Production Report

The 25th TDK Cup National College and University Creative Design and Production Competition - Flight Group

Competition Category:

Flight Team Number:

C11 Team Name: Pushing the Limit

School: National Taiwan University

Department: Department of Mechanical

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July 30, 110th year of the Republic of China

Table of contents

Catalog

1. Summary of Robot Features

Building on last year's experience, we will continue to use the same machine we used in last year's competition, and improve upon it. Because the frame of this group is relatively small, in order to meet the performance requirements of the competition, we have expanded the bottomface, which could only hold batteries last year, to accommodate two additional lenses, sensors, a pickup arm, and other electronic control components. It's no exaggeration to call it a magically large space.

Furthermore, this year we are competing as a joint team, and the team name Pushing the Limit clearly indicates our relationship with the other team, Beyond the Limit. We hope that Pushing the Limit can not only play the initially expected supporting role, but that the two teams can "exceed their limits" and shine together in the competition.

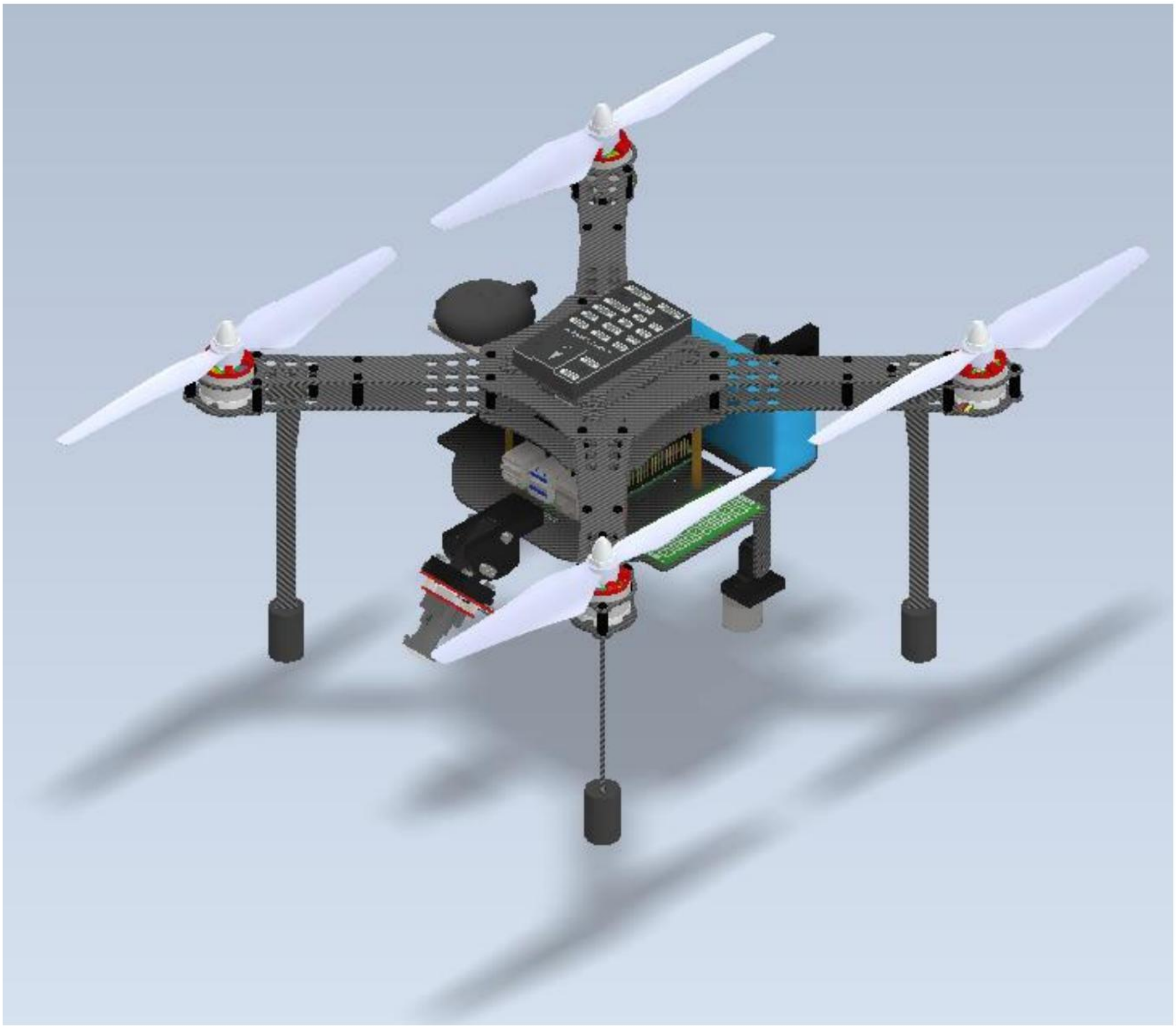


Figure 1-1 Overall design drawing

2. Mechanism Design

Based on the parts list in Figure 2-1, the following section will introduce the design concepts of the various components of this quadcopter. We divide the quadcopter into two main categories: the frame and the bottom functional area. The flight controller and motor control system, which belong to the frame, are commercially available functional parts and are therefore not within the scope of the mechanical design discussion.

一代機						
分類		品項/次組合	數量	製程	零件名稱	規格
機架	本體	centerface	2	碳纖切割	centerface_measured	
		減震組	1	碳纖切割	Pixhawk 4減震下板	
			1	碳纖切割	Pixhawk 4減震鎖板	
		GPS固定板	1	壓克力切割	GPS固定板	
	機臂x4	bottomwing	4	碳纖切割	new bottomwing	
		topwing	4	碳纖切割	new topwing	
		短銅柱	24	市購	短銅柱	N/A
		雙層短銅柱	8	市購	雙層短銅柱	N/A
	Legsx4	leg	4	碳纖切割	new leg	高度155mm（含減震海綿）
		降落泡棉	4	市購	降落泡棉	N/A
	飛控	Pixhawk4	1	市購	Pixhawk4	
		GPS	1	市購	PX4 Neo M8N GPS	u-blox Neo-M8N
底部功能區	連接及底座	bottomface	1	碳纖切割	new bottomface	
		銅柱	4	市購	銅柱	N/A
	手臂	馬達固定件	1	3D列印	90s固定架	
		伺服馬達	1	市購	Assembly SERVO	MG90S（含steering gears）
		電磁鐵桿	1	3D列印	電磁鐵鎖板	
			1	碳纖切割	電磁鐵桿板	
		電磁鐵	1	市購	電磁鐵	
	視覺	鏡頭	1	市購	camera	Raspberry Pi Camera v2
		紅外線感測器	4or2	市購	N/A	
		雷射感測器	1	市購	TOF sensor TF MINI PLUS v2	TFmini Plus
		前鏡頭組	1	3D列印	雲台底座	
			1	3D列印	雲台底座2	
			1	市購	openmv4_h7	openmv
			1	3D列印	openmv固定板	
電機電控		馬達	4	市購	Brushless motor 2212 920kv	EMAX MT2212-II KV900
		電變	4	市購	電變	好盈XRotor 20A
		槳	4	市購	rotor1,rotor2	EMAX 10x4.5
		分電板	1	市購	PM06	PM06
		電池	1	市購	4200MAH LI-PO Battery	Desire Power 3S 4200mAh
		Rpi4	1	市購	Raspberry-Pi-4-Model-B-03	含Spacer5mm*4（墊高用）
		洞洞板	1	市購	N/A	N/A

Figure 2-1 Parts List

2-1 rack:

This part can be considered the skeleton of this quadcopter assembly, because only with a skeleton can the bottom functional areas, like skin and flesh, extend outwards. The skin and flesh are then covered with various functional parts, like clothing, such as the vision system and arms of this assembly. We further subdivide the frame into: the main body, the arms extending from the main body, and the legs fixed to the arms. Figure 2-2 shows a partial parts list for the main body and arms; the design concepts of the main body and arms (including legs) will be described in detail below.

本體	centerface	2	碳纖切割	centerface_measured	
	減震組	1	碳纖切割	Pixhawk 4減震下板	
		1	碳纖切割	Pixhawk 4減震鎖板	
	GPS固定板	1	壓克力切割	GPS固定板	
機臂x4	bottomwing	4	碳纖切割	new bottomwing	
	topwing	4	碳纖切割	new topwing	
	短銅柱	24	市購	短銅柱	N/A
	雙層短銅柱	8	市購	雙層短銅柱	N/A
Legsx4	leg	4	碳纖切割	new leg	高度155mm(含減震海綿)
	降落泡棉	4	市購	降落泡棉	N/A

Figure 2-2 Parts list of the main body and arm

2-1-1 body:

It mainly consists of two identical centerfaces (the lower centerface is connected to the bottom face by copper pillars to accommodate circuit boards, batteries, grippers, and other functional components, which will be described in section 2-2, the bottom functional area), and two shock-absorbing plates. These plates help secure the Pixhawk 4 flight controller board and absorb shocks, while also serving as a GPS mounting plate for the u-blox Neo-M8N positioning system. A schematic diagram of the main body is shown in Figure 2-3, the blue section of the quadcopter body. The design concepts of the four types of plates used in this section will be introduced below.

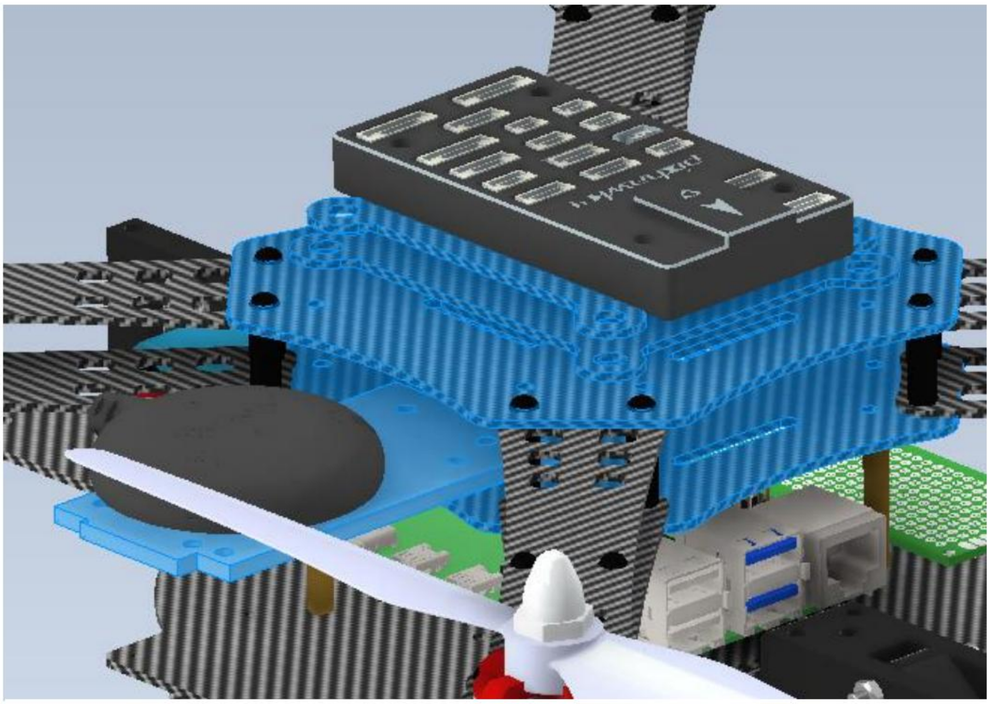


Figure 2-3 Four-axis body

2-1-1-1 centerfaceÿ

This board is a ready-made part purchased from the market and is the main board material that makes up the main body. Since the centerface did not face the problem of insufficient strength as the topwing or bottomwing last year (described in 2-1-2-1), it does not need to be redesigned or cut this year. However, other rack parts purchased from the market last year will basically be redesigned to achieve better mechanical performance.

2-1-1-2 Vibration Damping

Plate: As mentioned in 2-1-1, the vibration damping plate helps secure the Pixhawk 4. Last year, we purchased commercially available parts, as shown in Figure 2-5. This year, we believe it can be redesigned so that the flight controller board can be directly locked onto it. Therefore, referring to the design concept of last year's commercially available parts, we designed a vibration damping locking plate and a vibration damping lower plate. The former will have corresponding locking holes for the Pixhawk, and the latter will be glued to the upper centerface with foam adhesive, as shown in Figure 2-4.

Figure 2-5 Shock-absorbing kit used last year

Figure 2-4 Implementation of the Newly Designed Shock Absorber Kit

2-1-1-3 GPS Fixing Plate: This plate

uses the same design as last year without any changes. A plate corresponding to the centerface keyhole is designed, and the positioning system is fixed on it. See Figure 2-7 for the actual installation diagram.

This concludes the introduction to the design concept of the main frame. The next section will introduce the arms.

Figure 2-7 GPS Kit

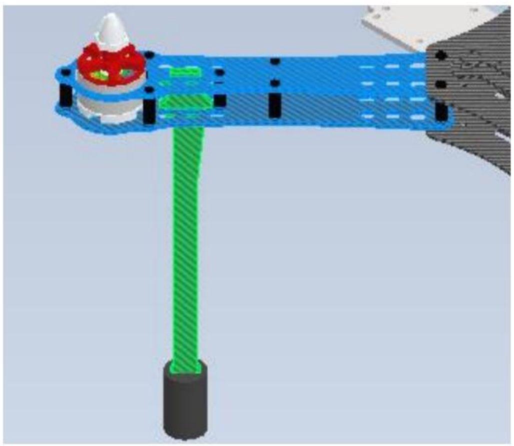


Figure 2-6 Four-axis robotic arm (including leg)

2-1-2 Arms (including Legs):

It includes a bottom wing and a top wing, which are connected by black aluminum pillars to form the arm. The bottom wing is used for... Fixed motor. In addition, the leg used to support and elevate the main body is designed to be clamped between the bottom wing and top wing. See Figure 2-6 for a schematic diagram of the arm (the blue parts from bottom to top are the bottom wing and top wing, and the green parts are the leg).

The following introduces the design concepts of three types of sheet metal for the machine arm.

2-1-2-1 Wings & Leg: Like the 2-1-1-1

Centerface, these are off-the-shelf parts purchased last year. The purchased wings and leg had excessively lightweight designs, resulting in insufficient strength. Therefore, they were redesigned this year and included with the new design.

CNC machining produces new sheet metal for better mechanical properties. A comparison of the redesigned wings and leg (parts with a carbon fiber appearance in Figure 2-8) and the original commercially available parts can be seen in Figure 2-8 (see Figure 2-1, where it can be seen that redesigned/improved parts will have "new" added to their part name field, such as new bottomwing).

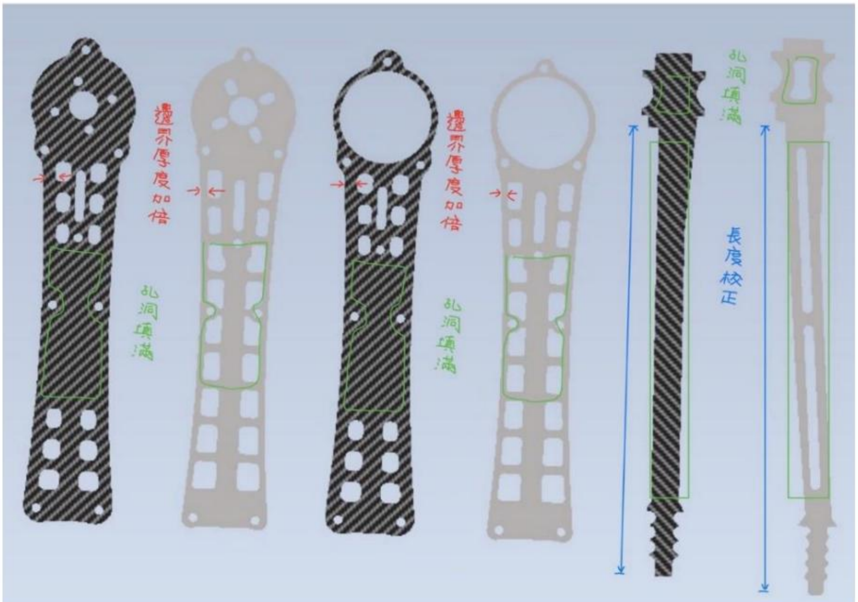


Figure 2-8 Comparison of old and new designs (refer to the same color markings and text descriptions in the above figure)

Figure 2-8 shows the new design for the two types of wings (left 1 and 3). We filled most of the holes in the middle of the wing, leaving only some holes on both sides for the wiring. To facilitate CNC machining, the four corners of the holes are rounded with larger radius than last year, and the boundary thickness is doubled from 2mm to 4mm to prevent the arm from breaking at the boundary this year. In addition, the motor locking hole in the bottom wing has also been improved, changing the original slot into a hole for better alignment during assembly; the leg part has simply been filled in the original hollowed-out area.

The engineering drawings created last year using scanning may differ in size from the actual parts. Therefore, it is necessary to confirm whether some important dimensions of these three redesigned parts match the original actual parts. For example, confirm that the distance from the bottom of the arm to the ground is 158mm and perform length correction, changing the leg dimension to the correct length to confirm that the four-axis height in the software matches the actual height. See Figures 2-9 and 2-10 for comparison.

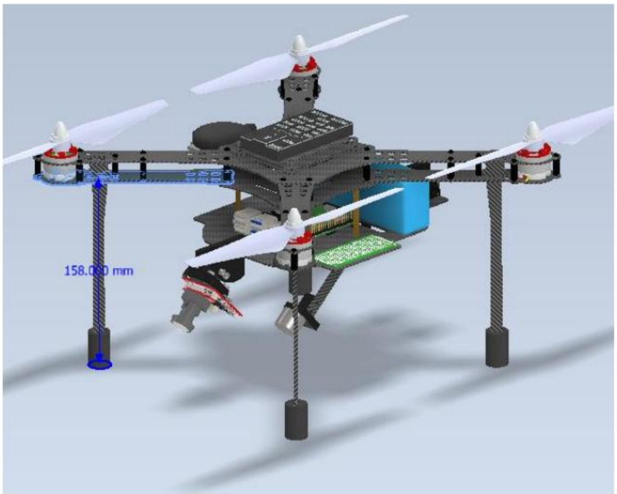


Figure 2-9: Ground distance measured from the rack last year: 164.8 mm. Figure 2-10: Ground distance measured from the new rack after calibration: 158.0 mm.

The upper part of the leg has a thicker section that fits into the groove between the upper and lower wings, as shown in the picture. As shown in Figure 2-11, a pointed, outward-protruding section is designed below the leg to insert it into the landing foam. A perspective view can be seen in Figure 2-12 (the blue transparent part is the landing foam). Finally, the main body and arms (including motors and legs) are assembled to complete the frame design, as shown in Figure 2-13.

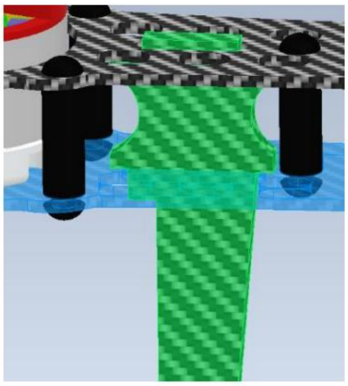


Figure 2-11 Enlarged view of leg assembly

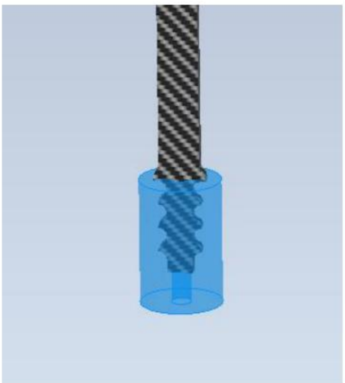


Figure 2-12 Perspective view of leg and drop foam assembly

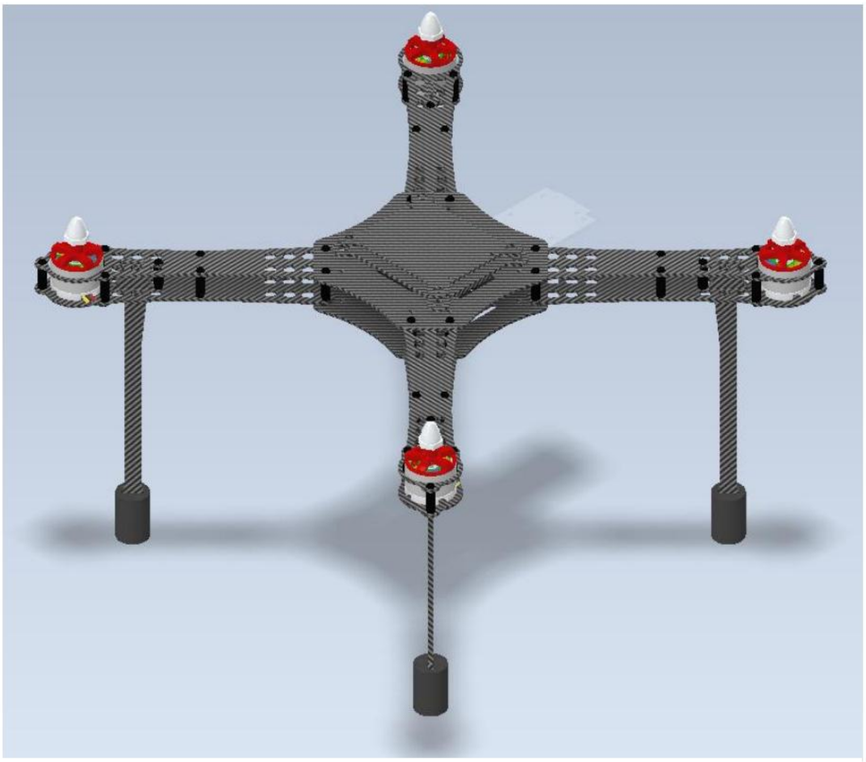


Figure 2-13 Rack Assembly Diagram

2-2 Bottom Functional Area: This part can be

considered the skin and flesh, and outer garment, of this quadcopter assembly. The bottom functional area is further divided into: the connector and base (which connects to the main body and provides space for other functional components via the bottom surface), the arm responsible for picking up objects, and the vision system acting as the quadcopter's eyes. See the table below for a cut-out of the parts list. The following will first introduce the design concepts of the arm and vision system (fixing the front lens), and finally explain how the bottom surface of the connector and base is designed with the necessary holes for placing the components.

底部功能區	連接及底座	bottomface	1	碳纖切割	new bottomface	
		銅柱	4	市購	銅柱	N/A
	手臂	馬達固定件	1	3D列印	90s固定架	
		伺服馬達	1	市購	Assembly SERVO	MG90S(含steering gears)
		電磁鐵桿	1	3D列印	電磁鐵鎖板	
			1	碳纖切割	電磁鐵桿板	
		電磁鐵	1	市購	電磁鐵	
	視覺	鏡頭	1	市購	camera	Raspberry Pi Camera v2
		紅外線感測器	4or2	市購	N/A	
		雷射感測器	1	市購	TOF sensor TF MINI PLUS v2	TFmini Plus
		前鏡頭組	1	3D列印	雲台底座	
			1	3D列印	雲台底座2	
			1	市購	openmv4_h7	openmv
			1	3D列印	openmv固定板	

Figure 2-14 Parts list for arm, vision system, connection components, and base.

2-2-1 Arm:

This is a four-axis mechanism used to pick up and drop goods, controlling the opening and closing of electromagnets to achieve the task of picking up and dropping. The arm mechanism includes a servo motor, a 3D printed part for fixing the motor, and an electromagnet rod mechanism connecting the motor and the electromagnet, as shown in the green part of Figure 2-15. The following will introduce the design concept of the arm and the self-designed parts, including the 90s mounting bracket and the electromagnet rod.

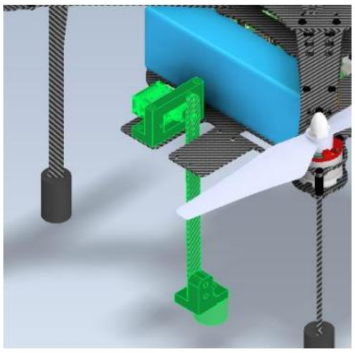


Figure 2-15 Arm mechanism for picking up the metal box

2-2-1-1 Arm Concept: First, the

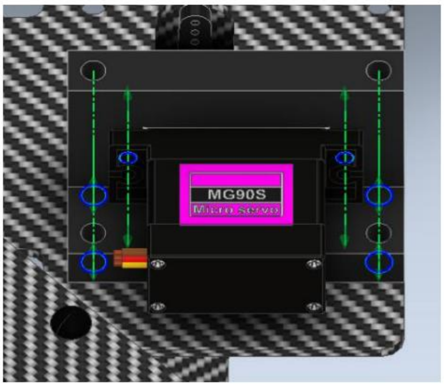
design concept of the entire pickup mechanism utilizes an L-shaped 90s mounting bracket, allowing the motor to lie flat on a reference surface. Next, a long rod connects to the servo motor. The motor drives the servo motor, which in turn drives the connected electromagnet rod plate. Finally, the part connecting to the electromagnet is another L-shaped electromagnet locking plate, responsible for connecting the electromagnet rod plate and the electromagnet. The combination of the electromagnet rod plate, locking plate, and electromagnet is collectively called the electromagnet rod. The design concepts of the 90s mounting bracket and the electromagnet rod will then be introduced in sequence.

2-2-1-2 90s Fixture:

An L-shaped part that fixes the motor to a plane. The concept of this part is quite easy to understand. It has a total of six holes. Two of these holes (the locking holes on both sides of the 90s mounting bracket in Figure 2-17) are used to lock the servo motor, and the remaining four holes are used to fix the arm mechanism to the bottom surface of the bottom functional area. The assembly diagram is shown in Figure 2-17.

When designing, it's important to pay attention to the thickness of the L-shaped part. It must not be too thick, as this could cause interference with the servo motor and prevent it from rotating freely. The designed thickness is 6.6mm, as shown in Figure 2-16. This provides sufficient strength for the printed part without being too thick and causing interference with the servo motor.

Another point to note is material utilization. This design ensures that there is no interference between the keyholes while still leaving sufficient distance, as shown in Figure 2-18. It also minimizes the length of the parts (the edge of the green part in Figure 2-18 is 43.1mm) and reduces the volume, which also makes the entire quadcopter lighter and avoids unnecessary weight.



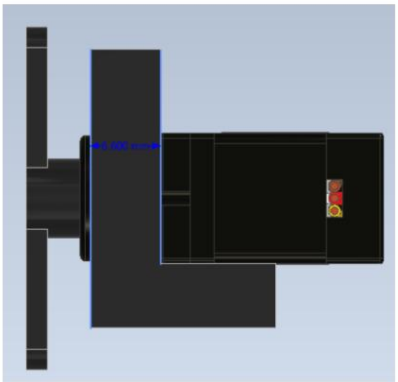
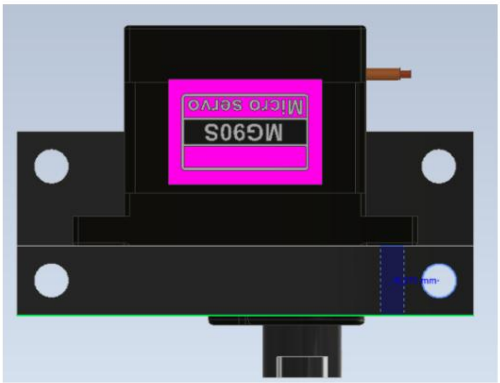



Figure 2-17 Function of the locking hole in the 90s fixing bracket; Figure 2-16 L-shaped thickness 6.6mm; Figure 2-18 Lock hole spacing 4.375mm.

The minimum distance is approximately 1.7 mm.

2-2-1-3 Electromagnet rod (electromagnet rod plate + electromagnet lock plate): Originally, this part was intended to be directly 3D printed as a single piece, but later, considering the strength of the long rod, it was finally disassembled into a long strip of carbon fiber plate plus a 3D printed part for locking the electromagnet.

First, let's introduce the electromagnet rod plate, which is a simple long strip-shaped part. It has a lock hole at the top corresponding to the servo motor, and two holes at the bottom to lock with the 3D printed part of the electromagnet.

Next is the electromagnet locking plate, a component that mates with the aforementioned electromagnet rod plate. Since the electromagnet has internal threads that allow screws to be directly inserted, the initial design was to use a plate to directly lock the screws into the electromagnet. However, this plate needs to be locked to the long rod, and a part extending from the bottom can be opened to correspond to the locking hole of the electromagnet rod plate. Similarly, two holes need to be opened to lock it to the rod plate. Therefore, the final 3D printed part is also L-shaped.

Finally, there is an exploded view of the electromagnet rod and the electromagnet combined, as shown in Figure 2-19.

Figure 2-19 Exploded view of electromagnet rod and electromagnet

2-2-2 Visual:

Composed of lenses and sensors, there are two types of lenses observing the scene in front/below, and two types of sensors sensing the environment below/left/right and rear. The mechanism design will be introduced here. Since the other lenses and sensors only need to have corresponding lock holes on the fixing parts, they are not discussed here. The vision part focuses on the design of the front lens fixing device, which includes the gimbal base fixed to the bottom functional area, the gimbal base 2 that can help the front lens rotate and adjust the elevation angle, and the OPMV fixing plate connecting the base 2 and the front lens. The schematic diagram of the front lens assembly is shown in blue in Figure 2-20. The following will introduce the design concept of the fixing device and the three parts designed by ourselves.

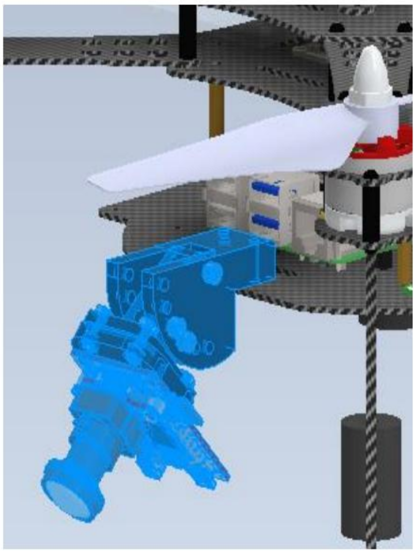


Figure 2-20 Front lens fixing mechanism

2-2-2-1 Front Lens Assembly Concept:

The front lens we designed uses the concept of a gimbal, as shown in Figure 2-21, which allows it to rotate around one axis and adjust the elevation angle (the degree of freedom of rotation around one axis is smaller than that in Figure 2-21, but it is sufficient if you only need to look forward). This allows us to make adjustments and changes in real time to easily observe the scene in front of the four axes.

Figure 2-21 Design inspiration for the adjustable angle gimbal

The following will describe each component of the gimbal mechanism in sequence, including the gimbal base, gimbal base 2, and OpenMV mounting plate. The gimbal base connects to the bottom face of the bottom functional area. The gimbal base 2 is placed in the slot on the gimbal base and can be rotated in the slot to adjust the tilt angle. Finally, the OpenMV front camera is locked to the OpenMV mounting plate on the gimbal base 2.

2-2-2-2 Gimbal Base: The gimbal

base mainly has three locking holes on the rear flat surface.

The bottomface lock allows the lens body to extend out of the camera body.

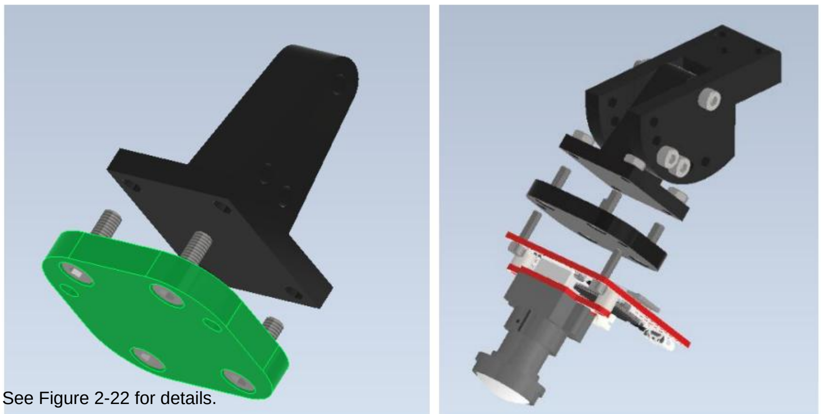
2-2-2-3 Gimbal Base 2: This

mechanism acts as a bridge connecting the base and the front lens, and it has...

One main locking hole (allowing base 2 to rotate) and two adjustment locking holes can be fixed to the base with screws. The base is designed with multiple hole positions. The tilt angle can be adjusted by connecting the two adjustment locking holes of base 2 to different holes of the base.

2-2-2-4 OpenMV Mounting Plate: A

separate plate is printed inside the gimbal mechanism of the front lens to facilitate connection between the front lens and gimbal base 2. Replacing the lens only requires redesigning the mounting plate corresponding to the new lens's locking hole, saving time compared to printing gimbal base 2. The locking holes on the mounting plate and base 2 will have additional holes with a larger radius to accommodate the screw heads, preventing interference from protruding screw heads when the lens and mounting plate are locked together. See Figure 2-22 for details.



In addition, another function of the mounting plate is to facilitate

the replacement of ... equipment is worn out, as shown in the exploded view of the front

lens assembly in Figure 2-23 and Figure 2-22. (Buried screw heads on the mounting plate)

This concludes the introduction to the design of the front lens fixing mechanism for the visual part. Finally, here is an exploded view of the disassembly and assembly of this mechanism, as shown in Figure 2-23.

2-2-3 Connection and Base:

After completing the design of the arm and front lens mounting device, the next step is to consider how to place these components in the bottom functional area. The purpose of this part is to provide space for other functional components and to act as a bridge connecting them to the main body. The bottom surface and copper pillars, along with the connection and base diagram, are shown in Figure 2-25 (blue section, transparent to avoid confusion with the blue battery). The following describes the initial component placement plan and the design of the bottom surface.

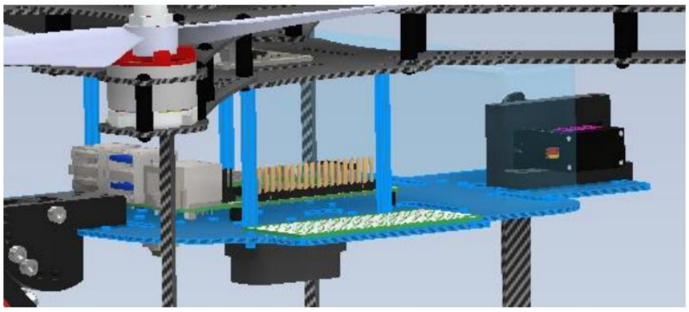


Figure 2-25 Connection and base diagram

Figure 2-24 Bottom Function Area Component Layout

(Viewed from above, the components in the dotted line area are below the bottom face)

2-2-3-1 Component Placement Planning:

The components to be placed in the bottom functional area include: battery, arm mechanism, front lens, lower lens, laser sensor and Rpi4, and perforated board. We aim to place the front and lower lenses further forward, while the arm mechanism is placed further back. This allows the vision system to first observe whether the salt mountain and cargo delivery area have been reached, and then control the electromagnets on the arm to attract and release cargo at the correct time. The battery is placed as close to the center as possible to avoid shifting the center of gravity forward or backward. The lower lens and laser sensor are positioned downwards. The former observes the view above the ground, while the latter senses the distance to the ground. The lower lens needs to connect to the Rpi4 via a transmission line, so their relative positions can be tied together. For convenience, the laser sensor is also placed near the lower lens. Finally, the perforated board is very lightweight, so placing it on either side has negligible impact on the center of gravity. Detailed planning can be seen in Figure 2-24 (which can be compared with the design results in Figures 2-27 and 2-28). Next, the redesign of the bottomface will be introduced.

2-2-3-2 bottomfaceÿ

The sole plate forming the connection and base, like the four types of plates described in Frame 2-1, was a readily available part purchased from the market last year. This year, due to different requirements, the bottomface was redesigned. Last year, for example, we only placed the battery on the bottomface, allowing us to use the original manufacturer's plates. However, this year, in addition to the battery, we added the aforementioned arm, front lens, and other commercially available parts such as the sub-vision lens, laser sensor, RPi4, and perforated board, thus requiring significantly more space.

As shown in Figure 2-24, the corresponding keyholes can be designed according to the placement of the parts. To reduce unnecessary volume, it is roughly designed as a circle (the purple line part in Figure 2-26), with extensions and cuts in some places. The parts highlighted in red and blue can be seen in the text description of Figure 2-26. The green parts will be used for the wiring of the laser sensor and the lower lens, respectively; the yellow part, where the front end of the circular plate is cut, is to prevent the gimbal base from being affected by the protrusion of the curved part. The extended parts without boxes are the parts outside the purple lines. The left and right sides are for placing the perforated plate; and the rear is where the battery and arm mechanism are placed. This completes the bottomface design.

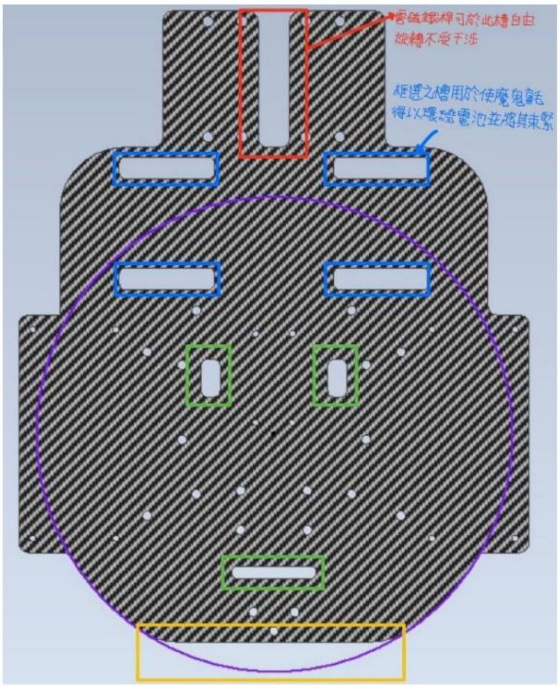


Figure 2-26 New bottomface design description

Finally, assemble the parts described in sections 2-2-1 to 2-2-3, including any remaining commercially available functional parts, to complete the base. Design of the functional area. See Figure 2-27, and a lower view Figure 2-28 is provided to facilitate understanding of the relative positions of the lower lens (blue square part) and the laser sensor (actually located behind the lower lens, shown as the bottom in the figure, green rectangle). The bottom face is made transparent for easy viewing of the relative positions with the parts above.

Based on the introductions in sections 2-1 to 2-2, some parts of last year's quadcopter were redesigned, and the design of this year's quadcopter was completed. Finally, the top, bottom, front, back, left, right, and isometric views of the complete assembly are attached (Figures 2-29 to 2-35).

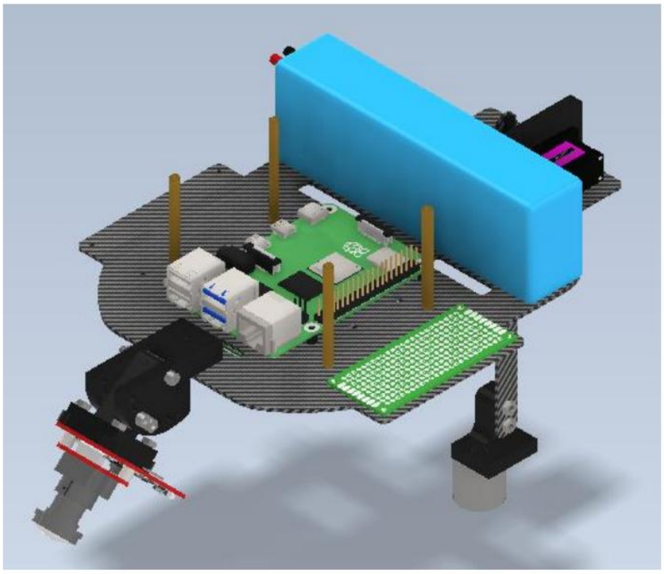


Figure 2-27 Assembly diagram of bottom functional area

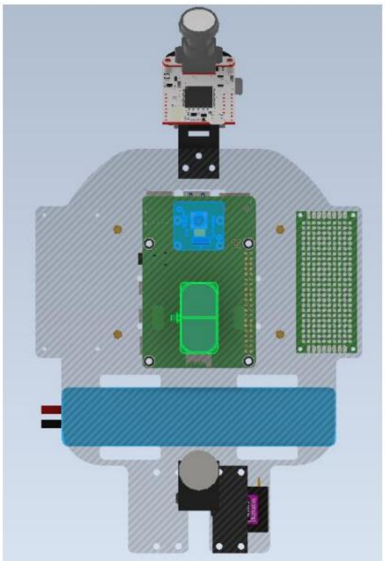


Figure 2-28 Bottom view of the function area

Figure 2-29 Top view of the overall assembly

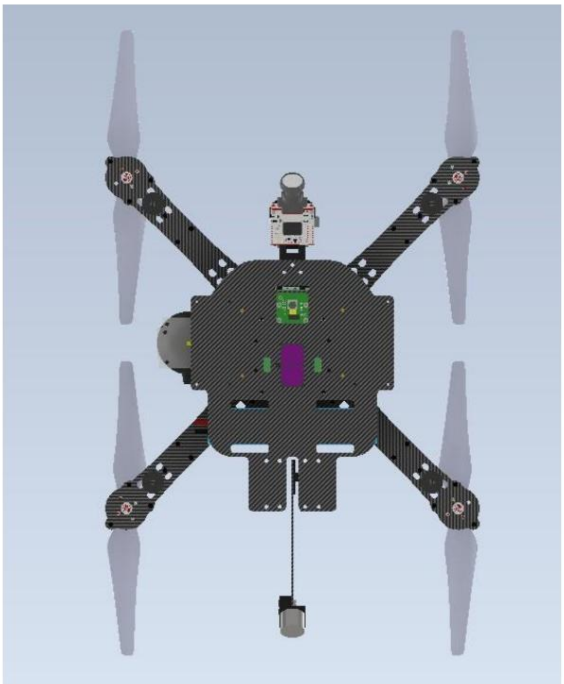


Figure 2-30 Bottom view of the overall assembly

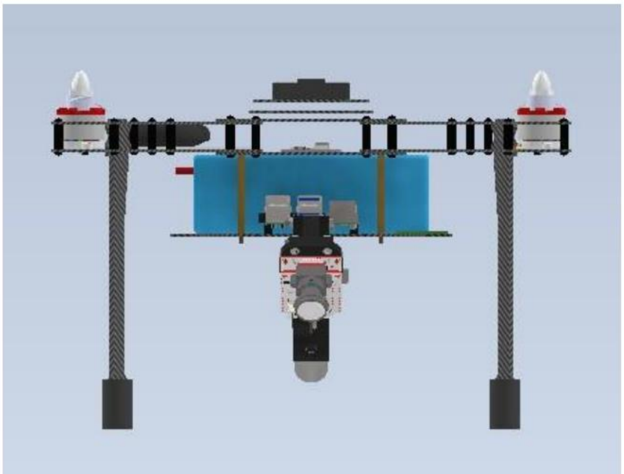


Figure 2-31 Front view of the overall assembly

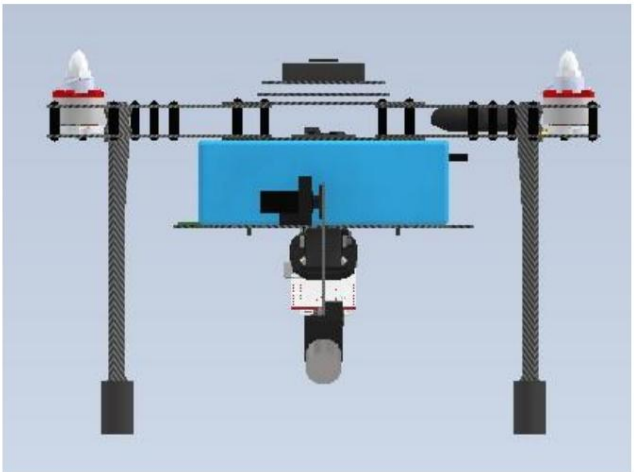


Figure 2-32 Rear view of the overall assembly

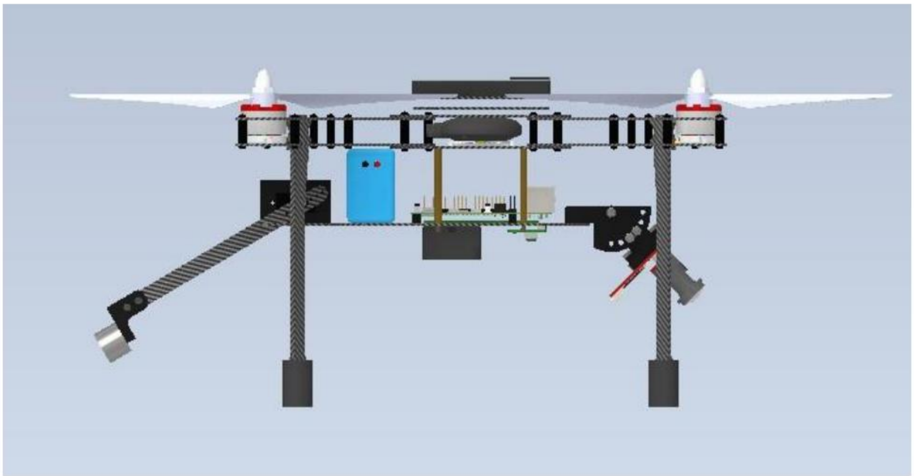


Figure 2-33 Left view of the overall assembly

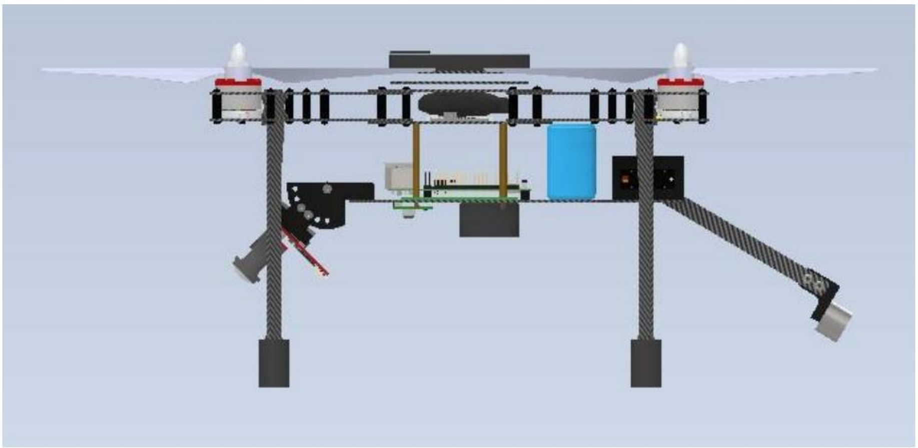


Figure 2-34 Right view of the overall assembly

Figure 2-35 Overall Combination Isometric View

3. Electrical Control Design

Firstly, the flight control system will continue to use the Pixhawk 4. Regarding positioning, GPS is not the primary choice due to the indoor venue. While optical flow positioning is more accurate indoors, the lack of texture on the competition floor makes it prone to misidentification, potentially leading to stalling and forward acceleration. Therefore, it was decided to forgo obtaining absolute position and instead use relative position for flight. On the horizontal plane, a downward-looking camera tracks the black line on the ground, and a laser sensor determines our distance from the ground. This allows us to derive our three-dimensional relative coordinates. Finally, a forward-looking camera tracks feature points on the field, using object size to determine our direction of travel.

Figure 3-1 Pixhawk 4

Figure 3-2 Motor

Regarding the measurement of the aircraft's distance from the ground, we initially considered using ultrasound for ranging. However, considering the reduced reflectivity caused by the ground surface, we ultimately decided to use laser ranging as the sensor for ground distance. For the flight propulsion, the selected motor is the EMAX MT2212-II KV900; the electronic control system is... The Hobbywing XRotor 20A features an EMAX 10x4.5 (Pitch: 4.5 in.; Propeller Diameter: 10 in.) propeller. For the battery, a Desire Power 3S 4200mAh unit has been chosen.

In addition to the four-axis main body, there are two additional functions: a gripper and a vision system.

For the gripper, an electromagnet was chosen as the object-grabbing component. (This is supplemented based on improvements made during testing on June 5th.) Due to the limited attraction distance of the electromagnet, a robotic arm was added. This electromagnet arm can be manufactured using 3D printing and operated by an MG90S servo motor.

For the vision aspect, the requirements are divided into two parts: the camera lens and the laser sensor. A Raspberry Pi Camera v2 is selected as the downward-facing camera, and an openmv4_h7 is chosen as the front camera; for the laser sensor, a TFmini Plus is selected for this purpose.

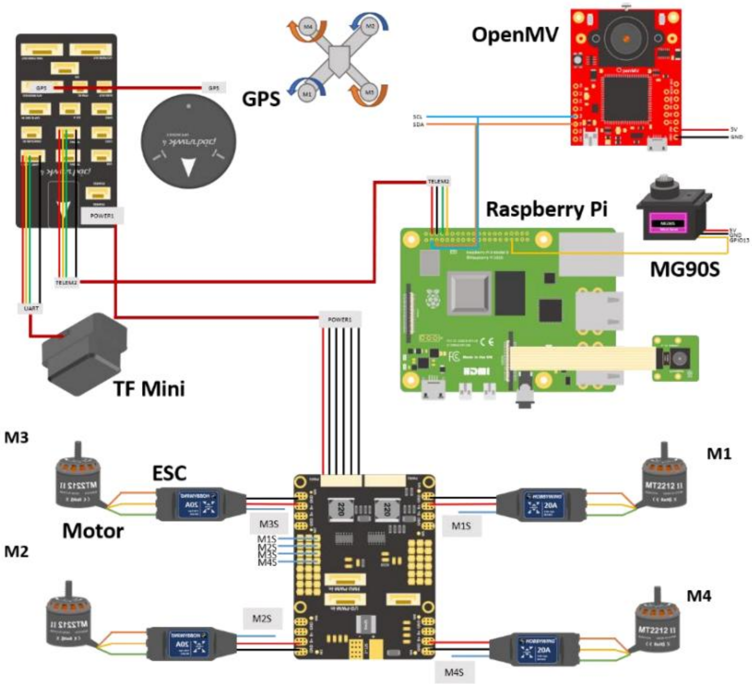


Figure 3-3 Overall Electronic Control Design

4. Explanation of the integration of creativity, science and technology with humanities

The reason for using electromagnets to grip objects in the salt mountain is inspired by the use of giant electromagnets to grip and move containers in ports, and the operation of waste incineration plants. The idea was to leverage their commonalities by using electromagnets as grippers. While electromagnets are commonly seen in everything from telephones and alarm clocks to ports, docks, and railway transportation, the unique feature of quadcopters is their ability to fly, offering greater freedom and flexibility, and thus being less confined to ground-based operations. Expanding this further, continuously improving the

electromagnet grippers, and strengthening them to create robotic arms capable of complex tasks, quadcopters could become mobile work platforms in the air: enabling flexible and complex operations even in environments where securing equipment is impossible. Furthermore, because we use carbon fiber for the frame, we achieve greater strength per unit weight with a lighter weight, resisting external loads. Extending this to a more humanistic perspective, the domestic tourism industry has been severely impacted by the

pandemic. The decrease in visitor numbers has led to the underutilization of tourist attractions and historical sites, causing a decline in the related cultural industry. These sectors must overcome their reliance on tourists and passively wait for a resurgence of population. How can we bring a glimmer of hope to scenic spots and historical sites—places that were overcrowded on weekends before the pandemic—in this era of social distancing? Consider this: what if we created robots to disperse the previously overcrowded population, freeing people from social distancing concerns while still allowing them

to appreciate the splendor of historical artifacts? Furthermore, could they interact with these sites via computers, combined with increasingly widespread online payments, to tour and even make purchases within the scenic areas, creating a completely new look for the tourism industry, distinct from traditional methods?

The above is merely an idea, but some aspects are achievable. Our robot already possesses automatic tracking capabilities. Equipped with two cameras and computer-aided control, it can guide tourists along fixed routes through scenic spots. Visitors can use the computer-generated visuals to avoid crowds, glimpse the scenery, and even use the computer to complete simple challenges. This increases the interactive fun and offers a unique experience.

The Ministry of Transportation commissioned Taiwan AI Labs to develop the "Sea and Land Wandering" smart tourism project, which integrates virtual and real experiences, aiming to provide domestic and international tourists with an immersive experience through its platform. The robots we created can not only provide digital tourists with wonderful experiences and satisfy their first-person perspective enjoyment, but also offer a unique two-way experience unlike the one-way experience provided by other platforms.

As our robot's gripper continues to develop and mature, it will be able to move closer to the goal of enabling remote consumption and fostering a deeper interaction and connection with Tainan's local cultural industries. Furthermore, it will allow tourists to connect with the relaxed pace of Tainan's historic city, providing opportunities for interaction and exchange. Coupled with the prevalence of online payments, it can further stimulate spending by both tourists and local residents. With continued performance improvements and refinements, our robot will undoubtedly provide visitors with an immersive and engaging experience.

5. Encountering difficulties

1. The pandemic prevented its implementation.

Due to the pandemic, opportunities for joint testing and discussion are scarce, so we can only conduct four-axis virtual site simulations. To avoid hands-on practice, we decided to first use Gazebo as a virtual environment for practice, and to use software for CAD drawing of the aircraft. When problems arose and needed to be discussed, we would use online meetings to ensure that our progress would not be delayed due to the pandemic.

2. The Electromagnetic Gripper for Salt

Mountain Retrieval: The gripper is slightly behind schedule compared to other aspects. The initial idea was to use an electromagnet to obtain points for this project. However, due to unfamiliarity with its performance and characteristics, coupled with a lack of prior experience, we were initially at a loss. During initial testing, we discovered that the electromagnet could only pick up objects from a shorter distance than expected. After discussions with team members, design adjustments were made during the CAD drawing phase.

Further discussions were only possible after the pandemic subsided. With efforts focused on other parts, there wasn't enough time for thorough testing of the electromagnet gripper. Currently, it's uncertain whether the quadcopter effectively grips the metal box during automated flight; this is an area requiring continued effort.

3. Constructing a Complete Test

Venue: Finding a location on campus that was the same size as the actual competition venue and suitable for setting up the venue was extremely difficult. Furthermore, this venue needed to be reusable and likely needed throughout the entire competition preparation period. Therefore, we chose the department's practical training center. Although its internal space was still insufficient to construct a complete venue, at least one open area could be used to build the venue using leftover aluminum extrusion from the department's project course. However, we also faced the challenge of insufficient aluminum extrusion. Due to budget constraints, we could only use the remaining aluminum extrusion to build a venue that met functional requirements while also ensuring

engineering and structural safety. Initially, we planned to use mesh as a barrier at the venue boundaries. However, after purchasing two rolls of mesh, we discovered that the required quantity far exceeded our expectations. We would either have to spend a lot of money to buy many rolls of mesh or order mesh from an external supplier to fit the dimensions of the constructed venue. After discussion among the team members, it was decided that the netting would not be used after the competition, and due to budget constraints, the

cheaper and more durable PP

board would be used as the boundary of the field. **4.** Flight Controller Internal Control System The flight controller's internal control system is a black box to the average user. When we want to operate the flight controller, we can only do so through its interface. Therefore, using different flight modes and control methods may not achieve the expected performance. We devised two solutions: First, deconstruct each internal node of the flight controller to understand its firmware control and hardware signal processing. Second, directly output the final motor control signal, thus bypassing the black box and directly using the desired and suitable control algorithm.

6. Future Plans

1. Conduct motor-related characteristic experiments to obtain precise control parameters. 2. Gain a thorough understanding of the flight control hardware and establish a complete control architecture. 3. Conduct extensive field testing to determine quadcopter stability. 4. Optimize the performance and computing power of the flight computer. 5. Continuously improve the mechanism based on problems encountered in field testing. 6. Improve the electromagnet to increase its attraction range. 7. Improve the testing environment to closely resemble the actual test environment.

7. Team Member Roles and Responsibilities

The job duties can be roughly divided into the following points:

Mechanism Design:

For the design, we combined last year's experience with brainstorming and discussions among team members. We spent approximately four to five weeks intensively discussing and refining last year's mechanism, determining the required material strength based on the shape and strength requirements of each part. Broadly speaking, the design can be divided into two types: flat, plate-like parts will be made by cutting carbon fiber, a small portion by cutting acrylic, and the remaining parts will be manufactured using 3D printing.

In addition, since carbon fiber CNC machining takes a long time, a test cut is performed on an acrylic sheet of equal thickness before it is sent to the manufacturer for cutting. The test is also conducted to check whether there are any interferences that cannot be seen in the software after assembly.
Carbon fiber cutting will only proceed after all concerns have been confirmed, to ensure that time and money are used effectively.

Electrical control design:

Complete the quadcopter circuit connection, flight control settings, establish the control system, communication between the onboard computer and the flight controller, and design computer vision algorithms.

Venue setup and virtual environment setup: The venue

layout was arranged using various colored papers and tapes: the white ground was collaged with A4 photocopy paper, the red and green landing points were collaged with 5 full-size colored paper sheets and then cut out, the black tracking lines were pasted with 4.8 cm black tape, and the netting and routes around the venue were raised using extruded aluminum frames; the virtual environment was set up using Gazebo simulation.

In summary,

our group's collaborative approach was very different from traditional departmental group work. Because our group members came from different universities and two different departments, their understanding of quadcopters, mechanisms, and flight control varied greatly, ranging from in-depth knowledge to complete lack of background. Each person approached each issue from a very different perspective. During discussions, we discovered that these diverse learning experiences and areas of expertise sparked amazing insights. This provided an opportunity to understand the strengths and specializations of different departments, allowing each member to utilize their own knowledge and work together for the competition. The preparation process offered a rare opportunity to learn from each other, leveraging our accumulated knowledge to exchange ideas and interact from equal

but slightly different perspectives. The results were surprising and satisfying. Sometimes, lacking a foundation allowed us to break free from limitations and solve problems in a more flexible and creative way. Those with prior knowledge could review their learning journey and deepen their application of professional knowledge by explaining to their teammates. We helped each other and grew throughout the process.

The 25th TDK Cup National College and University Creative Design and Production Competition

Weekly Work Report

Appendix: Weekly Work Report

ÿ Define Competition

Requirements (P1) ÿ

Define Specifications

(P2) ÿ Select Parts (P3) ÿ Assemble the

Mech and Introduce it (P4-P5) ÿ Draw the

Mech CAD (P6-P13) ÿ Test the Gripper

CAD (P14-P16) ÿ 3D

Printing (P17) ÿ Create the Virtual

Environment (P18-P22) ÿ Establish Software Architecture and

Initial Testing (P23-P24) ÿ Light Signal Judgment and

Hovering Test (P25-P26) ÿ Connect Simulation and Physical Components (P27-P28)

Weekly Work Report
Date filled in: April 10, 110
Determine the competition requirements

Building on our experience from last year's competition, we decided to register for the flight category again this year, and increase our team size to 7 people.

(Divided into two teams), the team members have also been significantly expanded to include individuals from diverse backgrounds. Regarding the hardware, improvements have been made...

Last year's quadcopter will serve as the first-generation model for this project; additionally, based on the experience gained last time, a completely new second-generation model will be designed.

This week we held our first meeting. Besides discussing everyone's roles, we also studied the rules for this event and addressed these issues.

Together, we planned the direction and set goals for this competition.

Regarding the six parts of the scoring for this competition, we found that traffic lights...

Compared to last year, some parts no longer require the identification of left and right turn signals, therefore they should

You can reliably score points; another crucial skill to master is identifying and following flight paths.

This time, we will first build a virtual environment to test our software.

Whether the requirements can be met depends on whether the flight path can be successfully completed.

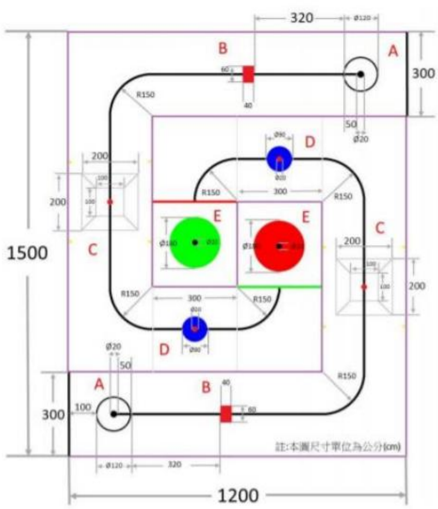
The line should be a basic score. Regarding the portion of goods taken and delivered, last year we...

Those who abandoned this part later, this year, based on last year's experience, will...

In this section, where we're trying to score points, we've decided to use an electromagnet to pick up the pieces.

Pick up the goods (tin box). The score can be roughly divided into a conservative score and a target score.

The scores are shown in the table below:



	Flight along route, takeoff, traffic lights, cargo pickup, cargo drop, landing					
keep Score	40-3n	10	20	C 15	D 0	25
Target Score	40	10	20	A 50	A 50	30

Additionally, we noticed that this time there's an extra requirement compared to the last time: "light strips (red and green) must be installed on the robot."

We will also add red and green light strips to meet this requirement!

I believe that last year's experience will make our operations much smoother this year!

Hoping to win an award this year!!

Weekly Work Report	
Date filled in: April 17,	110 (Specifications established)

After confirming the competition rules and scoring method, we began to address the areas where we had failed based on last year's competition experience. This is a key area for improvement in the design of this aircraft.

First, we found that the previous design of the overall aircraft structure relied heavily on splicing sheet metal and screw-locking at the joints. Furthermore, the previous quadcopter itself didn't use tubular materials, making this jointing method prone to resonance due to excessive gaps. To address this, we used hot melt adhesive to cover the original joints, filling the gaps and minimizing resonance. Regarding the appearance design and space utilization, we also made some optimizations to the hardware. Previously, the battery was directly strapped to the sheet metal, resulting in a messy appearance and cumbersome replacement procedures. Therefore, in the new design, we modularized the entire structure, fixing the battery to the side panel. This is not only more aesthetically pleasing but also makes battery replacement much easier. As for the main sheet metal itself, we increased the size of the previously used square sheet metal to form a near-rectangular octagon. Without altering the overall layout, this significantly increased usable space, allowing for more flexible space planning. Finally, last year we designed the quadcopter's landing gear with one landing gear under each of the four motors. The advantage of this design was that it could better overcome rough terrain, but it also made landing less stable. However, in the extremely flat competition venue, using ski-shaped landing gear made landing easier and smoother. Therefore, in this design, we changed the aircraft's landing gear to use ski-shaped landing gear.

Next, regarding positioning, GPS wasn't the primary choice due to the indoor venue. While optical flow positioning is more accurate indoors, the lack of texture on the competition floor made it prone to misidentification, potentially leading to stalling and lurching forward. Therefore, we decided to forgo absolute positioning and rely solely on relative positioning. On the horizontal plane, we used a downward-facing camera to track the black lines on the ground and a laser sensor to determine our distance from the ground, thus deriving our three-dimensional relative coordinates. We also supplemented this with left and right infrared sensors for obstacle avoidance, preventing the aircraft from colliding with the netting due to deviation from its trajectory. Finally, a forward-looking camera tracked feature points on the field, using object size to determine our direction of travel. For measuring the aircraft's distance from the ground, we considered using ultrasound, but due to the reduced reflectivity caused by ground electricity, we ultimately decided to use laser ranging as the ground distance sensor. Finally, for the levels involving retrieving items, we initially considered using a traditional robotic arm. However, after evaluation and discussion, we felt that using a robotic arm would make it difficult to accurately grasp the metal box, as it would require precise positioning of the item (the metal box) and sufficient force from the

robotic arm to lift it. Considering that the item to be picked up is indeed a metal box, we decided to use an electromagnet. Furthermore, using an electromagnet allows for better control over the timing and location of the drop, resulting in a higher score opportunity in levels where items are dropped.

Weekly Work Report	
Date entered: April	24, 110 (Selecting parts)

Based on our previous experience, we chose to use the same machine as last time, reinforcing the weaker hardware components. For the sheet metal and support rods, we remanufactured them using carbon fiber, achieving a balance between lightweight and robustness. Furthermore, we added landing foam to the part of the support rods that contacts the ground to improve the chances of a successful landing.

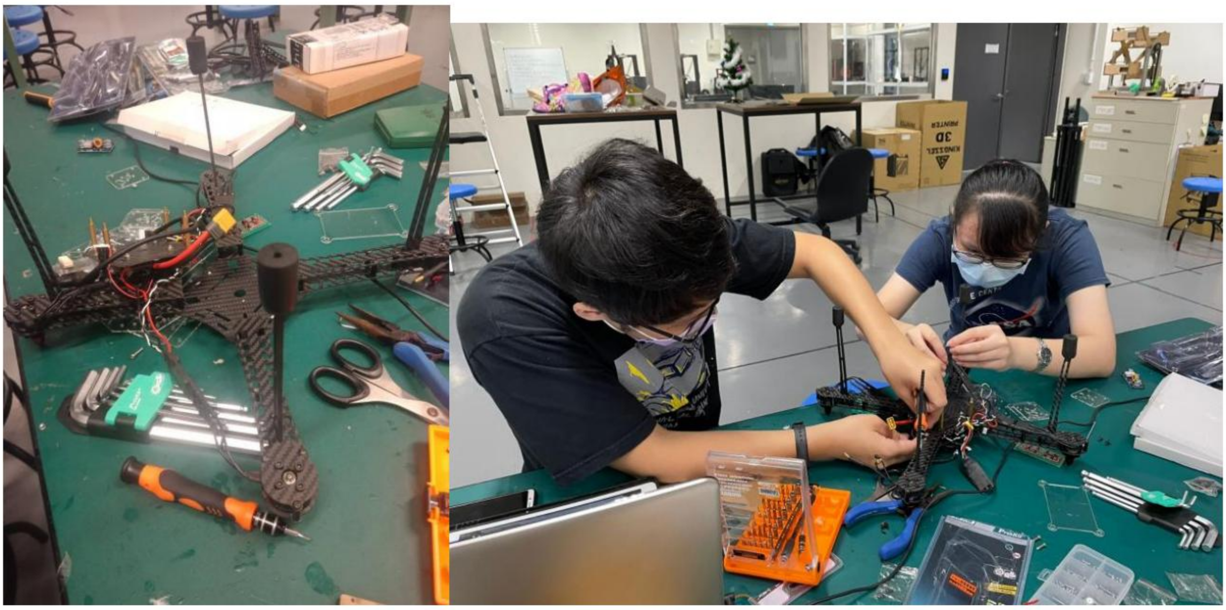
For the flight control system, we continued using the Pixhawk 4. For the positioning system, we continued using the u-blox Neo-M8N.

For the electronic control section, we selected the EMAX MT2212-II motor. The KV900 is used; the EMU is a Hobbywing XRotor 20A; the propeller is an EMAX 10x4.5 (Pitch: 4.5 in.; Propeller Diameter 10 in.). Regarding the battery, the charge capacity requirement has been changed from 4200mAh to 1300mAh, therefore, this time...
Desire Power 3S 1300mAhÿ

In addition to the quadcopter itself, we have two additional functions: a gripper and a vision system. For the gripper, we decided to use an electromagnet for the object-grabbing mechanism. (This is supplemented based on improvements made during testing on June 5th.) Because the electromagnet's attraction distance is limited, we decided to add a robotic arm. This electromagnet arm can be manufactured using 3D printing and manipulated by an MG90S servo motor. For the vision system, we can divide the requirements into three parts: a camera, an infrared sensor, and a laser sensor. We chose a Raspberry Pi Camera v2 as the downward-facing camera and an openmv4_h7 as the front-facing camera. For the laser sensor, we selected the TFmini Plus.

Weekly Work Report	
Date of Completion:	May 1, 2011. Assembly and
Introduction: Continuing with	

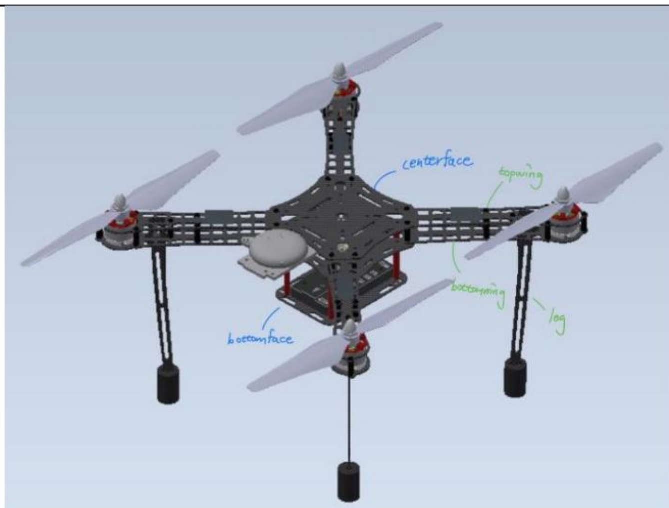
the model used in last year's competition, this week we reassembled the model that we had previously disassembled for easier storage. Since stainless steel screws were not used last year, we found that some of the screw heads had rusted off during assembly. Therefore, the main task of this disassembly and assembly work was to replace some screws that lock the upper and lower plates, the arms, and the arms and motors together.



(The top right photo shows Ko Yung-yung (right) and Chou Yu-lun (left) assembling their equipment.)

一代機					
分類		品項	數量	製程	規格
機體	本體	bottomface	1	碳纖切割	
		centerface	2	碳纖切割	
		長銅柱	4	市購	N/A
	leg子組合X4	bottomwing	4	碳纖切割	
		topwing	4	碳纖切割	
		短銅柱	24	市購	N/A
		雙層短銅柱	8	市購	N/A
		leg	4	碳纖切割	
		降落泡棉	4	市購	N/A

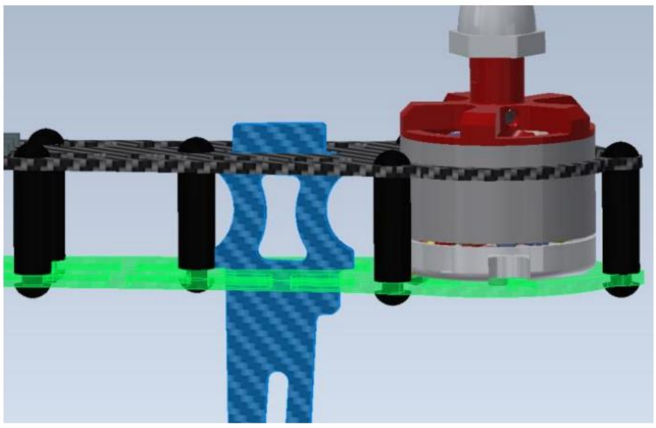
We're continuing with last year's design (see the first generation parts list below). The advantage is that it saves time on some parts design. To ensure that the names of the parts won't be confusing during the design explanations in the following weeks, we'll briefly introduce the function of the carbon fiber cut parts and how they are fixed.



(The part names on the diagram are labeled with the same color as the text of the category items on the parts list.)

First, there is the main body, which consists of a center face and a bottom face, connected by a long red aluminum pillar. The center face has two identical boards, one on top and one on the bottom. The bottom face is used to expand and accommodate functional components such as circuit boards, batteries, and grippers.

Next is the leg assembly, which consists of a bottom wing used to lock the motor, a top wing that is locked to it by short black copper pillars, and a leg fixed between the upper and lower wing. The leg has a thicker part in the middle so that it can be clamped between the upper and lower wing, as shown in the figure below.



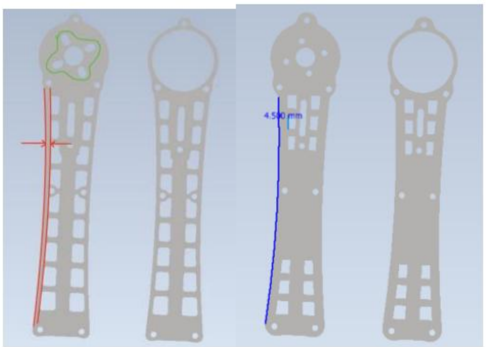
Based on last year's experience, because the existing upper and lower wing boards have many sections cut out in the middle to reduce weight,
When the machine accidentally hits an obstacle or lands at an unfavorable angle, the wing is prone to breakage due to insufficient strength. Therefore, this year we plan to fill in the hollowed-out parts of both types of wings to increase their strength. The leg also has hollowed-out parts, so we will fill them in and send them to CNC machine new plates. This completes the fourth week's report. Next week's goal is to redesign the bottom wing and top wing of the arm. If time permits, we will also rebuild the leg.

Weekly Work Report

Date: May 8, 2011. Continuing from last week's progress, this week

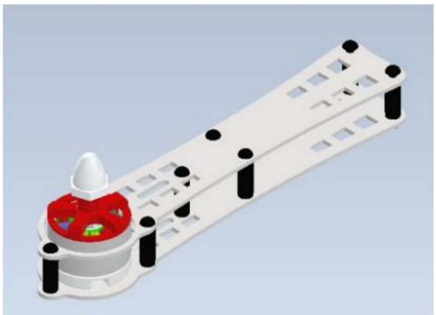
we will redesign the fuselage

arm. First, based on the engineering drawings created last year using the scanning function, and supplemented by measurements with calipers, we have roughly marked the areas we want to mprove on the image. The first is the red area, because last year wing breakage usually occurred here due to its thinness; therefore, this reconstruction will strengthen this area. The second is the motor locking hole on the bottom wing. Last week, when replacing the motor screws, we also discovered that a slot is not actually needed here; a locking hole corresponding to the motor's hole position is sufficient. Finally, mprovements will be made to the hollowed-out sections on both sides of the wing used for weight reduction or wiring.



(The order of the two images from left to right is bottomwing and topwing) The drawing result is shown on the right

of the image above. The hollowed-out part leaves six holes at the front and six holes at the back to ensure that the middle part of the wing still has sufficient strength. In addition, the first point of improvement is that we will increase the thickness of the boundary by about twice the original to avoid repeating the same mistake this year. The arm assembly, the overall assembly and the image below (the PM06 power distribution board will be fixed to the lower centerface).



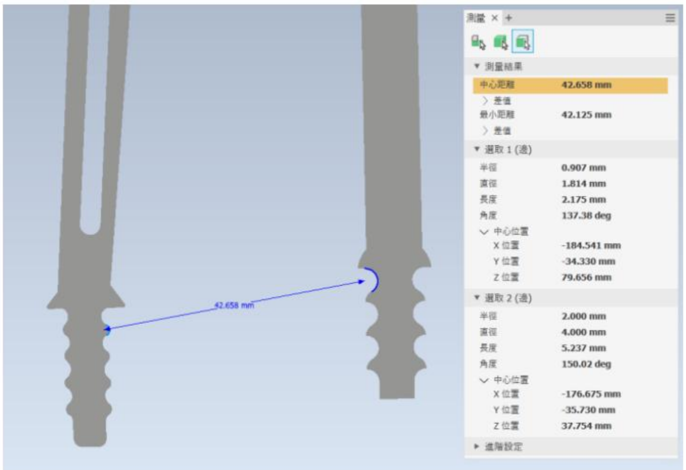
Finally, we redesigned the wing, manufactured and trial-assembled it using 1.5mm acrylic sheet laser cutting, to ensure that it did not require design changes and was of standard size that could be sent for CNC cutting. The assembly photo of the wing and the leg can be seen in the picture below, where the redesigned wing can also effectively fix the leg.

This concludes this week's progress. Next week, the rebuild of the leg will be completed, and the rack mounting for the Pixhawk will be redesigned.

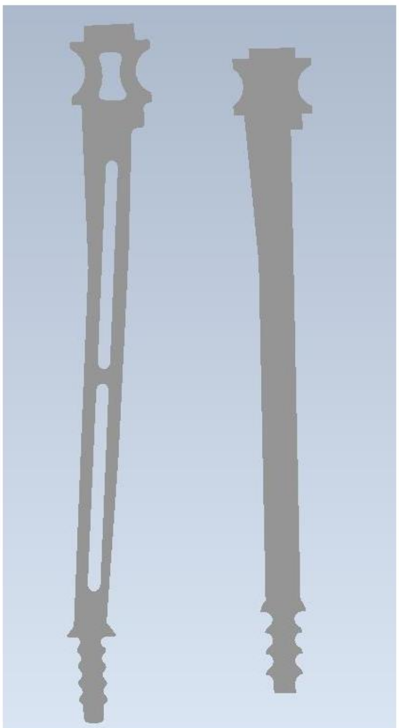
4. Shock absorption kit (Note: The GPS positioning system will be fixed using last year's configuration).

Weekly Work Report	
Date: May 15, 2011. Follow	ing up on last week's progress, this week
the leg was redesigned. Similar	

to last week, the engineering drawings created last year using a scanning function were used, supplemented by measurements with calipers. The hollowed-out parts of the leg were filled in. Considering that this year's CNC machining manufacturers' tools cannot process dimensions smaller than 2mm, but the minimum dimension at the old leg insertion point for the landing foam was less than 2mm (see the image below, 0.907mm), all dimensions at this point were changed to 2mm to comply with manufacturing limitations.

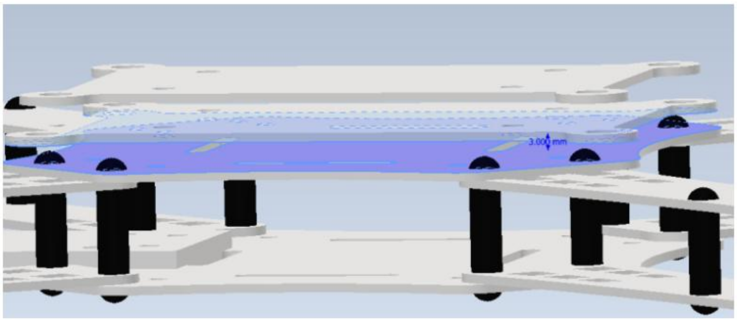


In addition, the actual measured height of the leg below the bottomwing on the arm was 158mm, so the length of the newly designed leg was adjusted. The final comparison of the two is shown below.



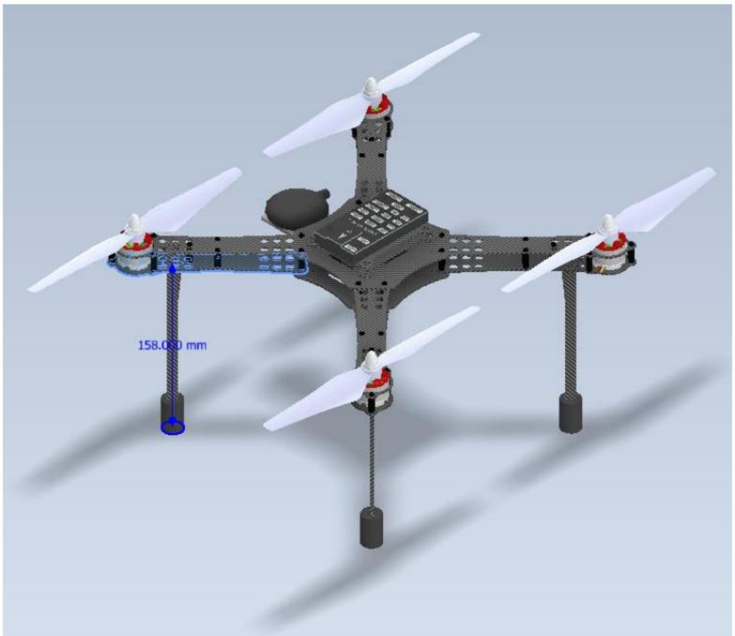
Finally, for the design of the shock absorber kit, please refer to the following diagram.

Two shock-absorbing plates were designed. The lower shock-absorbing plate is expected to be fixed to the upper ceramic face with sufficiently adhesive foam and raised to avoid interference with the screws connecting the main body to the arm. The assembly diagram is shown below. The Pixhawk 4 will be placed on the upper shock-absorbing plate, and the two shock-absorbing plates will be connected by four shock-absorbing balls (not shown in the software, but represented by the diagram below) to help absorb shock.



Note 1: Because we wanted to retain the original design of the centerface, we did not directly drill holes in the upper centerface to fix it to the upper shock-absorbing plate with shock-absorbing balls. Otherwise, directly drilling holes would have saved weight and space. Note 2: The distance between the upper centerface and the lower shock-absorbing plate in the above diagram is 3mm. The actual installation height may not be this. Just ensure that the two plates are not interfered with by the screw heads connecting the arm. Finally, assemble the whole machine, continuing to use the mounting plate of last year's GPS positioning system. The complete assembly is as follows. Confirm.

The distance from the bottomwing to the ground (the bottom of the foam base) is the same as the actual measurement, which is 158mm.



The reconstruction and design of the rack have been largely completed this week. Since the first-generation rack is relatively small and many new parts have been added this year, it is necessary to increase the area of the original bottom face in order to have enough space to place the components. We will start working on this aspect of the design next week.

Weekly Work Report

Date: May 22, 2011	. CAD drawing of the machine

body. Due to the

space requirements for parts mentioned last week, a new bottomface will be redesigned this week. First, we need to determine the functional components to be placed on it, including RPi4, lower lens, laser sensor, battery, perforated board, and the previously designed lens fixing mechanism and electromagnet mechanism for picking up the metal box. This week, we will first sketch the hole positions of RPi4, lower lens, and laser sensor. Except for RPi4, the other two parts will be locked under the bottomface. Therefore, to avoid overlapping of the locking holes, their projections on the sketch will actually overlap. However, it is impossible for all three parts to be flat on the bottomface. Currently, RPi4 will be raised to avoid interference. The sketch is as follows.

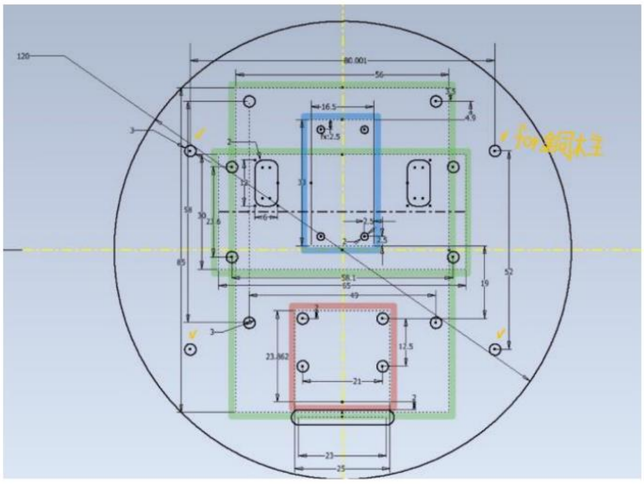
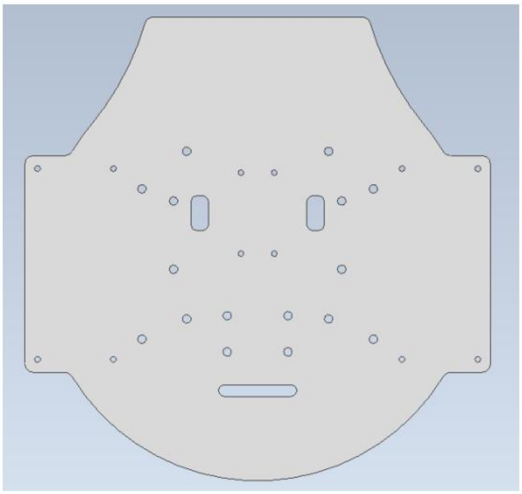


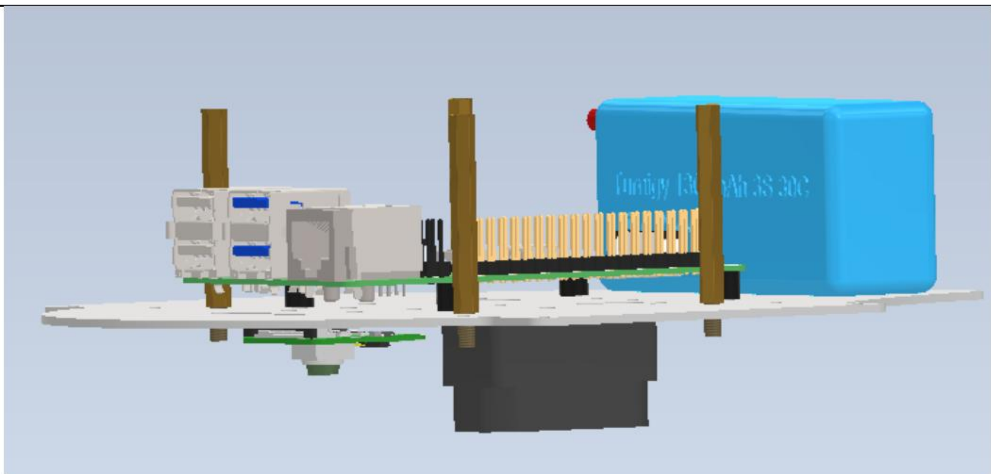
Image caption: The dotted lines in the image indicate the relative position of the part placed on the bottom face; the green areas represent... RPi4 (you can see two green ones, which are for the bottomface configuration that can be used by both types of circuit boards), red for the lower camera, blue for the laser sensor, and the four holes marked in yellow are the copper pillar lock holes for the bottomface and the lower centerface. The battery and

perforated board are still to be placed. Considering weight distribution, the heavier battery will be placed in the middle, and the perforated board will be placed on the left or right. However, since we don't want to waste extra space, rectangles will only extend from the left, right, and rear sides (top in the top view), with rounded corners. The basic shape of the bottomface is shown below. The expansion parts of the bottomface will be designed based on the lock holes of the two mechanisms mentioned above that have not yet been designed.



(Note: The slots that look like eyes and mouths in the picture are for facilitating cable routing.)

Next, the bottom functional area, with the bottom face as the main body, will be integrated as follows. The battery will be fixed by Velcro, and a groove will be opened on the bottom face so that the Velcro can wrap around and bind the battery. However, the size of the Velcro is not yet determined. As for the perforated plate, it is not drawn in the engineering drawing. At present, only the key hole is drawn.



This completes the seventh week of expansion on the bottomface. The overall assembly is shown in the image below. Next week's goal is to design the mechanism for fixing the front camera. As for the arm, we will directly use the second-generation arm designed next week, and adjust the arm length according to the height of the leg from the ground.

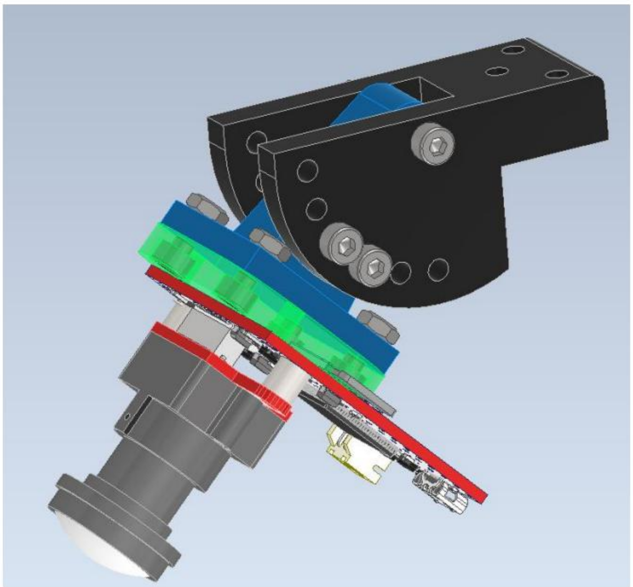
Weekly Work Report

Date filled in: May	29, 110 (Drawn as CAD for

machine body)

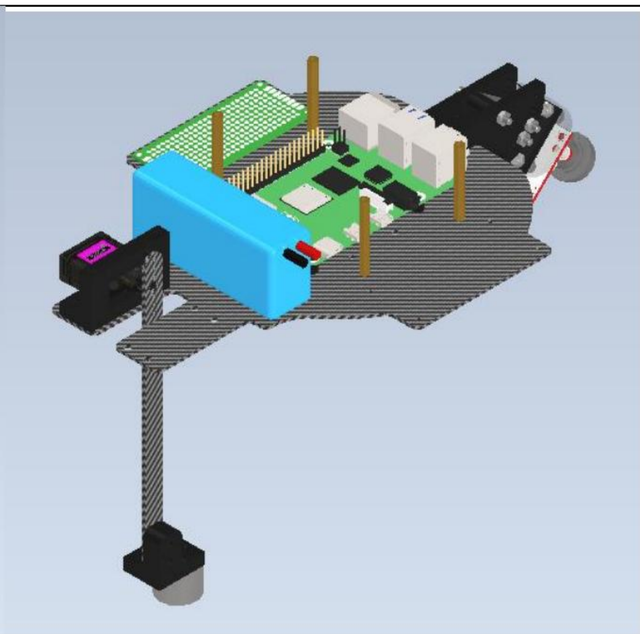
This week we designed the front lens mounting device, which is inspired by a photography-related device called a "gimbal". Its function is to fix the photography equipment on it and it has a free axis of rotation. See the picture below for reference.

Since the front lens we use only needs to be able to see the scenery in front of the camera, we only designed a mechanism to adjust the tilt angle, as shown in the figure below.



The black part is called the gimbal base, which has three locking holes on the rear flat surface to lock with the bottom face. The blue part is the gimbal base 2, which acts as a bridge connecting the base and the front lens. It has two locking holes and can be fixed to the base with screws. The base also has multiple holes for adjusting the tilt angle. It is worth mentioning that the green part, the front lens mounting plate, is first locked to the base 2, and then the front lens is locked to the mounting plate. The purpose of this design is that the front lens still needs to be tested. If the lens needs to be replaced in the future, it is not necessary to redesign and print the locking holes on the base 2. It is only necessary to modify the locking holes on the mounting plate according to the holes on the selected lens. This can also effectively reduce 3D printing time. Next is the arm. We

directly refer to the gripper mechanism designed by the second generation machine and adjust the arm length according to the leg length, as shown in the left figure below. For detailed design explanations, please refer to the weekly report of our other team (team number C09) in the same week.



Finally, we flattened the front end of the bottomface to prevent the gimbal base from being interfered with by the curved part. We then extended a rectangle at the rear and designed a locking hole for the L-shaped mechanism of the arm. We also designed a groove, similar to the third layer plate of the second-generation machine, so that the arm can rotate without interfering with the bottomface.

Add the previously added lens assembly and arm to the bottom functional area, and also assemble the perforated plate. The assembly is shown in the right image above. The final assembly is shown in the image below. This completes the design of all the mechanisms of the first-generation camera. Next week's goal is to study how to control the electromagnet.

Weekly Work Report

Date entered: June 5, 2011. Testing the gripper: After

discussion this

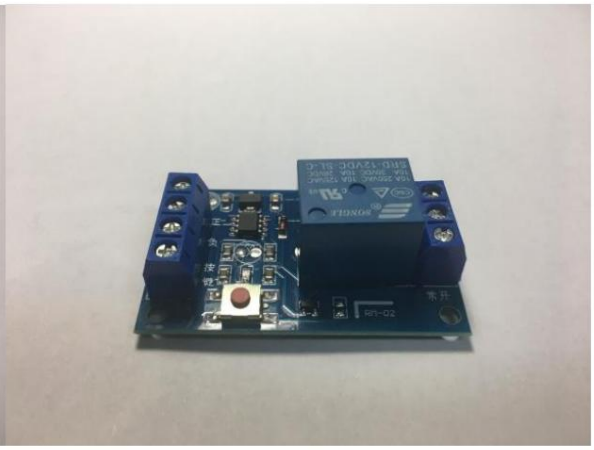
week, it was decided to first use an electromagnet as the tool for gripping goods. First, suitable [products/equipment] were found online.

The electromagnet and relay were tested first, and the electromagnet's attraction force was tested to see if it could lift the small iron box.

Electromagnet:

We'll first choose an electromagnet with a suction force of 2.5KG, a weight of 25G, and a voltage of 12V/0.26A. If the function isn't ideal, then try...

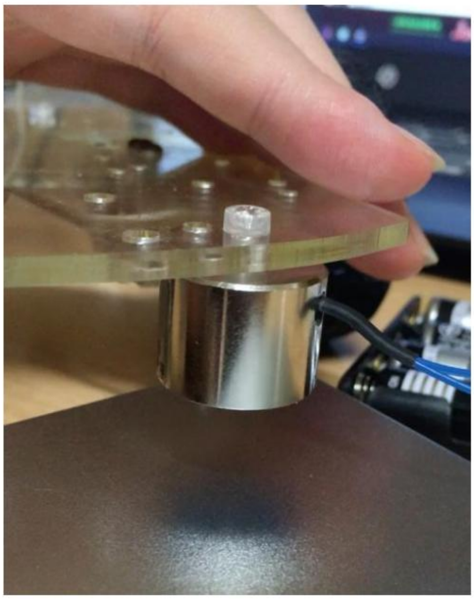
Use one with stronger suction.



After testing, we found that this electromagnet has enough force to lift the small metal box, even after vigorous shaking.

It won't fall down even if it moves, but it only works when it's very close to the small metal box (about 0.3 cm). Therefore, after discussion, it was decided that it might be necessary to attach it to a robotic arm to reach the box, otherwise the plane would land directly on the ground.

In addition, electromagnets can overheat when used for extended periods, so this issue may need to be addressed; otherwise, the electromagnet module might burn out during flight in competitions.



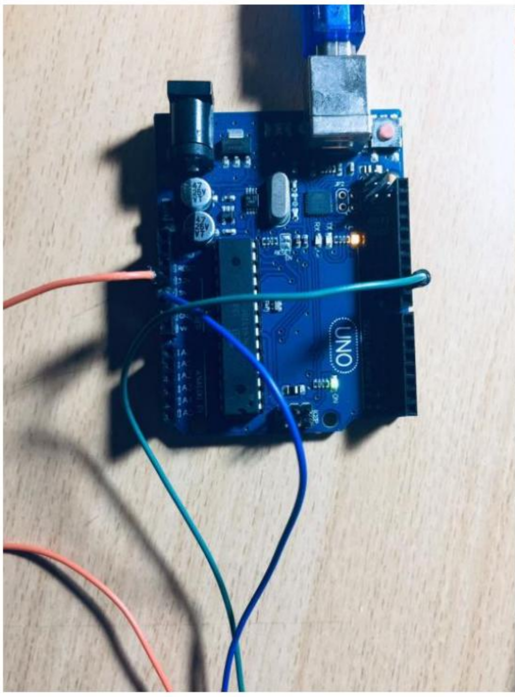
Next week, we need to figure out how to connect the relay and the electromagnet to create electromagnet magnetic control so that the goods can be lifted and lowered reliably.

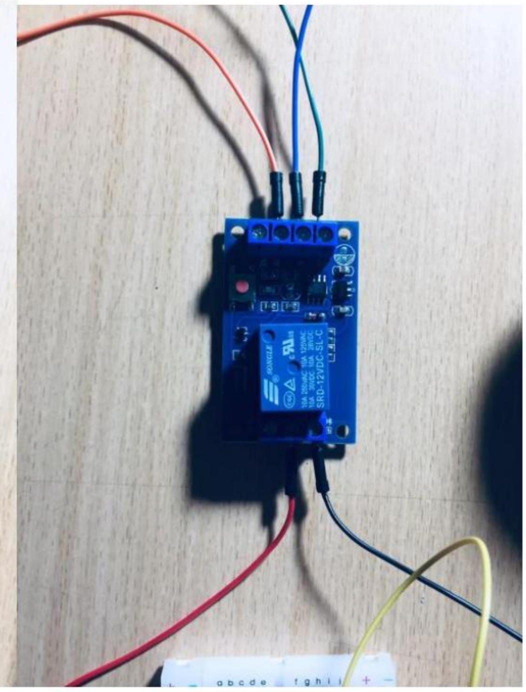
Weekly Work Report

Date entered: June 12, 2011. This week, we continued testing the

electromagnet gripper,

following last week's experiment. We also continued testing the connection between the electromagnet and the Arduino relay to control the lifting and lowering of the metal box.

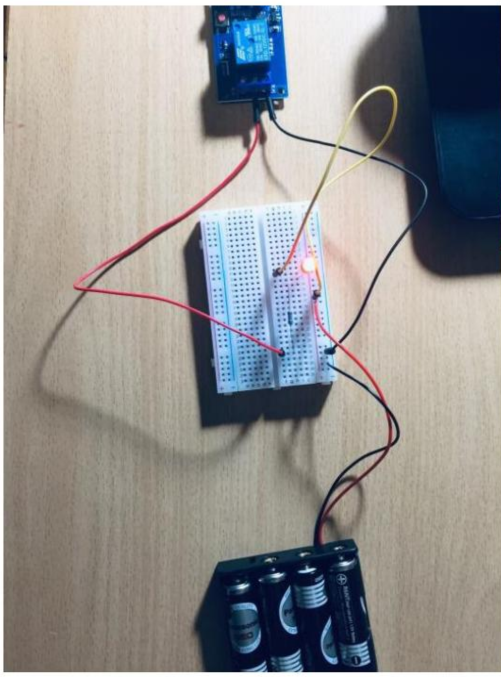


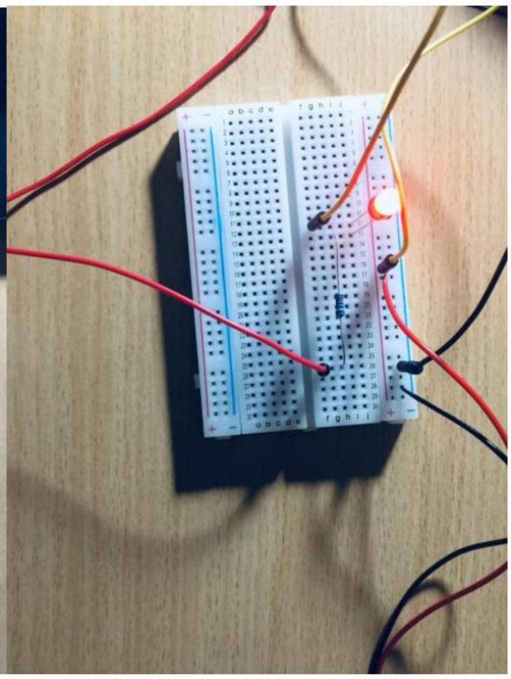


The key testing focus was on the connection between the relay and the electromagnet, and overcoming the problem of battery overheating. Electromagnet (net weight)

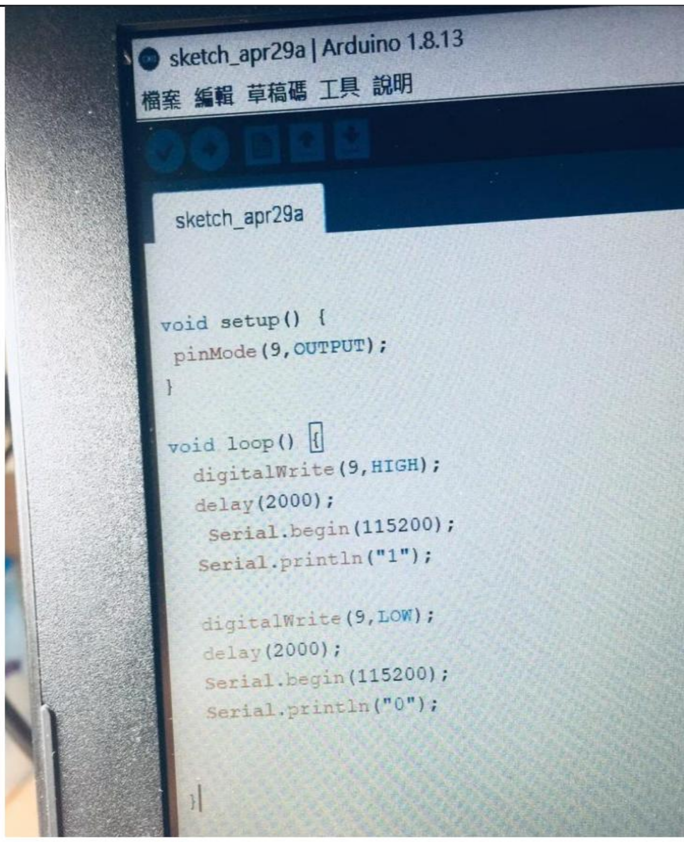
The electromagnet has a suction power of 2.5kg (25g), and the relay is an Arduino single-button 12V relay. First, try connecting the electromagnet and the relay through a breadboard and DuPont wires,

and use whether the light bulb lights up as a criterion to determine if the connection is successful.





After testing, it was found that the electromagnet was functioning normally, but the relay did not respond when connected to the laptop.



Further investigation revealed a connection port issue: the COM port was not displayed on the laptop, possibly due to a lack of support on the laptop.

After researching the Arduino UNO USB port, I tried installing the CH340 driver.

3. 點選連接埠 (COM 和 LPT)，出現如圖 10-7(b) 畫面。如果連接埠 (COM 和 LPT) 中沒有出現 Arduino 佔用的序列埠，而是出現其它裝置下有偵測到一個 USB2.0-Serial 的裝置，這表示電腦無法判讀這塊 Arduino 板，必須從網路上以關鍵字搜尋下載 CH340 驅動程式。首先找到可以下載這個程式的網頁，參考相關網頁說明，並於下載後解壓縮，然後執行檔案夾中 SETUP.EXE 檔。安裝後，其它裝置裡的 USB2.0-Serial 就會自動消失，而在連接埠 (COM 和 LPT) 中出現 USB-SERIAL CH340 的裝置就是剛插入的 Arduino 開發板，讀出它所佔用的序列埠，在 Arduino IDE 中工具下選取開發板使用的序列埠。

(a) Windows 視窗左下角 Start(開始) 鍵上按右鍵出現的選單

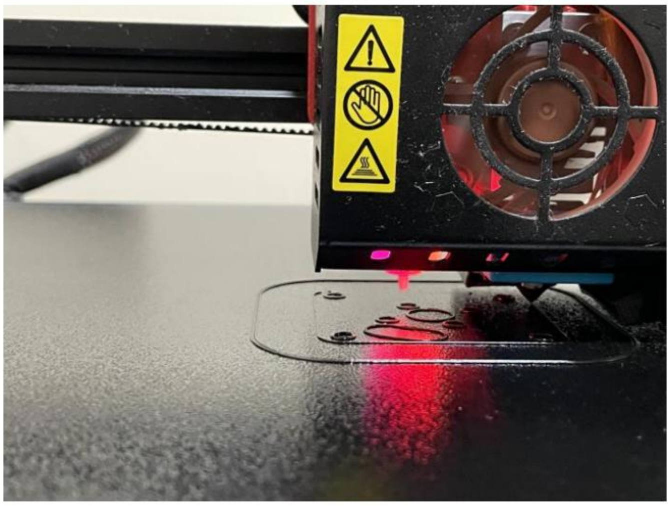
(b) Arduino UNO 尚未接電腦前，裝置管理員下的連接埠 (COM 和 LPT) 內容

Weekly Work Report

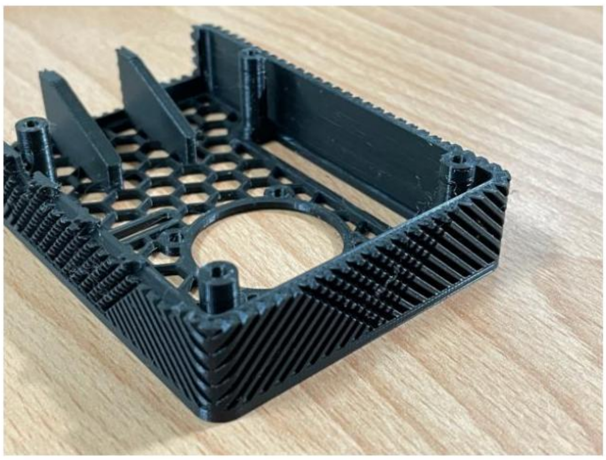
The 3D printing unit, dated June 19, 2011,

relies

heavily on 3D printing for its four-axis design, including side panels for mounting sensors and grippers for picking up metal boxes. Therefore, after completing the CAD model, we enthusiastically began prototyping and manufacturing using a classmate's 3D printer. The image below shows the 3D printer in operation.



The rapid prototyping capabilities of 3D printing allow us to quickly test the compatibility between parts before actual cutting. Before processing the sheet metal, we first use 3D printing to confirm whether the dimensions of the parts will cause interference between the mechanisms.



The image on the right shows a Raspberry Pi casing manufactured using 3D printing. Using 3D printing, we can save... Instead of spending money on a physical case, you can design and choose one that suits your needs. We'll be using the Raspberry Pi for a lot of complex visual calculations, which generate a lot of heat. Therefore, we'll need a cooling fan to prevent overheating and ensure smooth operation. The case design must be compatible, including a way to mount and lock the fan in place.

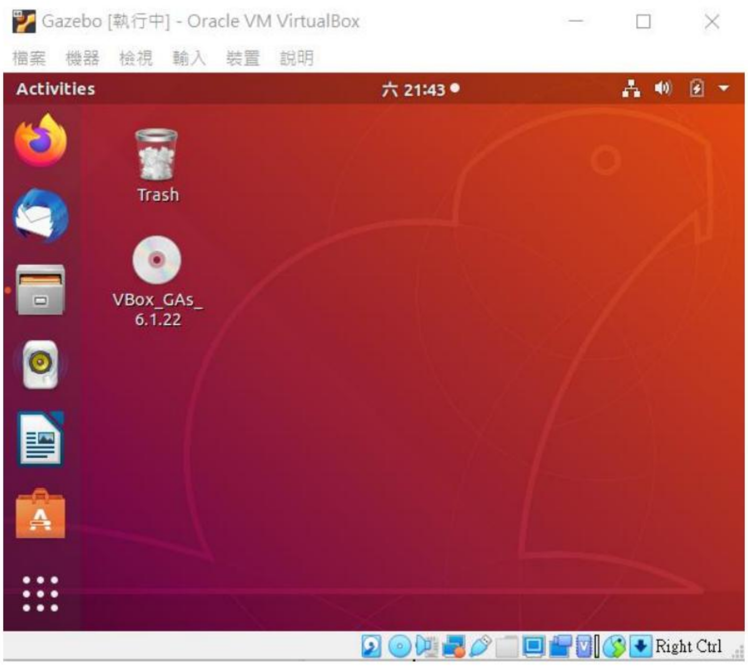
Weekly Work Report

Date: June 26, 2011. Creating a virtual

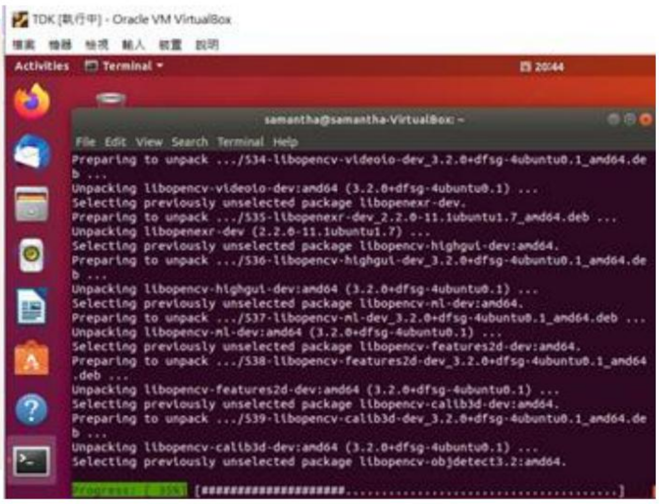
environment: This

week we wanted to build a virtual simulation arena for practice, and we chose to use Gazebo.

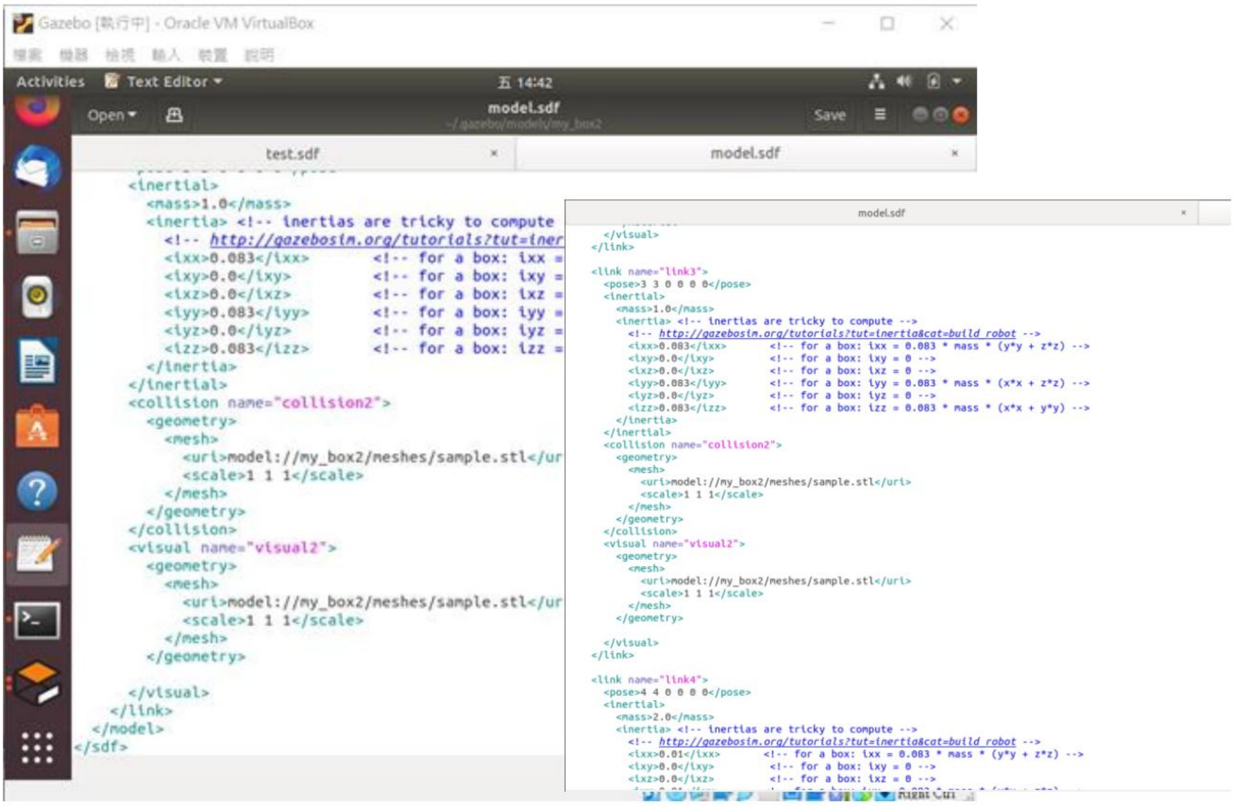
First, install Virtual Machine:



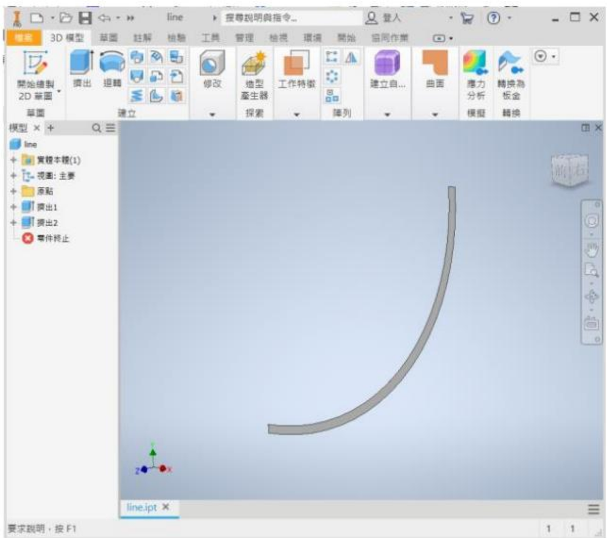
Then install Ubuntu 18.04.5 (a version compatible with Gazebo):



And I learned to type Gazebo commands myself:



Try sculpting some objects or importing 3D files from external sources.



Gazebo tutorial websites:

http://gazebosim.org/tutorials/?tut=build_robot http://gazebosim.org/tutorials?tut=build_model http://gazebosim.org/tutorials?tut=color_model

Weekly Work Report

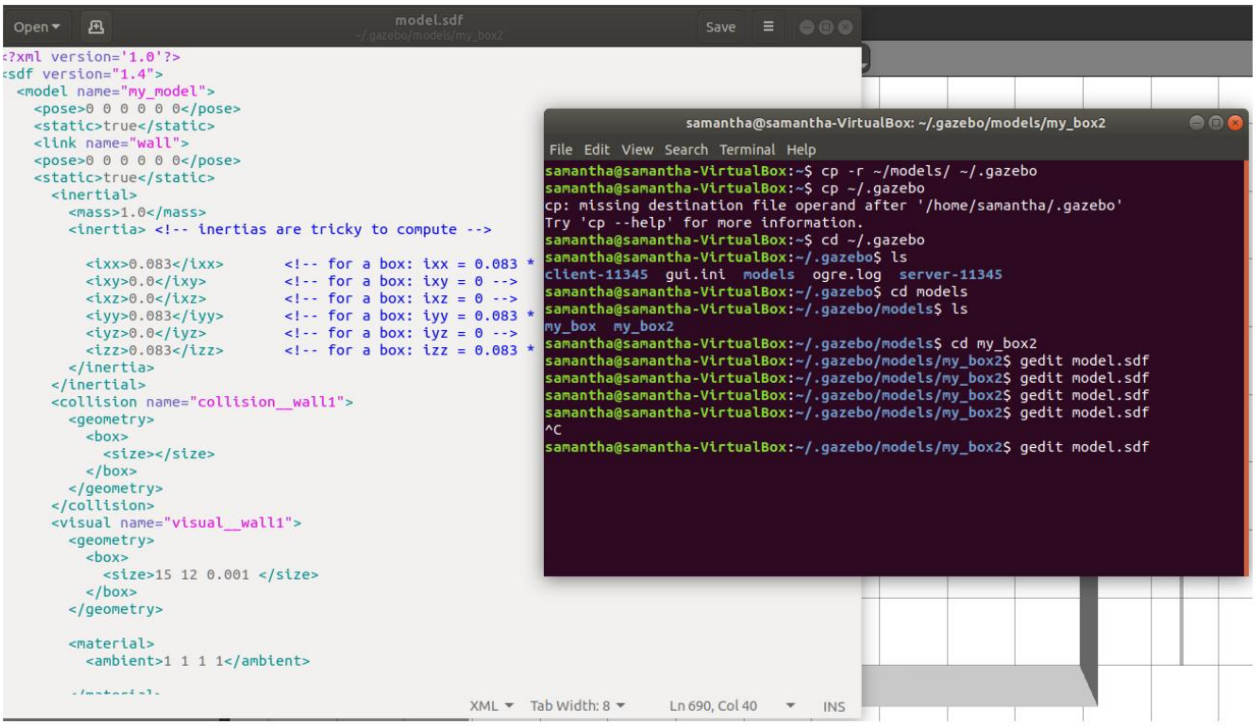
Date entered: July 3, 2011. Virtual Environment

Creation: Continuing

from last week, the necessary software for the virtual environment has been installed. This week, we will continue creating the virtual environment, preparing for...

In the virtual machine, the Gazebo environment is used to create a virtual field to dynamically simulate quadcopter operation.

Use the command `gedit model.sdf` to open the SDF file editing environment.



Then, based on the site specifications in the manual, a three-dimensional site was created.

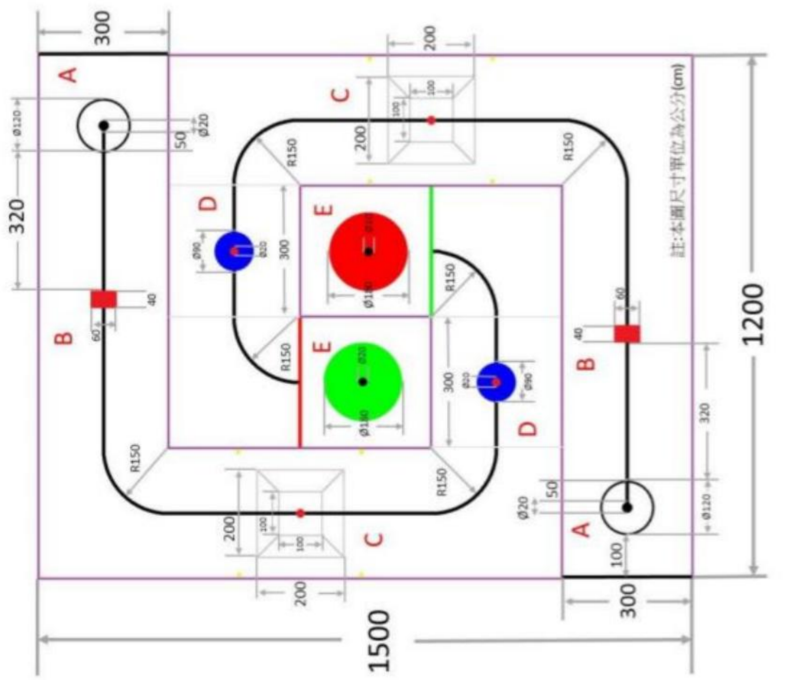
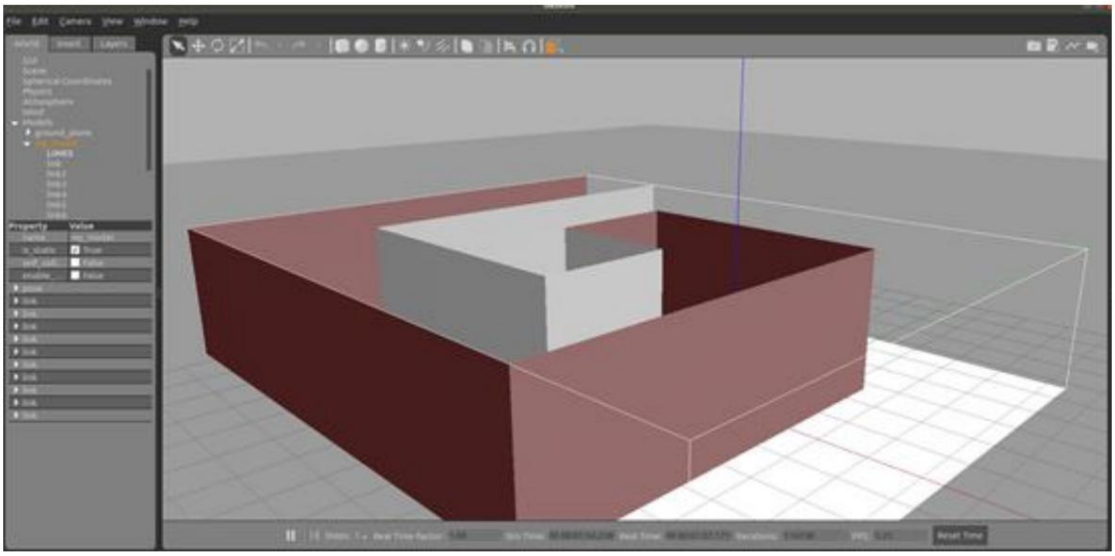
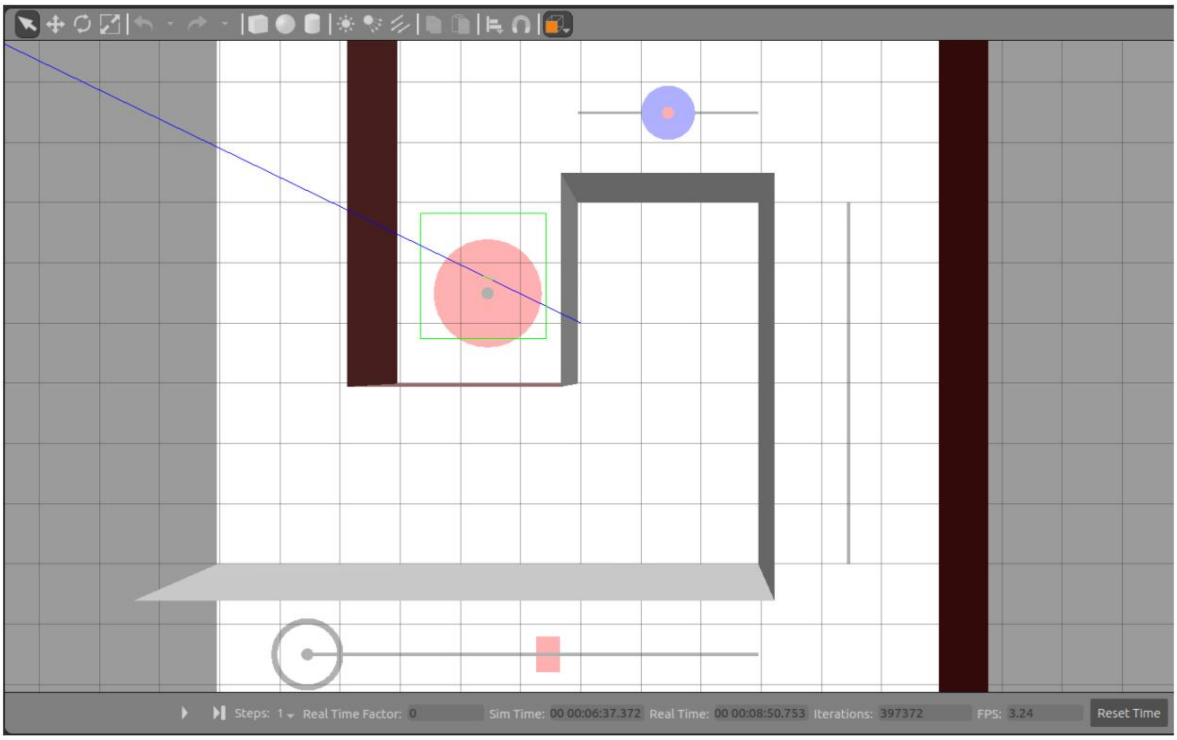


圖 2、競賽場地尺寸圖(單位 cm)

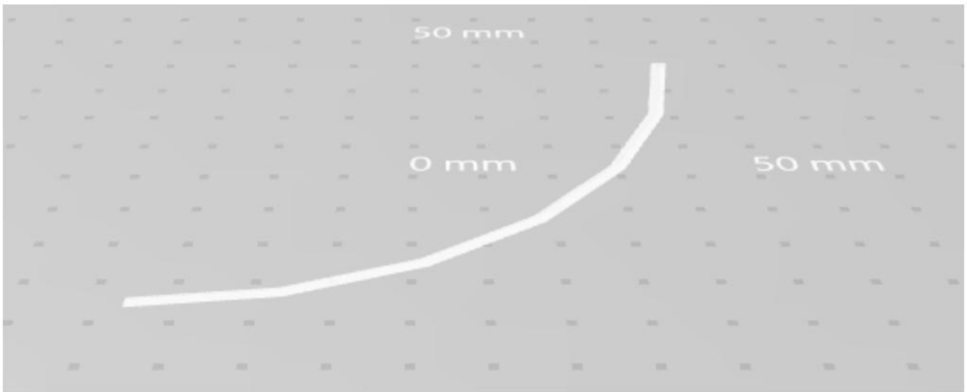
Side view of the venue



Site top view



However, the curved lines on the floor are still not resolved; I plan to draw them using Iventor and then import them into Gazebo.



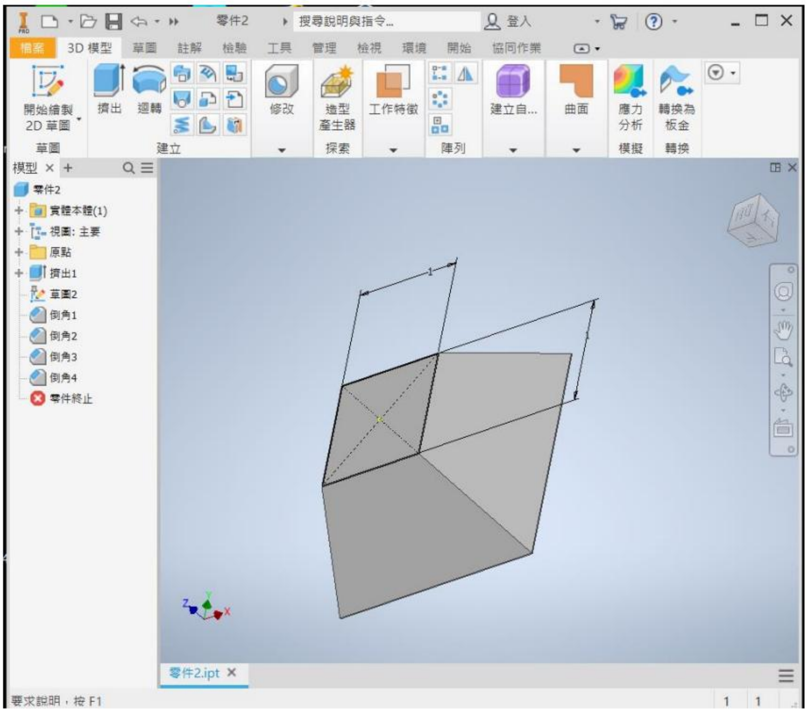
Machine Translated by Google

Weekly Work Report	
Date entered: July 10, 2011	. Virtual environment creation continues
from last week's virtual	

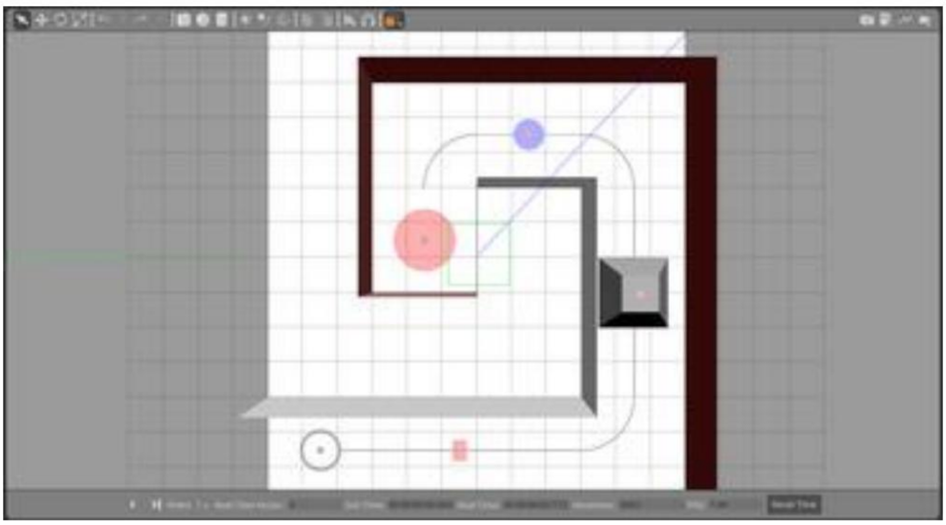
environment creation. It is expected that the remaining 3D entities will be created and placed into the virtual reality environment.

Just like last week, I first used Inventor to draw the curved lines at the corners of the floor, but after importing them into Gazebo, I couldn't see any entity appear. Later, I found that it was because the export unit specifications were different from those in Gazebo.

After resolving the three curved lines in the corner, continue drawing the salt mountain using Inventor:



I then imported it into the virtual environment in Gazebo, made some minor adjustments to its position, and the final virtual environment was complete!



Weekly Work Report

Date: July 17, 2011 Software Architecture Establishment and

Preliminary Testing

Due to the pandemic, the progress of physical implementation will inevitably be affected. Delays in software development could impact the final product's completion or even prevent its completion altogether. Therefore, software testing and simulation are being conducted concurrently with the hardware development phase. The simulation will cover the program architecture, security, and control. The control aspects will show the greatest difference between the actual system and the simulation, requiring parameter adjustments after physical implementation. However, simulation can provide a general direction for these adjustments. This week's progress includes architecture planning. Both the simulation and physical system architectures are built on ROS, with each node communicating with the flight controller via MAVLink. The planned firmware is...

The PX4 software environment is Ubuntu 18.04, and the emulation platform is Gazebo. The overall software architecture is shown in Figure 1 below.

Figure 1

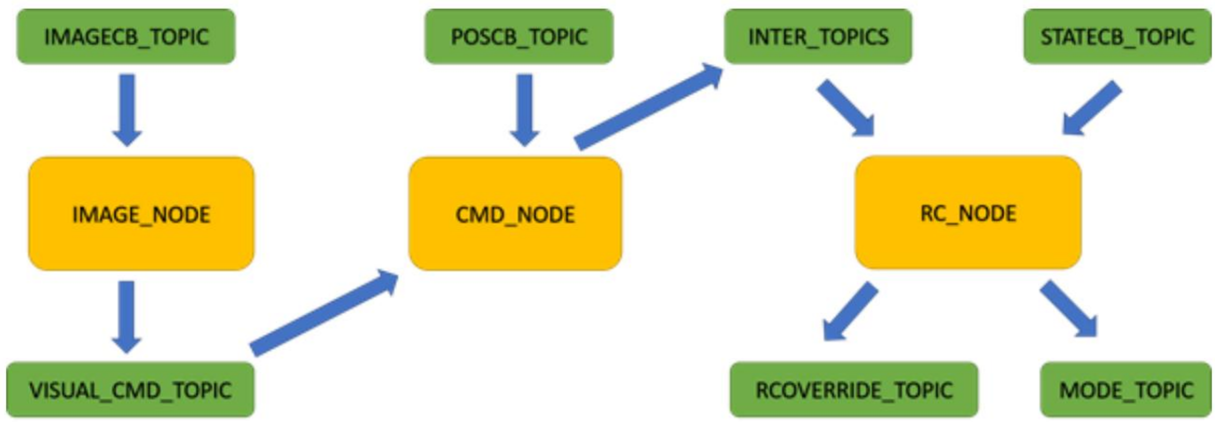


Figure 1 shows the nodes and topics to be set up. The arrows indicate extraction and sending. Nodes communicate with other nodes by extracting topics and sending messages to those topics. This week's progress is to complete this architecture and the virtual environment. See Figure 2 for the virtual environment (including the integration of the venue and the machine).

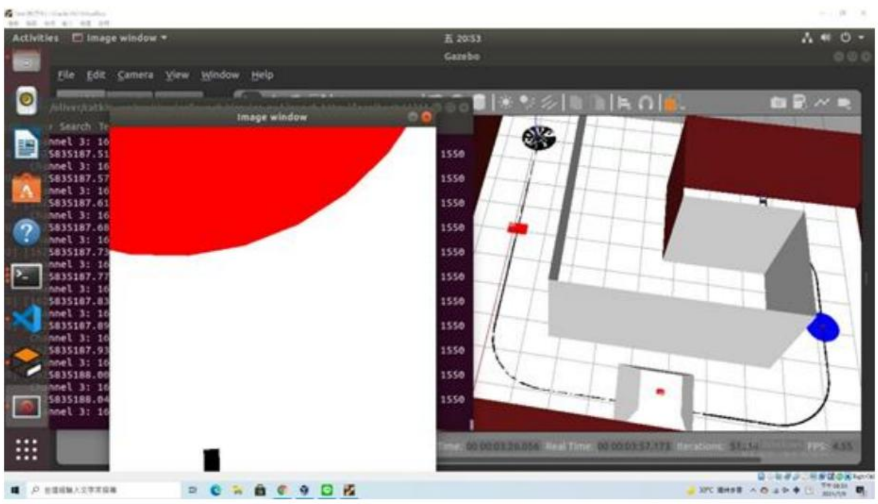


Figure 2 shows the virtual environment and test diagram (the red circle indicating simple line following to the end).

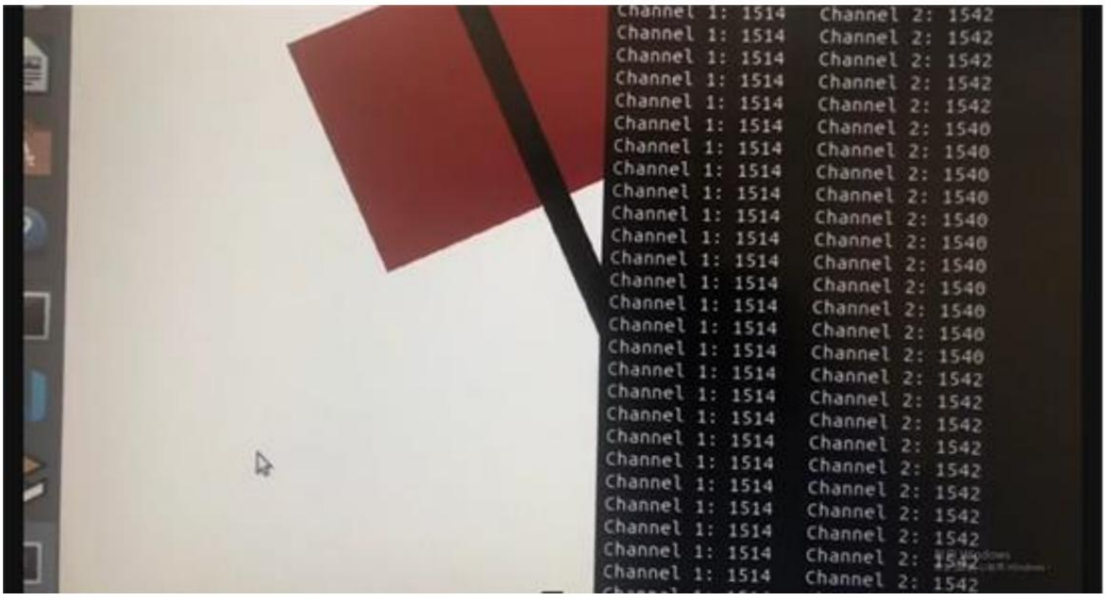
This week's progress also includes completing simulated tracking and altitude hold tests. In sending control signals, the method of overwriting the remote control channel was chosen because it is more intuitive and simpler. Altitude control uses discrete remote control signals and a P control.

The tracking device uses a simple yaw angle rotation combined with forward movement. The program calculates the distance from the center of the screen to the line and the line vector, weighting both to determine the forward direction, which is an angle. Since the actual remote control signal is not an angle controller, a PD controller was attempted (a P controller was tried, but with poor results). At a constant altitude of 1.5m (because the P controller operates slightly below 1.5m), good convergence results were achieved. The current simulation progress allows for complete flight (pure tracking ignoring other signals). Due to the lack of a complex mathematical model, adjustments are made based on guesswork. The general parameter adjustment logic is to first add a P controller to align the calculated control values with the remote control signal. For angle control during tracking, considering the difference between the calculated control values (angle) and the remote control signal (angular velocity), a simple P control might have a delay issue; therefore, a D term was added.

In addition, the assembly and production of the actual machine is also underway this week. Since the materials are ready, it is expected to be completed next week.

Weekly Work Report	
Date entered: July 24	2011. The progress of this
week's light signal judgment and	

hovering test continued from last week, attempting to simulate visual hovering. After several attempts, it was able to at least maintain the visibility of the target object, but it still swayed left, right, forward, and backward without converging, as shown in Figure 1 below, attempting to hover in the initial red light area. As for how to achieve convergence later, it may require adjusting parameters using a live device or redesigning the controller.



As the

airframe is largely complete this week, the hovering and convergence testing is expected to proceed directly to live-action testing. Depending on the results, we will determine whether a different controller design is needed, or if parameter adjustments will suffice. The live-action testing progress is shown in Figure 2.

Flight can already be controlled by a remote controller. Next week, we will assemble the onboard computer and attempt to control the aircraft via computer.

Figure 2

Before conducting actual flight testing, we tested the connection between the onboard computer and the flight controller this week. Using PX4 and RPI, we established a node via ROS to read flight controller information and send control signals to control the aircraft. Communication between the two systems worked without issue this week, as shown in Figure 3. The interface is UART, with the flight controller's telem1 set as the communication port, and the RPI's serial port set to ttyAMA0. As shown in Figure 3, the launch flight controller node has the same Topic as the simulation, enabling communication between the two systems.

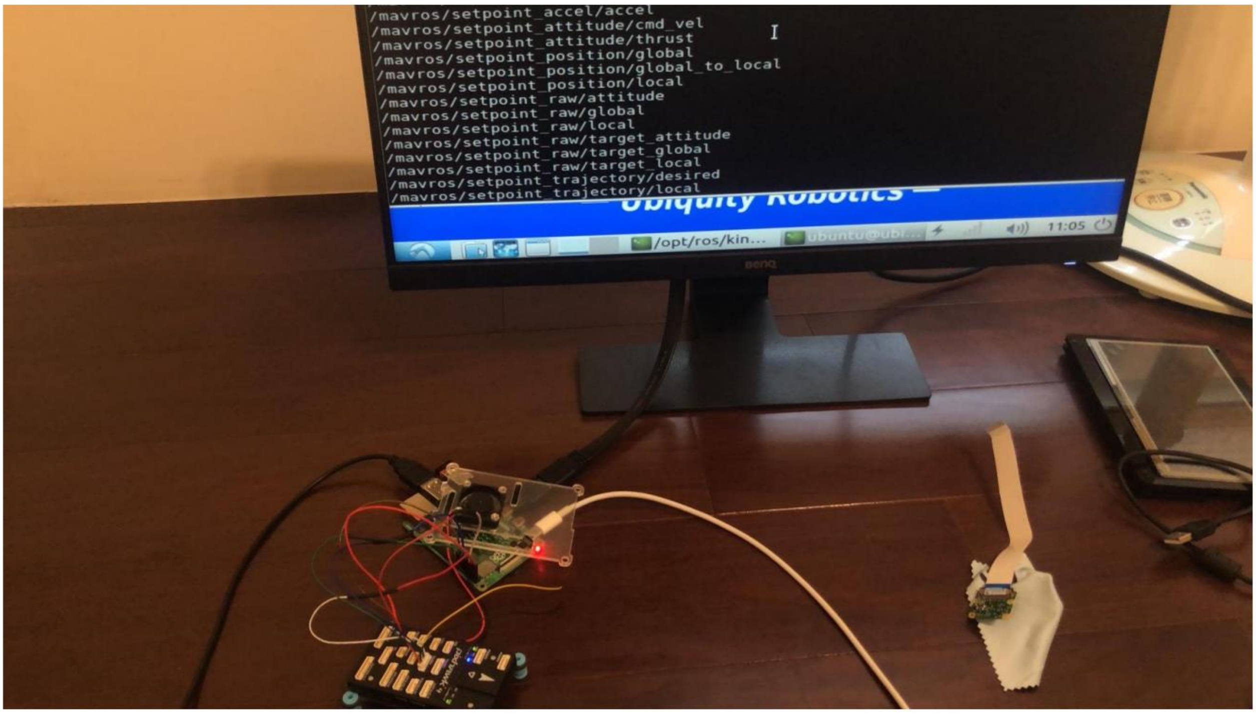


Figure 3

also shows RPI camera testing conducted this week. Although one RPI camera interface failed, spare parts were available.

It will not affect the progress.

Weekly Work Report

Date: July 30, 2011. Regarding the integration of simulation and physical systems:

Although the programming principles of simulation and physical systems are the same, there are slight differences in certain nodes and the acquisition of sensor data. For example, in the simulation, the data is sent to a Topic, but in reality, an RPI camera is used, requiring custom parallel threads or nodes to be written. Furthermore, in physical integration, safety switches are necessary to ensure that the program executes until landing and disarming in the event of a loss of control. This week's progress focuses on these two aspects. Figure 1 shows the safety mechanism for the bladeless test, ensuring disarming after program interruption. During testing, it was found that ROS does not check whether there is actually a connection to the flight controller; this requires special attention, and currently there is no good solution.

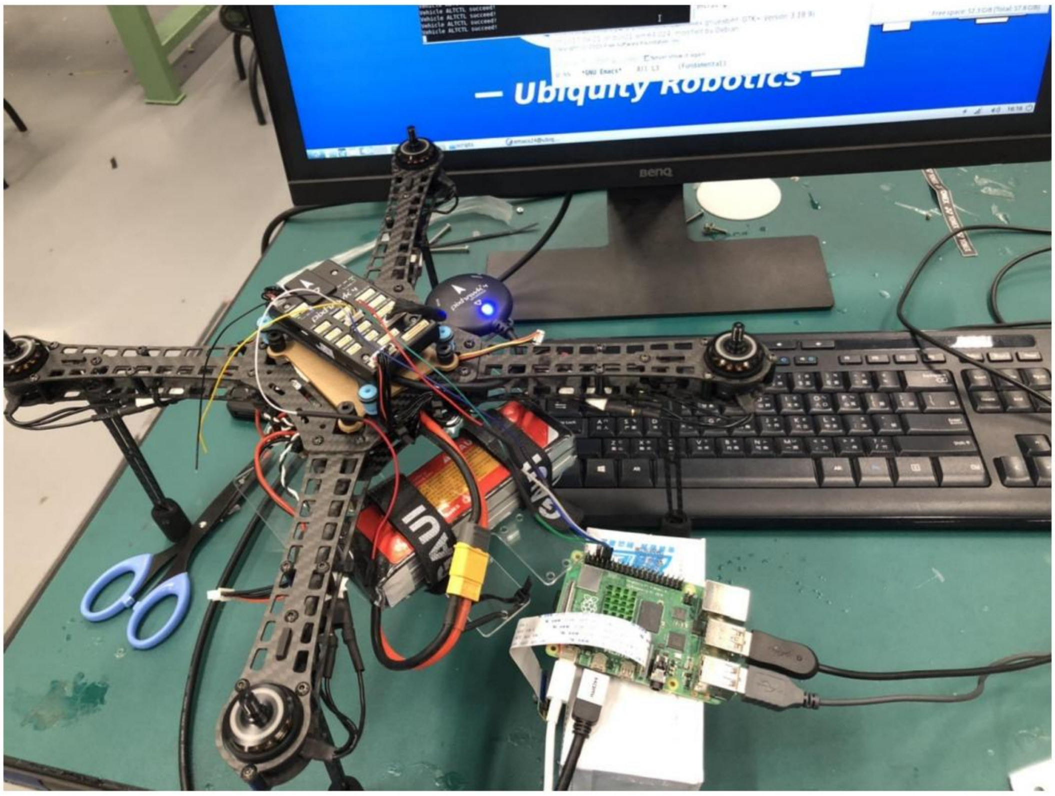


Figure 1

The hardware progress involves installing the onboard computer and starting testing at the designated site, the actual condition of which is shown in Figure 2 (to be supplemented).

In addition, curve calibration of motor and control signals was also carried out simultaneously this week. According to the official PX4 documentation, by inputting experimental signals and thrust data, the originally linear thrust can be curve-fitted to reduce control oscillations. Figure 3 shows the experimental setup and configuration. Since the PWM signal does not require the same control board, an Arduino was used for ease of experimentation. The setup in Figure 3 can be tested immediately after mounting the propellers, and the experimental data can be recorded and input into the flight controller for calibration. Future plans include internal PID parameter tuning of the flight controller's autotune.

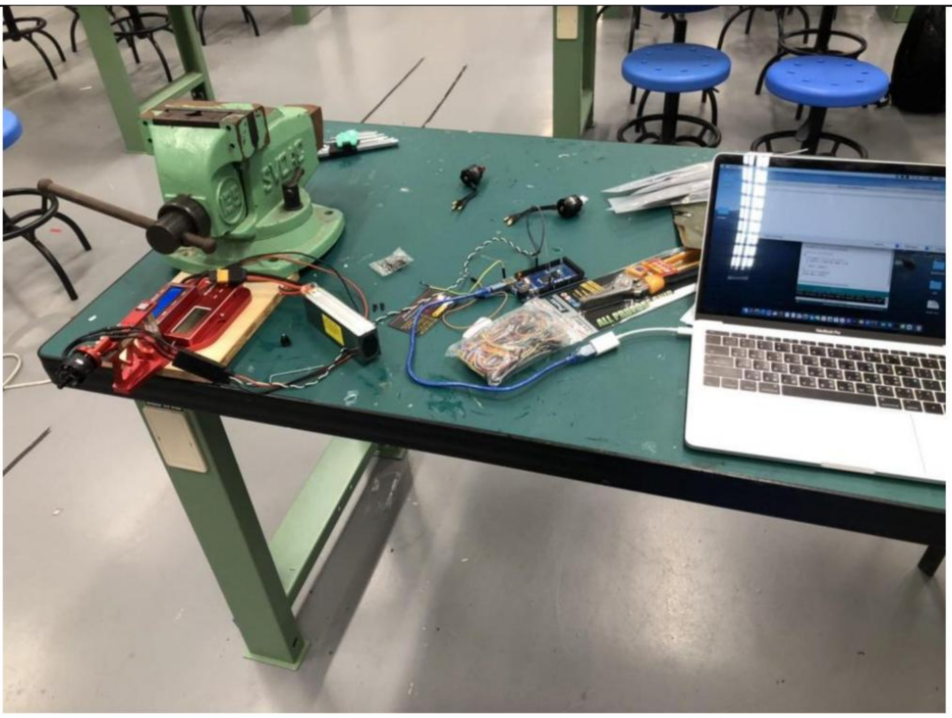


Figure 3