture recent advancements and discussions related to the COVID -19 pandemic.

2. Experiment: Model Making

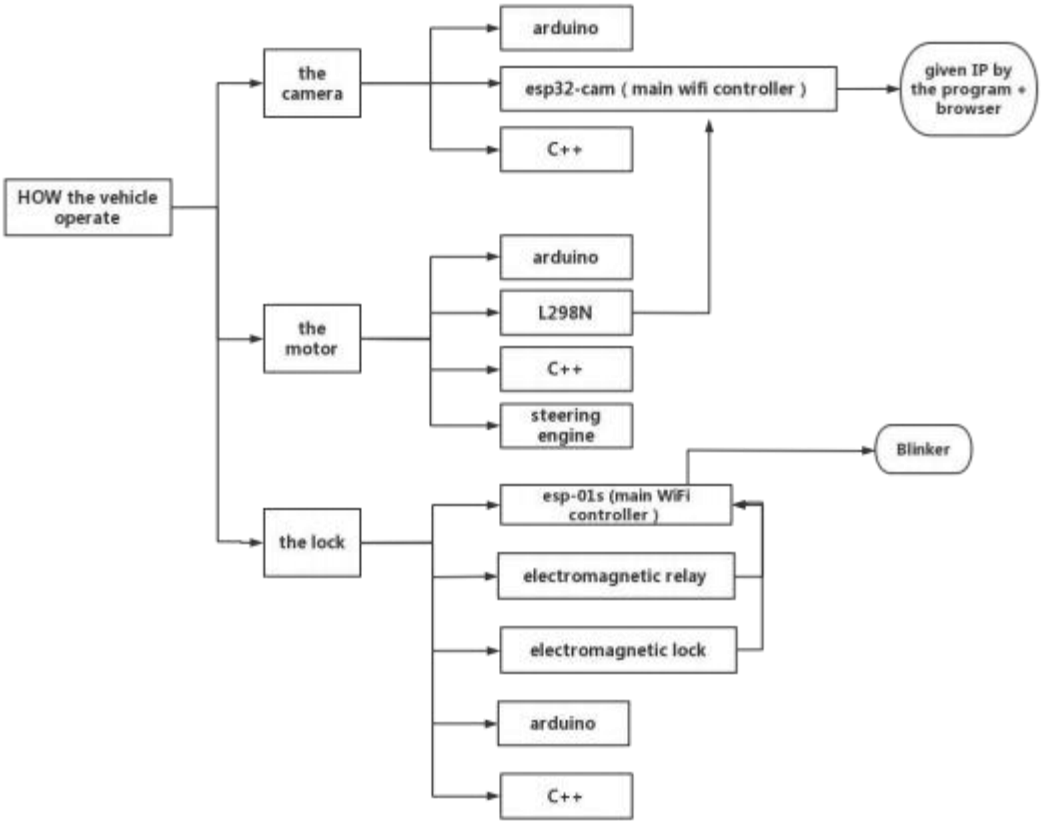


Fig 2. A mind map of the technical aspects of the car

- Using electronic components to achieve the remote control vehicle and the camera function.



Fig 3. The electronic components I have used in the vehicle system.

(From left to right, ESP burn -in block, ESP32 -CAM module, L298N motor driver board module.)

In completing the camera function part of the cart, I decided to use the esp32 development board and the OV2640 camera in the Arduino platform, combined with the programming in the Arduino, to transmit the video data to the specified IP address via WIFI I use the esp32 as the development board, connect the L298N to it, control the L298N through programming, and then further send commands through WIFI to control the four motors of the trolley to control the rotation and direction of the wheels of the trolley, and complete the commands of the trolley movement.

- Using electronic components to achieve the remote unlock function.

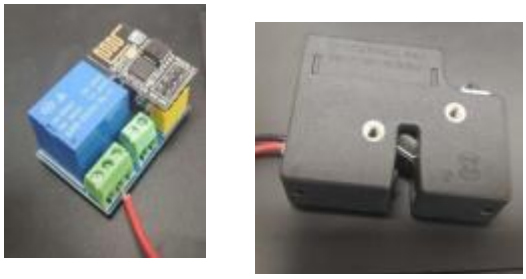


Fig 4. The electronic components I have used in the lock system.
(From left to right, esp01s WIFI module & relay combination, electromagnetic locks.)

I connected the relay to the solenoid lock and when energized the solenoid lock will pop the latch to unlock the door.

- The 3D model of the vehicle's basic

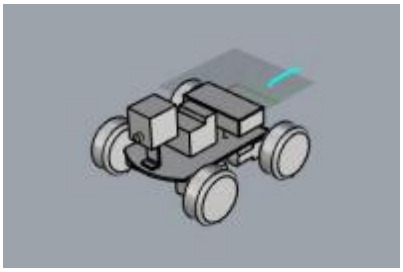


Fig 5. The screenshot of the finished vehicle modeling

I used fusion360 to model the chassis of my car, which I will use for subsequent shell modeling to determine and adjust the dimensions.

- The 3D model of the locker

I started with a preliminary drawing, and then based on my vehicle bottom modeling I re - planned and adjusted the way the cart opens and closes with specific dimensional data. The entire modeling of the vehicle shell was done in Rhino 7 modeling software.

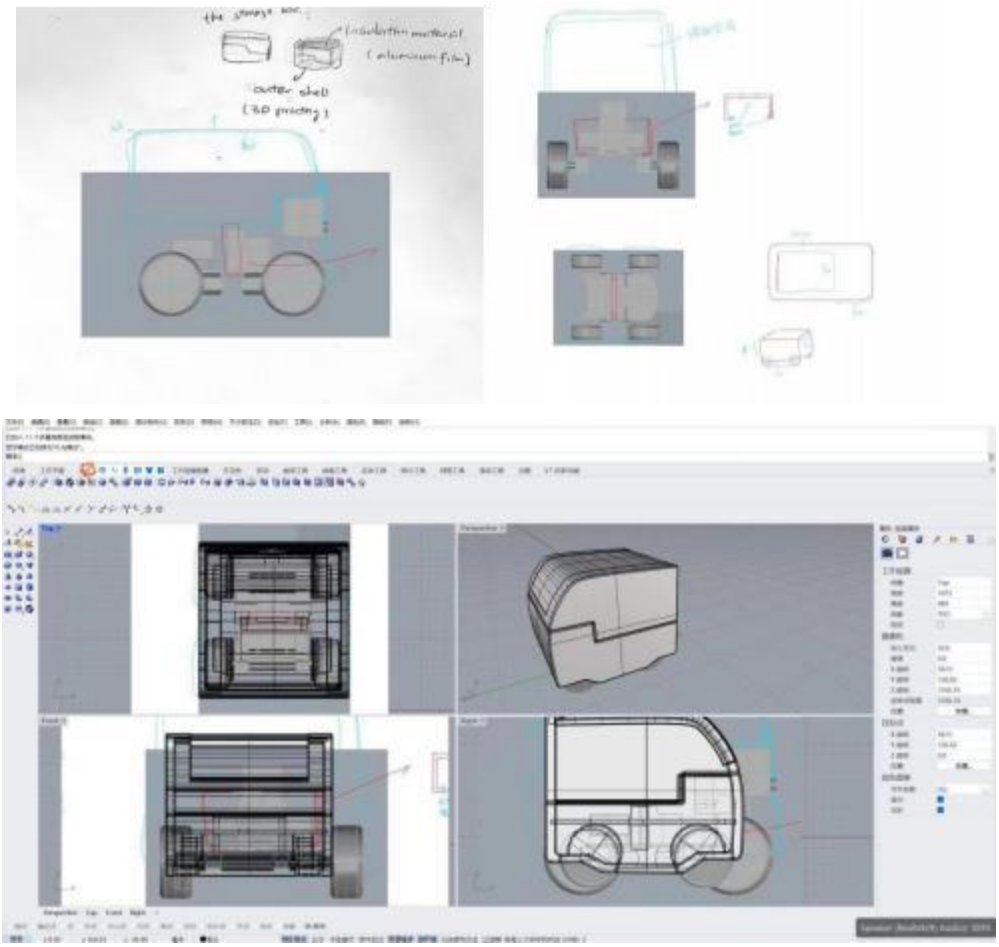


Fig 6. Screenshots of the design drawings (two above) and the actual modeling (one below)

Afterwards, the modeling design was put into practice through 3 d printing technology. The whole printing process took one and a half weeks and two versions of the model were printed.



Fig 7. Screenshot of the first modeling and photos of the 3d printed object

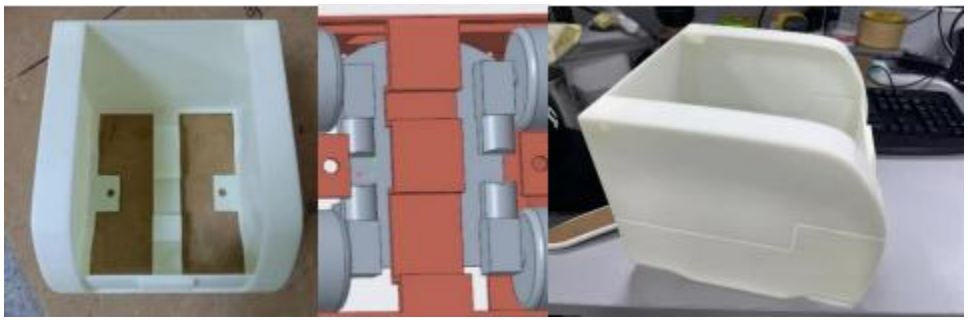


Fig 8. Screenshot of the first modeling and photos of the 3d printed object

Because of the errors in the measurement of the data of the cart and the poor consideration of the modeling design, the first modeling could not be successfully mounted on the cart after printing. So I started my second attempt, I re-measured the data, improved the design of the cart, left enough space for the tyres and various parts, and after two days of intensive modeling and adjustments I sent it to a local 3d printing studio for printing, during which time I also started to prepare for the cardboard version of the casing, as I wasn't sure if the studio would be able to successfully complete the task of modeling and printing the cart within the timeframe.

- The program to control the vehicle and the car function & the program to control the remote control unlock

This code is written in C++ and is designed for the ESP32 platform, specifically for controlling a surveillance car equipped with a camera. The code is written in C++ for the ESP32 platform, a popular microcontroller with built-in Wi-Fi.

```
#include "esp_camera.h"
#include <WiFi.h>

//
// WARNING!!! Make sure that you have either selected ESP32 Wrover Module,
//            or another board which has PSRAM enabled
//
// Adafruit ESP32 Feather

// Select camera model
//#define CAMERA_MODEL_WROVER_KIT
//#define CAMERA_MODEL_M5STACK_PSRAM
#define CAMERA_MODEL_AI_THINKER
```

```
#if defined(CAMERA_MODEL_WROVER_KIT)
#define PWDN_GPIO_NUM    -1
#define RESET_GPIO_NUM   -1
#define XCLK_GPIO_NUM    21-
```

Fig 9. Screenshot of part of the code

There are two libraries I have included in these code:
-"esp_camera.h": provides functions and definitions for using the camera on the ESP32; -"WiFi.h": enables Wi-Fi functionality on the ESP32.

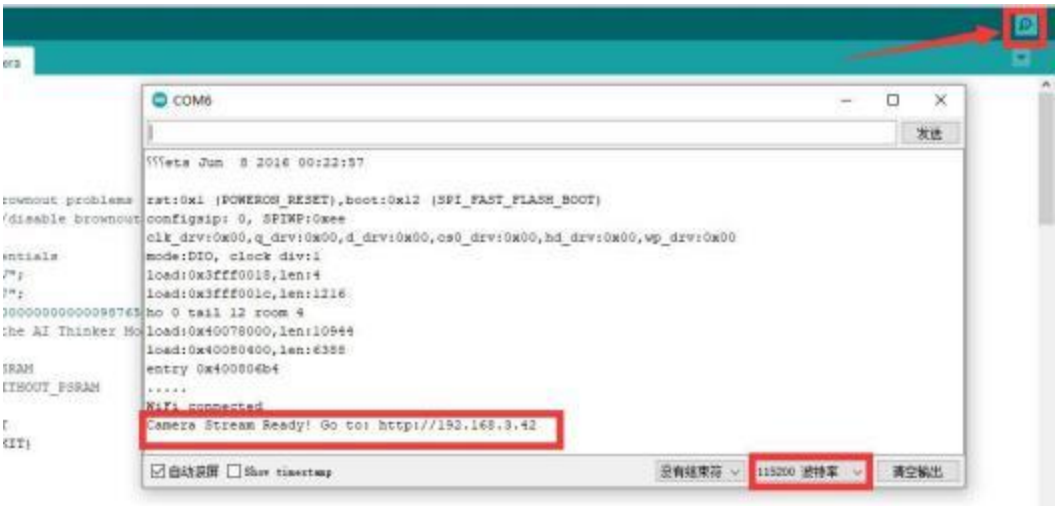


Fig 10. Screenshot of serial port monitor

Once the code is successfully uploaded, open the serial port monitor in the top right corner of ESP32 -CAM and select a baud rate of 115200. Press the reset button on the ESP32 -CAM circuit board. When ESP32 -CAM successfully connects to WiFi, you will see the http address.Everyone has the different address. (Here it is "192.168.3.42")



Fig 11. Screenshot of the browser

Open your browser and enter “192.168.3.42” (use your own IP address if it's different), which will appear in your serial port monitor. Then, the video will load, as shown in Fig 11.)



```
#define BUTTON_1 "btn-abc"

int GPIO1=0;//定义GPIO口用于控制继电器

BlinkerButton Button1(BUTTON_1);

void button1_callback(const String & state)
{
    digitalWrite(LED_BUILTIN, !digitalRead(LED_BUILTIN));
    digitalWrite(GPIO1,  !digitalRead(GPIO1));

}

void dataRead(const String & data)
{
    BLINKER_LOG("Blinker readString: ", data);

}

void setup()
{
    Serial.begin(115200);
```

Fig 12. Screenshot of part of the code and the app developed by Blinker.

This code is written in C++ and is designed for microcontrollers to interface with the Blinker platform. (Blinker is a platform that provides visual programming and IoT solution development capabilities.) There is one library included :`Blinker.h`: This is the main library for interfacing with the Blinker platform.

Other explanation:

- `auth`: This is the authentication token for the device on the Blinker platform.
- `ssid` and `pswd`: These are the Wi-Fi credentials for connecting the device to the internet.

Here are the functionality of this code:

- The code sets up a device to interface with the Blinker platform.
- Once powered on and the code is running, the device will connect to the specified Wi- Fi network.
- The device will then connect to the Blinker platform using the provided authentication token.
- When the button on the Blinker platform is pressed, the built -in LED and the device connected to GPIO1 will toggle their states.
- Any data received from the Blinker platform will be logged for debugging purposes.

3. Other judgements

In order to get more objective and convincible results , I designed a judgment table for 3 main function of the vehicle, involving Movement, Camera and Lock. Each element is graded from 0 to 1. I took 4 tests to fill the judgement table one by one.

Results & Discussion

1. Models



Fig 13. Simulation of this remote control vehicle at work in the real world (made via Keyshot11)

In my final result, my vehicle has been able to perform wifi remote control through the in-built program and real-time transmission of video images to the control terminal, with the capability of stable operation and video transmission in wifi range. In terms of the remote unlocking function, I wrote a more complete set of procedures based on the blinker platform, theoretically, after the relay is connected to the appropriate voltage, the remote switch lock function can be easily implemented on the mobile blinker application.

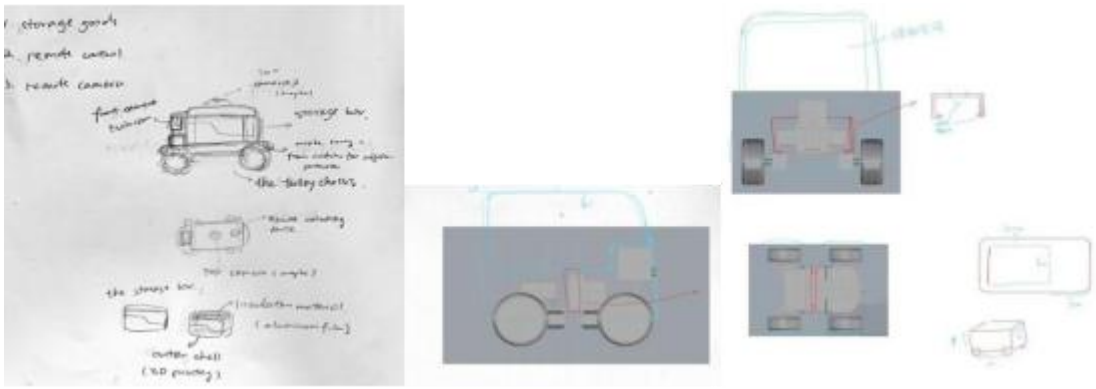


Fig 14. The first draft(1 in left hand side) and the sketches before modeling(2 in right hand side)

My first draft of the design and subsequent sketches before modeling show the turnover of my design, based on the dimensions of my cart's chassis I have made cosmetic adjustments to give the cart more storage space.

Below is a picture of the adjustments I made when modeling the cart, as the first 3d print out of the object did not fit my cart perfectly, so I modified these parts.

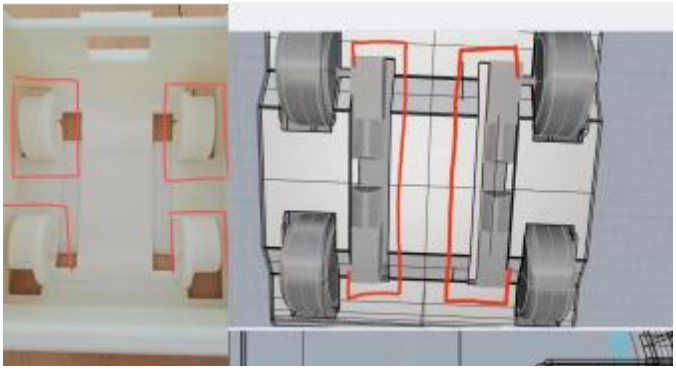


Fig 15. The changes in the modeling

In the end my cart fitted its shell perfectly, I also purchased some translucent blackout material to cover the cart's transparent hood, this design allows items placed in the storage space to be seen but not have light affecting them in their own right, below is the final physical image of the cart.

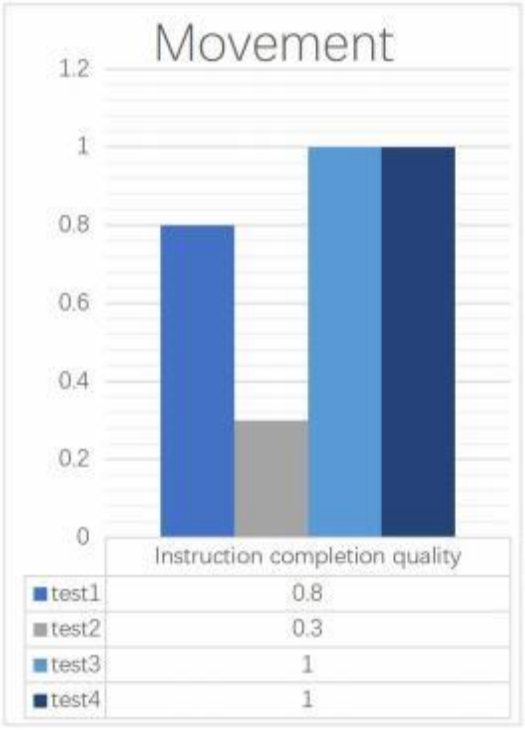


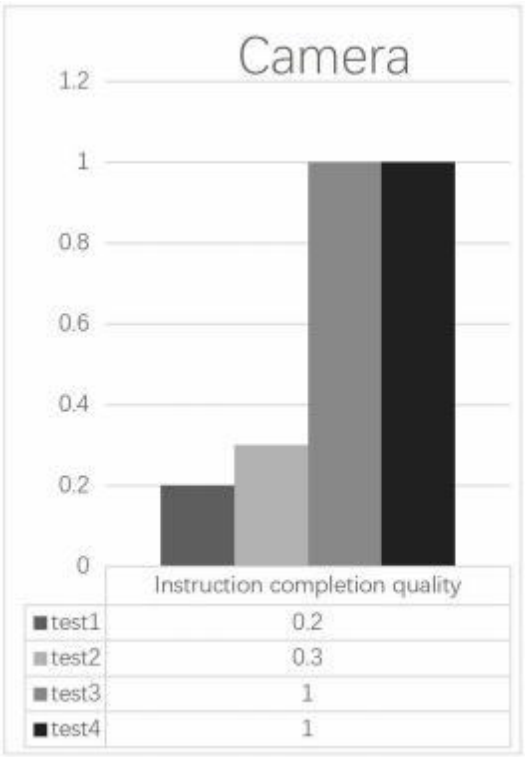
Fig 16. The final product

2. Judgement Tables

In total, I collect 4 groups of data for each function. For Movement and Camera , after the first two constant adjustments, both experiments eventually converged to be stable and smooth. The video transmission speed of the camera is still very limited, in addition to the indoor internet speed, after starting to run for a while, the camera is likely to lag due to the scenery changing too quickly, unless the cart temporarily stops running for a while, waiting for the image to update.

In the part of the remote unlocking function, I tested the operation in many ways, unfortunately due to the blinker software network connection is not stable and there are still some problems with the programming, ultimately it is not possible to complete the remote control unlocking commands when the console is more than 7 meters away from the Wi-Fi relay.







The more detail version of the judgement tables could be seen in Appendix 1 、 Appendix 2 and Appendix 3.

Movement: 0.2 marks for good completion in the forward direction, 0.2 marks for good completion in the backward direction, 0.2 marks for good completion in the left direction, 0.2 marks for good completion in the right direction, and 0.2 marks for a reaction time of less than or equal to 1 second.

Camera:(Delay time obtained from data monitor) 1 point for transmission time difference less than 0.2 seconds, 0.8 points for 0.5 seconds, 0.5 points for 1 second, 0.3 points for less than 3 seconds, 0.2 points for more than or equal to 3 seconds.

Lock:Successful wifi connection 0.2, successful relay control 0.2, smooth latch ejection 0.4, delay time less than or equal to 1 second 0.2

Deduction of 0.1 -0.2 for deviation in completion (according to the actual situation)

Conclusion & Evaluation

In short, in a world recovering from a health crisis, the focus has shifted to reducing direct human interaction, paving the way for self-driving cars. The growing discussion on unmanned delivery service reflects this change in perspective and highlights the critical role that remote control technology will play in adapting to this unprecedented era. With the development of remotely controlled vehicles and the pace of innovation by leading companies, we are moving towards an era of safer, contact-free delivery.

1.Evaluate its impact on virus transmission

The main goal of this remotely controlled delivery van is to reduce virus transmission by reducing human contact. In order to assess its success, we must consider a number of key issues:

Testing and data: Has this vehicle been rigorously tested to measure its effectiveness in reducing virus transmission? Whilst the project has made significant progress, there is a need to ensure that thorough testing has been carried out in real-world environments to gather empirical data. So far, the trolley has been tested four times, initially demonstrating the viability of its video transport system and remote control system during operation. All four experiments were conducted indoors, and in order to simulate a hospital-like scenario, the experimental environment had wifi coverage and people walking around (to test the adequacy of the video-transport remote-control avoidance capability). Of course, for such a project, four experiments are still not enough, I still need to continue to update the code and find a real hospital site to make the test of the car more realistic.

Testing under medical conditions: In order to establish a clear correlation between vehicle use and reduced transmission, further testing under controlled medical conditions may be required. This controlled environment could provide definitive data to support the potential impact of the vehicle in reducing transmission rates.I have designed a simulation to demonstrate that remote controlled transport carts can reduce virus transmission by reducing human contact. (Perhaps still to be refined, this is just a preliminary idea)

Experiment name: Experiment to simulate the effect of a remote transport trolley on virus transmission

Purpose of the experiment: To assess whether remote-controlled transport trolleys are effective in reducing simulated virus transmission by reducing contact between infected and normal people.

Experimental equipment and materials:

1. remote-controlled transport trolley equipped with video transmission and transport function.

2. source of infection representative: use of stains or markers to represent potential sources of infection.

3. normal person representative: simulates a normal person.

4. indoor simulation scenes, including corridors, rooms, etc.

Experimental steps:

1. place an infection source representative (stain or marker) in the experimental scenario.

2. allow the normal human representative to simulate movement and contact under normal conditions without the intervention of a remote-controlled trolley.

3. record the contact between the infectious agent representative and the normal human representative, and any potential transmission.

4. introduce remote-controlled trolleys and use them for transport and delivery tasks to minimise direct contact between the infected source representative and the normal human representative.

5. record the contact between the infected source representative and the normal human representative after the use of the remote-controlled trolley, as well as any potential transmission, in comparison with step 2.

6. analyse the data and compare the differences between the two scenarios.

Results of the experiment:

(Hypothesis) Based on the experimental data, we can conclude that the use of the remote-controlled transport trolley was effective in reducing the contact between the infected source and the normal people under the simulated conditions, thus reducing the potential transmission of the virus.

(Please note that this experiment is a simulation to demonstrate the potential impact of the remote transport trolley and not a real virus transmission experiment. It is important to ensure that ethical standards and laws and regulations are met and that appropriate safety measures are taken before conducting any experiments to ensure the safety and feasibility of the experiment.)

2. Limitation

The video transmission speed of the camera is still very limited, in addition to the indoor internet speed, after starting to run for a while, the camera is likely to lag due to the scenery changing too quickly, unless the cart temporarily stops running for a while, waiting for the image to update.

In the remote control of the lock function, due to the instability of the blinker platform network connection and the code still has unresolved issues, and in the limited time available, I could not fully resolve this issue, so there is still the problem that the unlocking operation cannot be completed coherently after receiving the command. However, for the time being, I have completed the wiring problem to the electromagnetic lock and relay, and the code part will continue to be completed in the near future due to the uncertainty of occupying the length of time, but so far, this may be a pity.

3. Future Recommends

- To address video latency and safety concerns, consider upgrading the camera module to improve data processing capabilities, which may require rewiring adjustments.

- Optimise the remote unlocking mechanism while also allocating time to gain a deeper understanding of the circuitry and programming for this critical function.

- To maximise the potential of this unmanned delivery van, explore the possibility of adding additional features such as intelligent trajectory planning, facial recognition technology for enhanced safety, thermostatic equipment to better hold unstable and perishable items, and video cloud storage to facilitate monitoring of the delivery process and provide retrospective surveillance video in the event of an accident.

These recommendations will not only improve vehicle performance, but also contribute to the overall success in reducing virus propagation as they directly address the identified limitations, further improving the performance and usability of the remotely controlled delivery trucks:

1. Increase video transmission speeds: Video transmission speeds can be significantly increased by upgrading camera modules and data processing capabilities. This means that the live video stream will be smoother when the vehicle is being used for deliveries, giving the operator a more accurate view and therefore reducing the risk of operator error. This helps to ensure a clear line of sight during operations and reduces human contact during an outbreak.

2. Improved remote unlocking: By optimising the remote unlocking function to ensure it is reliable and consistent, operators can make deliveries more accurately. This means that delivery vans can be delivered without the need for personal intervention, ensuring that deliveries are contact-free, thus reducing the risk of potential virus transmission.

3. Increased intelligence: The introduction of intelligent trajectory planning and facial recognition technology makes vehicles smarter. This means that vehicles are able to plan routes more autonomously, reducing the need for remote operation, while facial recognition increases the security of deliveries as only authorised users can access the vehicle.

4. Thermostatic equipment and cloud storage: These features ensure that goods inside the vehicle are well protected and monitored. Thermostatic equipment helps keep perishable items fresh and reduces risk, while video cloud storage facilitates after-action review and tracking, as well as monitoring in the event of an accident.

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Appendix 1: The judgement table of movement function

	given command	response time (S)	reaction result	reaction analysis	grade
test 1	straight,back,left, right.left, right	1	The trolley ran more steadily until the left-right-right command was executed, the trolley was unable to turn in place when executing the right command, while it could turn in place to the left	The wiring between the trolley motor and the control board is not in place, and returns to normal after rewiring.	0.8
test 2	straight,back,back,left,right,right.left,right,left	1.5	The trolley only worked correctly when going forwards and left, the right command was executed with a large deviation of the path each time, and the backward command was not executed	Battery storage capacity was insufficient, it cannot work normally. The reasult returns to narmal after charging the battery.	0.3

test 3	straight,left,right,back,left,right,left,straight.back	1	acted smooth and nice	/	1
test 4	straight,left,right,back,left,right.left,right,back	1	acted smooth and nice	/	1

Appendix 2: The judgement table of camera function

Test Number \ record	response time (S)	grade
test 1	5.88	0.2
test 2	2.37	0.3
test 3	<0.2	1
test 4	<0.2	1

Appendix 3 : The judgement table of lock function

test number/ record	cmmand	delay (s)	wifi connection	relay control	smooth latch ejection	grade
test 1	open	3	done	done	/	0.4
test 2	open	1.5	done	the main board burned	/	0.3
test 3	open	1.5	done	done	not smooth but work	0.7
test 4	open	2	done	done	/	0.5

Appendix 4 : The Craven Table

Sourse	C–Credibility	R–Reliability	A–Ability to see	V–Vested Interest	E–Expertise	N–Neutrality	Valuable or not ?
(S. Kapser,2021)	This dissertation has been cited many times and lined up with other sources information.	This dissertation was found in ScienceDirect.Science Direct is the full-text database platform of Elsevier, the world's leading publishing company, and is the world's largest full-text and bibliographic electronic resource database for STM (Science, Technology, Medicine). ScienceDirect is in the first 5% belongs to the first area，the partition is classified according to the impact factor of the journal.It was definitely reliable.	It was published in ScienceDirect，vol 148，June 2021. It was up-to-date.	This paper is more in the study of the acceptance of the gender for this kind of automatic delivery logistics vehicle, the logistics trolley as a good solution to the direct contact between people, the exploration of logistics trolley may biased	The author is a university lecturer and worked as a project manager in Robert Bosch GmbH. “A Logistics expert with passion for digital transformation”- Linledin	This paper is more in the study of the acceptance of the gender for this kind of automatic delivery logistics vehicle, the logistics trolley as a good solution to the direct contact between people, the exploration of logistics trolley may biased.	yes
(S. G. Dastidar et al., 2022)	This dissertation has been cited many times and lined up with other sources information.	This dissertation was found in Institute of Electrical and Electronics Engineers(IEEE).IEEE is a 501(c)(3) professional association for electronics engineering, electrical engineering, and other related disciplines with its corporate office in	It was published in the Institute of Electrical and Electronics Engineers(IEEE),S. G. Dastidar et al., "Design Development of VEhicle for	As an academic report specialising in logistics systems，the source should remain unbiased.	The author is a senior analyst in EY（Indie n）.He got a bachelor degree in Narula Institute Of Technolog y.	As an academic report specialising in logistics systems，the source should remain unbiased.	yes

		New York Cityand its operations center in Piscataway, New Jersey. The IEEE was formed from the amalgamation of the American Institute of Electrical Engineers and the Institute of Radio Engineers in 1963.It was definitely reliable .	Delivery of Goods in Hazardous Areas (VEDHA)," 2022 IEEE VLSI Device Circuit and System (VLSI DCS), Kolkata, India, 2022, pp. 269-274, doi: 10.1109/VLSIDCS53788.2022.9811451.It was up to date.				
(Adarsh Kumar et al.,2021)	This dissertation has been cited many times and lined up with other sources information.	This dissertation was found in ScienceDirect.Science Direct is the full-text database platform of Elsevier, the world's leading publishing company, and is the world's largest full-text and bibliographic electronic resource database for STM (Science, Technology, Medicine). ScienceDirect is in the first 5% belongs to the first area，the partition is classified according to the impact factor of the journal.It was definitely reliable.	It was published in ScienceDirect，vol 115，February 2021. It was up-to-date.	As an academic report specialising in drone-based networked system，the source should remain unbiased.	The author is an Associate Professor in the School of Computer Science with University of Petroleum & Energy Studies, Dehradun, India .	As an academic report specialising in drone-based networked system，the source should remain unbiased.	yes