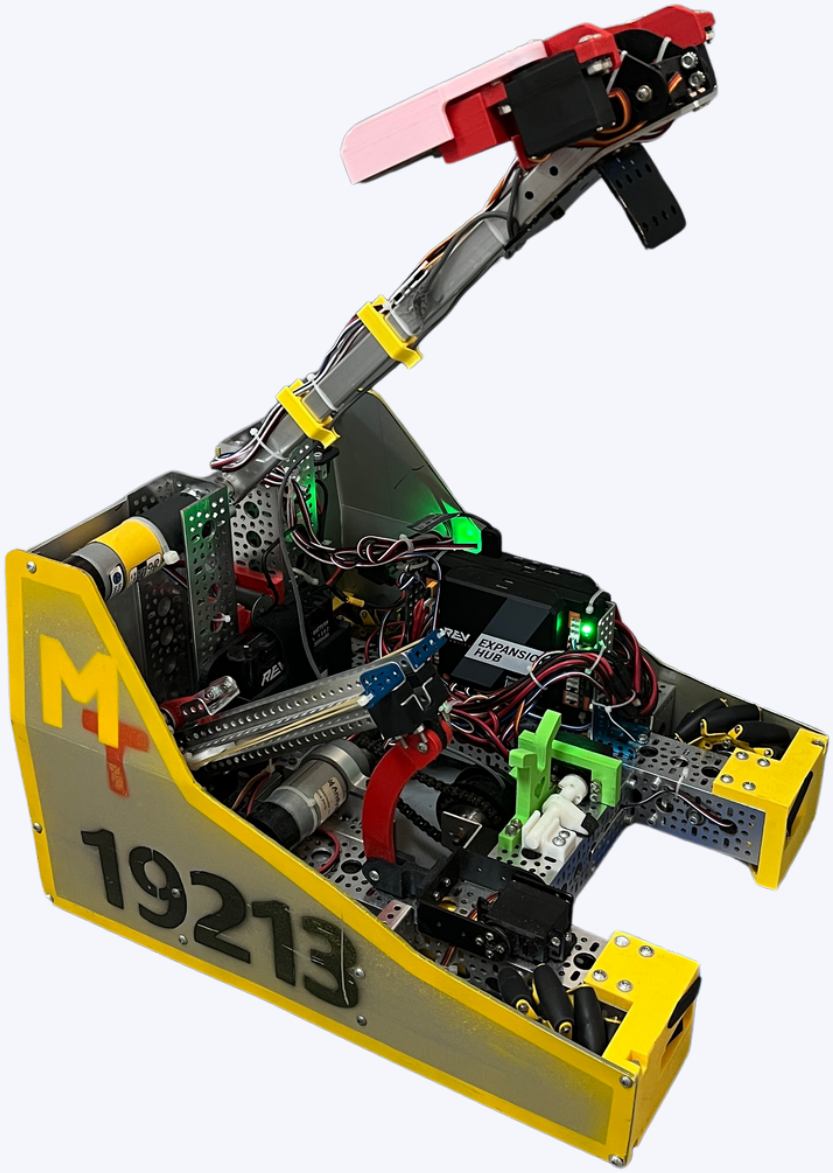
MYSTERY 19213

FIRST Tech Challenge



WE ARE A TEAM!
WE ARE A FAMILY!
MYSTERY! MYSTERY! GO! GO! GO!

Taiwan

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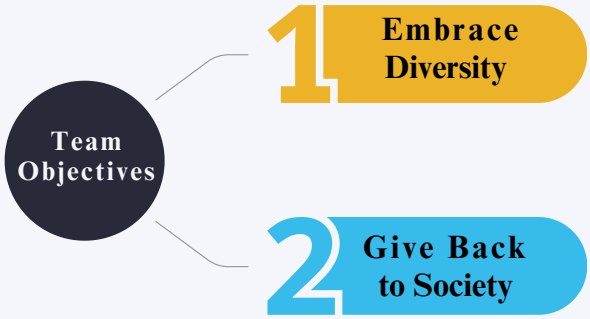
Team Introduction:
Short-Term and Long-Term Goals

Team Introduction

Mystery was founded in 2017 by 4 seniors who love robotics competitions. Since they had really enjoyed their gatherings, they decided to team up and join FLL competitions and so *Mystery* was born.

Our team has two main objectives: Embracing diversity and giving back to society! Driven by these, we welcome members from different schools as well as age and expertise levels. We also participate in community activities, where we promote competitions for FIRST.



Short-Term Goals

1.Technology Improvement

After several years of competition, we found that our capabilities in mechanical principles, automatic programs, and image recognition are weak. Therefore, we improve the team members' abilities through online teaching videos and inviting seniors to teach us. In addition, we also actively participate in various competitions to gain more experience.

2.Equipment Expansion

Over the last seven years of attending competitions, the team has accumulated a certain number of structural parts for hardware.
However, with the rapid annual change in tasks, the team's equipment on controllers, sensors and chassis modules also needs to be upgraded, so we will expand equipment through fundraising and other methods.

Moreover, *Mystery* has received assistance from many individuals along its journey of growth. Therefore, we are committed to fostering emotional connections and care, adhering to the principle of giving back to society what we have received. We achieve this by volunteering, promoting at parks, and organizing robotics camps as a way of giving back to our community.

Long-Term Goals

1.Promoting FTC

We utilize social media such as Instagram and Facebook to create videos or posts, sharing our experience, the process of robot creation, and the lessons learned to raise awareness of the FTC competition among the public.

2.Give Back to Society

We return to our schools and local community to advocate for robotics education. Additionally, we provide guidance to participants in FLL and RoboRAVE competitions, aiming to enhance their exposure and comprehension of the FTC while nurturing a passion for technology. Even after graduation, our seniors remain influenced by the team spirit, actively volunteering as competition volunteers.

Team Plan

Risk Analysis

	Risks	Solutions
Funds	Can't afford the FIRST competition registration fees.	1. Seek sponsors, sell our products, earn rewards, create a fundraising platform, hold a robotics camp. 2. Reduce costs, such as building the field by ourselves.
Training and Practicing	Members live in different regions, so it is hard to practice together.	1. Communicate with each other via LINE, Cloud or Google Meet. 2. Record production progress in pocket notebooks. 3. Leave comments on the social media platforms.
Skills	We don't have much knowledge about related technology.	1. Search for online resources and do self-study. 2. Exchange ideas with teams. 3. Visit corporate institutions to learn effective communication skills. 4. Advice and guidance from experienced seniors. 5. Do experiments to test designs.

SWOT Analysis

Strengths

1. Experienced players.
2. Diverse capabilities.
3. Guided by many experienced seniors.

Weaknesses

1. Logistics and schedules make it hard to practice together.
2. Insufficient manufacturing skills.
3. Limited English proficiency.

Opportunities

1. Good reputation because of long-term promotion.
2. Good relationships with many teams and neighbors.

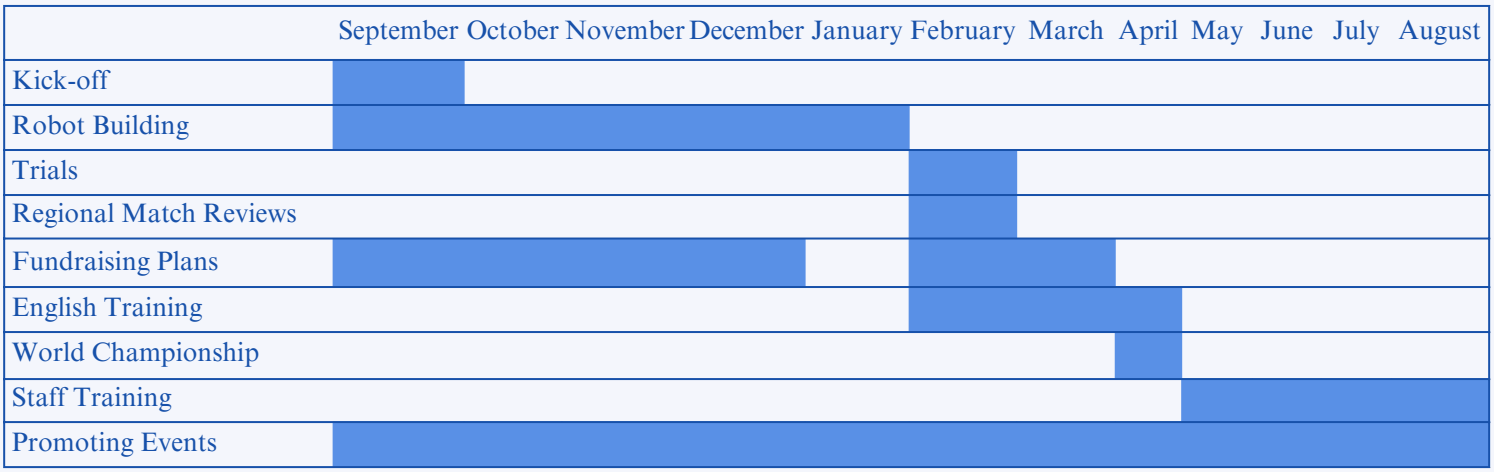
Threats

1. The public don't know about FTC.
2. Competition is fierce.
3. First time in championship competition.

Schedule and Training Plan

Schedule Planning

The members of our team come from different schools, and have lots of work in high school. In order to complete the work within a limited time, our team divided the work online. We use LINE, Cloud, co-editing software and online meetings to confirm the progress of the work, so that practice is not limited by time and location.



Training Plan

Our team has a history of 7 years, so there are many reference materials to help us learn. But, we recruit new team members every year, so the training program helps these team members become familiar with team affairs as soon as possible and allows old team members to continue to improve their capabilities.
This year, 5 of the team members have participated in the FTC, so we will also let the members learn from each other through experience sharing.

Engineering

We learn from the internet, graduated seniors and a mentor who is a mechanical engineering professor. Also, we participate in other robotics competitions to get more experience and improve skill.

Administrative Skills

We invite graduated team members who are studying in the School of Management to share their knowledge online about team management. For example, Gantt charts, SWOT analysis, etc. In addition, we also learn management skills from companies through corporate visits.

Driver Training

Cultivating a driver takes several months, so our driver should practice every day. We train the driver's familiarity and on-the-spot response by formulating tasks or simulating situations.

Organization Plan

Members	Contribution	Gains
Captain: Jimmy	Team Management Programming Robot Operation	I have participated in the FIRST for 7 years. When I was a player in Jr. FLL, I attended community promotions with my seniors. This experience helped me improve my communication skills with others.
David	Programming	During the course of this competition, I developed a deeper understanding of engineering knowledge and also enhanced my reporting skills.
Bob	Robot Design Team Logo Design	This is my third time in the FTC. I learned lots of skills which I wouldn't have learned from school, such as designing robots with Solidworks, 3D printer adjustment etc. Because of these skills, I can translate my ideas into physical objects.
Darcy	Tool Management Robot Design	This is my third time in the FTC. I learned lots of engineering skills, which makes me more confident. I also learn the importance of cooperation in a team.
Administrative Leader: Sara	Document Processing Task Allocation Video Editing Public relations	This is my first time in the FTC. I discovered my strengths and learned to communicate more efficiently and handle tasks more effectively. Also, I am thankful for the opportunity to edit videos for our team, as it aligns with my personal interests.
Anna	Document Processing Public Relations Translation	Before this competition, I was a shy girl. I gained confidence and improved my communication skills. Furthermore, I explored new areas that I had not previously ventured into.
Alex	Document Processing Budget Management Product Design Public Relations	This is my first time in the FTC. Although I didn't have any experience before, I still can my value in this team. Also, it not only improves my administrative skills, but also helps me gain more knowledge in engineering.
Hailey	Document Processing Product Design Public Relations	I learned some administrative skills, how to communicate effectively with others, and enhance my logical thinking abilities. I think that it is a rare opportunity to learn these skills.
Annie	Document Processing Poster Design	This is my first time in the FTC. I think that it is very different from other robotics competitions. Despite lacking prior experience in engineering, I have achieved significant success in the field. Also, I learned the importance of communication in a team.

Organizational Division

Mechanism

- Mechanism Design
- Mechanism Building
- Mechanism Analysis
- Structural Optimization

Program

- Automatic Program
- Manual Program
- Path Planning
- Circuit Configuration

Administration

- Document Processing
- Financial Management
- Video Editing
- Product Design
- Public Relations

Financial Plan

Fund-raising Plans

Target

- Over 7,000 USD
- Should at least cover our registration fee, production and administrative costs.

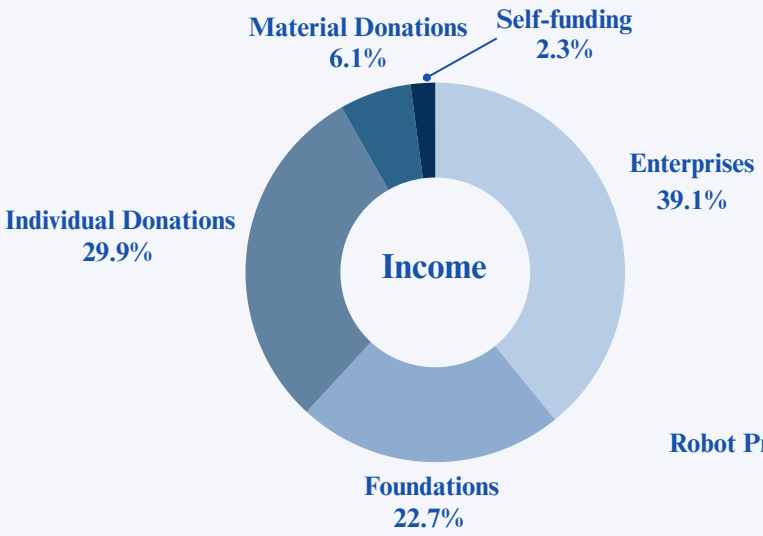
Strategies

- Increase revenues and reduce expenditure.
- Risk Diversification: Part of funds are self-funding resources, such as award money.
- Maintain good relations with our community.
- Increase exposure in communities actively and run a fan page.
- Send emails to ask for sponsorship from companies and foundations.

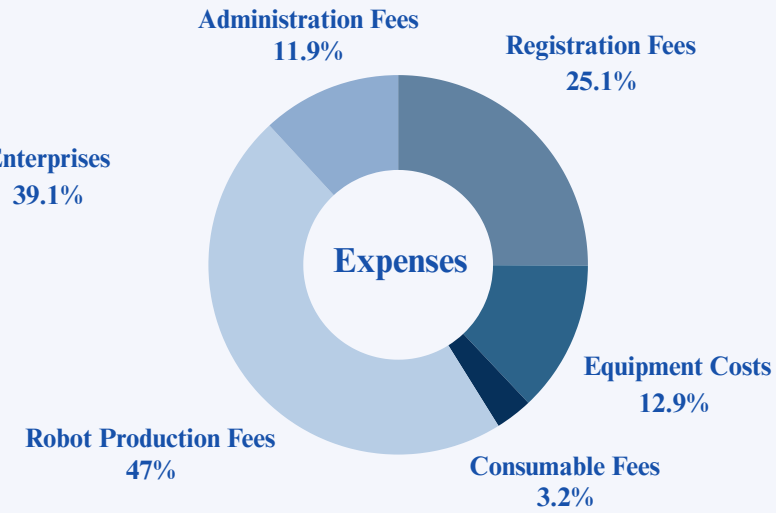
Financials

Our team's funding primarily comes from contributions made by companies, foundations, and individuals. Besides, some of the sponsors such as Matrix and Game Field from the ESUN ROBOT ASSOCIATION, donate materials.

We follow the principle of increasing income and reducing expenses, so for building blocks we use metal components, which can be disassembled repeatedly to replace disposable metal parts to reduce expenditure.



Total Income: 30,626 USD



Total Expenses: 10,336 USD

Outreach

Classification	Overview	Key Events
Activities	Participating in large-scale events allow numerous people to know *Mystery* and the FIRST competition quickly. Additionally, we can “give back” to society and learn from them what we can improve.	1.Promote among residents in our hometown, Jiali. 2. Participate in anniversary of Tainan Science Park. 3. Perform in Jiali District’s basketball game. 4. Participate in *Maker Festival* in Tainan. 5. Perform in Xigang Qingan Temple. 6. Set up a stall at Xinying night market. 7. Set up a stall at Jiali night market. 8. Promote in Jiali Zhongshan Park for 7 years (from 2017). 7. Promote with students from numerous educational institutions, including universities, junior high schools and senior high schools in Taiwan.
Assistance	We hold a robotics camp and teach the players who are participating in robotics competitions to promote the field of robotics. We hope that more students will have the opportunity to learn about robotics.	1.Assisted the FLL Challenge and FLL Explore team in Jiali for 7 years (from 2017). 2. Assisted the RoboRAVE team in Jiali for 5 years (2019~2023). 3.Assisted the Tainan robotics competition team in Jiali for 3 years (2020~2023). 4.Assisted the WorldSkills Competition in Jiali for 3 years (2021~2024). 4. Serve as teaching assistants of robotics camp in NNKIEH (National Nanke International Experimental High School). 5. Serve as teaching assistants of a robotics camp in ASJH (An-Shun Junior High School). 6. Hold the robotics camp in Xincen Elementary School.

Outreach

Classification	Overview	Key Events
Volunteering	Engaging as volunteers not only contributes to society and fosters a spirit of camaraderie but also unveils the complexities involved in organizing events. Through these experiences, we develop a profound appreciation for every competition.	1.Volunteer for the AI Anti-drug Robotic Competition for 4 years (2020~2023). 2. Cooperate with Chia Nan university in Anti-drug campaigns. 3.Volunteer for community office for 2 years to assist in pandemic prevention work (2020~2021). 4.Volunteer for Taiwan regional FIRST competitions for 2 years (2020~2021).
Teamwork	We learn from each other by sharing our ideas and experiences.	1.Communicated with team 14361. 2.Communicated with team 6436.
Supporting Enterprises	Visiting corporations is like standing on the shoulders of giants: it helps us to learn new skills quickly.	1. Visited Google Taipei. 2. Attended Zebra Technology's English presentation training.

- **Effects**:

1. From 2017 to 2024, the numbers of the FTC team in Tainan have grown from 1 to 11. **Ten of the teams are from the schools which we have promoted at before**.
2. We have been to 12 schools to promote the FIRST competition, and **11 of them established robotics clubs, 3 of them integrated robots into the course and 8 of them started to participate in the FIRST competition** (from FLL Explore to FRC).
3. In 2019 we were the **winners of Diageo Group's Keep Walking Dream Project**. Ten candidates were selected from more than 900 applicants. Our goal was to promote educational robotics.
4. Our work and achievements got **published in a book on STEM education and a magazine in Taiwan (ROBOCON)**.

相較於「字符」方塊夾爪偏向平面或 90 度的結構，參賽隊伍用來夾取「遺跡」的夾爪設計更是多樣化，夾取「遺跡」的夾爪主要以精確夾取小型物體，以及能伸縮的結構為主，因夾取「遺跡」需要花費不少時間，挑戰非高，此時聚焦作戰的策略考量就成為關鍵，許多聯盟都派出其中一個機器人負責挑戰這項任務，另一機器人則專心搶奪並放置「字符」，因為策略考量以及難度較高，成功夾取「遺跡」並放置到舒適區域的隊伍並不多。

夾取「遺跡」用的伸縮夾爪。

成功將「遺跡」放置於「舒適區域」。

亦有許多聯盟選擇放棄保衛「遺跡」的任務，卻能確放方塊來得分，比賽結束時，機身若完整回到「平衡石」上，即可再度加分，因此時間掌控也是很大的決勝因素。

臨場反應為致勝關鍵

獲得「FTC 機器人聯盟冠軍隊長獎」，並贏得出國參賽資格的單，除了「遺跡」的夾爪設計在兩天除才完成，底測器也臨時做壞，在賽前 5 分鐘才緊急向友隊借到，然而優異表現的為他們贏得代表隊資格，凱旋而歸。該隊機器人以滑軌抬高並伸縮夾爪結構，為本賽事經典的設計。

獲 FTC 卓越思考獎的「Mystery」隊非常關鍵，之前只參加過規模較小的競賽，首次參加 FTC 大賽，在隊長吳同學率領之下，各個隊員都非常用心投入比賽，由於隊員組成多種，有幾位從國小就一起學習機器人製作，也有隊員還是初學者，未見其經驗絕對就會得大至勝采，然而每位隊員都朝向同樣的目標，齊心協力完成這次任務，機器人硬體的關鍵部件采，因依照官方規定，以及廠商生產的部件，無法更改規格，有多處結構用 3D 列印製作客製化部件，輪子則採用麥克納姆輪設計，以多個小輪呈 45 度角組成，不但增加抓地力，更能在 XY 軸自由移動！許多參賽機器人也都採用這種輪子設計，特別適合需要快速在多障礙的場地搶奪物件時使用，該隊決勝機器的夾爪，則使用曲

雖然製作過程的四個月，但因天天熬夜製作，或聯會過了凸百年，「激鼎 B 隊」的部同學與謝同學也說到，比賽前天機器人發生故障，令人捏一把冷汗，不過有很棒的隊友支持，參賽過程除了制激也有溫馨，「Screw It」團隊另一隊「Screw It 小黑與粉粉 XD」的吳同學更激勵表達這次參賽所賽得的感動，認為在不斷熬夜製作的過程，已經盡了全力，並在分工合作的過程更了解隊友，花了三週完成製作，並測試多次才達到最終版，同時他也認為聯盟作戰策略與夾取小人為重點。

大會裁判長除了評點任務挑戰，也不忘提醒工程筆記的重要性，工程筆記除了能整理機器人結構與製作過程，良好的敘述理路與介紹也會為隊伍加分。

本賽事常見的麥克納姆輪。

「Mystery」隊獲頒特別獎人合照。

30 ROBOCON Magazine 2018.5

Robot Overview

Design Principles

Easy to Build

- Building block structure (Tetrix).
- Irregular components were printed by a 3D printer.

Easy to Fix

- Modular design.
- Building block structure.

Easy-to-get Materials

- Suspend by rope and reel.
- Launch by rubber band.
- Paper team prop.

Design Features

Modular Design

- Chassis, gripper, swing arm and launcher modules.

Colorful Design

Bright color components can aid the driver in distinguishing and ensuring the status of the structure more easily.

- Pale pink gripper.
- Bright green swing arm's fixed parts.
- Black hook.

Robot Ability

	Scores	Performance
Autonomous Period	60	• Purple pixels (team prop) • Yellow pixels (team prop) • Positioned in the back stage • Two white pixels
Driver-Controlled Period	98~116	• 16~22 pixels with three mosaics and a second set line.
End Game	50	• Rigging • Zone 1

Strategy

Design process

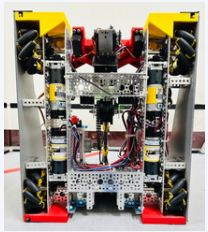
1. **Understand Current Issues:** What kind of problems do we face.
2. **Collect Relevant Information:** Which information is useful to us.
3. **Find out Solutions:** How to organize information that can be used in our solution.
4. **Suitable Design:** Design an available product which base on our solutions.
5. **Testing:** Do testing repeatedly with our design and find what to improve.
6. **Get Best Design:** Take best sequel to make sure we have stable quality.

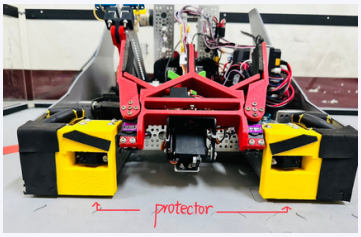
Strategies

- **Path Planning**: There are four different paths for an alliance color to match different allies. Also, it is strategically placed at the backstage edge to make room for allies.
- **Mechanism**: Repair time is short and there is a high chance of collision, so we follow 3 easy principles: easy to build, easy to fix and easy-to-get materials. For example, we build our robot with Matrix which is block-like components like LEGO and the modular design helps us to fix the robot more easily. Besides, our chassis has high mobility with Mecanum wheels and motors in 435RPM (2.2 m/s). They can move 509 cm in about 2.3 sec.
- **Programming**: By modular design our program can be modified more easily to fit different allies. It combines with different sensors to increase program reliability that ensures scoring in the Autonomous Period.
- **Scoring**: The Autonomous and End Game period is most important, so we retain 40 seconds for the End Game's mission to ensure scoring. The Driver-Controlled Period can be slow but make sure to get the mosaic bonus or set the line bonus. If an alliance can get pixels from the wing faster or can't get pixels from stacks, we will clamp white pixels from stacks. We are good at mosaic, so if allies are poor at it, they can transfer pixels from wing to backstage, and we just place them on a backdrop.

Mechanism Introduction

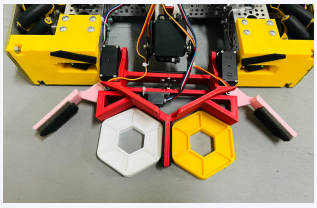
Chassis

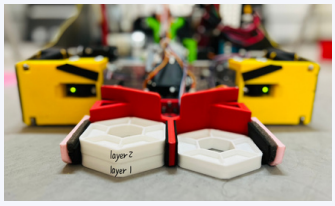




- **High Mobility**: Mecanum wheels with gobuda motors in 435RPM.
- **Optimal Protection**: With protectors and side panels, our chassis keeps wheels safe from damage.

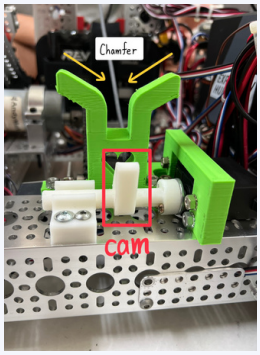
Gripper





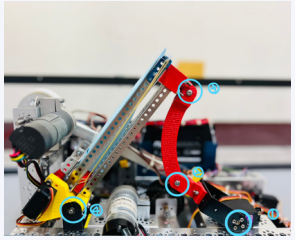
- **Easy Identification:** Two different bright colors aid driver visibility.
- **Efficient Performance:** Dual-layered, grooved design and the slope let pixels fall sequentially.
- **High Adaptability**: Clamp pixels in wide range.

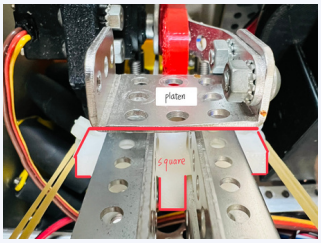
Swing Arm



- **Versatile Functionality:** Lifting and suspending.
- **Suitable Length**: Follow dimension limit but can attach second set line.
- **Precise Adjustment**：A cam to fine-tunes the height of the swing arm.
- **Stability**: Fixed parts to guide the position of the swing arm and avoid shaft distortion.
- **Suspension:** We used a reel with a motor that has a larger torque and a reduced gear ratio to accomplish the suspension.

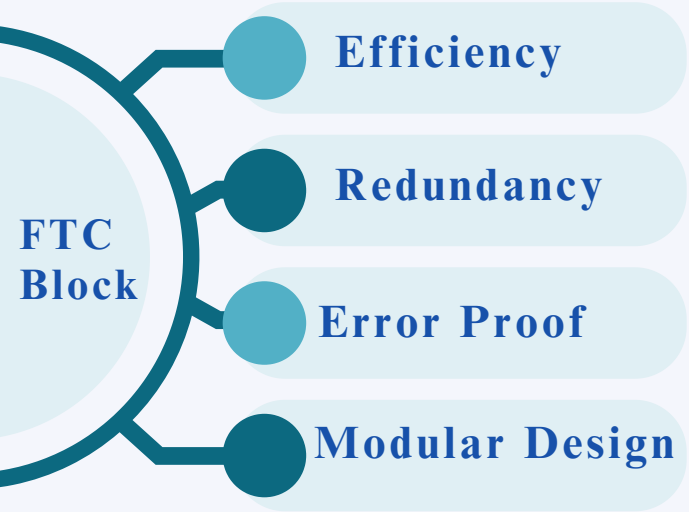
Launcher and Drone





- **Stability:** A four-bar linkage mechanism with more than one Fulcrum, makes the launch track more stable. Also, the platen can fix the drone, preventing it from falling.
- **Durability**: Pushing the drone by a square to increase area of thrust surface, extend its life.
- **Accuracy:** Heavy-top and small-wing design to reduce gliding.

Program Introduction



- We can quickly find the parts that need to be corrected and reduce the risk of making mistakes.
- Everyone can understand the program.

- Dual end conditions to avoid single sensor failure.

- It must meet specific conditions before it can be activated. For example, the button to launch a drone needs to be pressed and held to reduce the risk of accidental touch.
- During laser recognition, the outlier will be filtered to avoid misjudgment.

- Build the same calculation method into a module, such as moving module, clamping module, placing module, lifting module, etc., to quickly add or subtract specific functions.

FTC Block

Programming is done, using the FTC block language. Because we have learned scratch, EV3 or other block-type programs in school, each teammate can understand the program more easily. Also, when we held a robotic camp to promote the FTC, it led to faster achievement than by using textual programming languages. It helps us to promote the FTC easier.

Programming Testing

We aim for a stable and simple program, so we compare different procedures by doing various testings. For instance, in testing the motion of the block, we examined factors such as the distance covered by motor rotation, acceleration and deceleration rates, as well as the precision in reaching the desired position. To identify the team prop, we tested laser and image recognition. For the turning block, we tested IMU and GYRO. We will use experiments to get parameter and filter writing methods that are easier to write, are simpler, and have controllable errors.

Same Button with Different Functions

To ease the driver's workload, we've reduced the number of buttons on the joystick. Besides, some buttons serve different functions depending on the situation. For instance, under normal circumstances, pressing LB will cause the swing arm to drop slowly. However, if the swing arm encoder reaches its maximum value and the gripper is open (indicating that a pixel has been placed on the backdrop), pressing LB will immediately return the swing arm to its initial position.

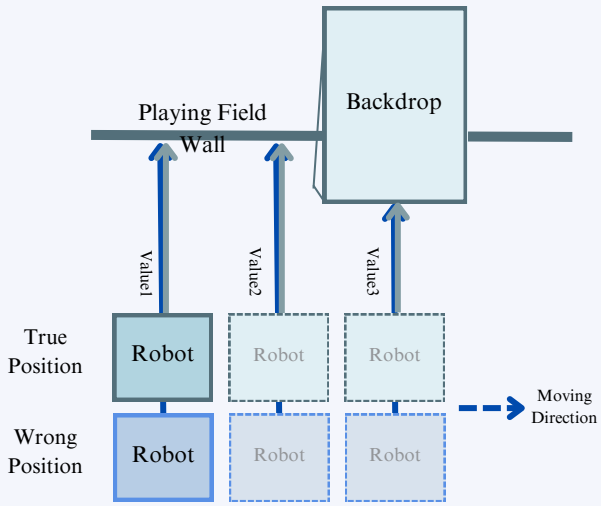
Customized Buttons

There are two drivers in our team. In order to match each driver's habits and achieve the best performance, there are two different sets of manual programs based on the driver's habits. The modular design of the program helps to accomplish this goal very quickly.

Program Introduction

Program Illustration: Laser Sensor

- **Running until less than X cm**
  If the robot move to the wrong position, then its value of 3 may not less than X cm forever, even though it is in front of the backdrop.
- **Running until difference more than Y cm**
  The difference between value 1 and 2 is zero, and the difference between value 2 and 3 is more than zero. So, wherever the robot starts at the true or wrong position, the end condition would be activated.
  However, if there is a laser sensor failure or detection of the wrong value, this design may not work.
- **Running until difference more than Y cm or encoder value more than Z**
  Using dual end conditions helps prevent infinite loops. Also, the outlier will be filtered to avoid misjudgment.



*Difference= Present Value - Past Value

Driver-controlled Enhancements

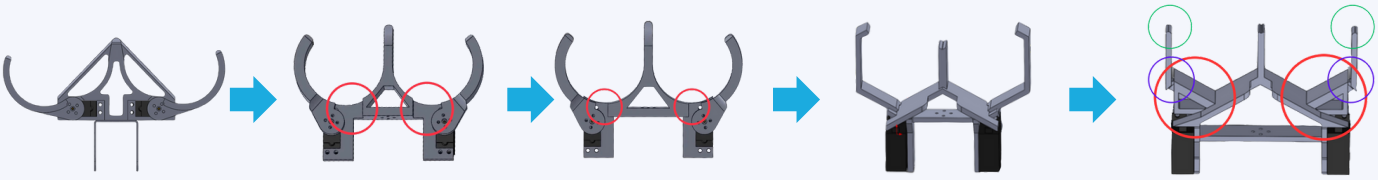
- The button of the synchronized action will be set in the red block, so the driver can control different functions at once. For example, moving and lifting at the same time.
- Buttons less frequently used are set in the orange block. For example, the button for launching the drone is placed on the Y button. This reduces the risk of pressing it accidently.
- The error-proof design can reduce the risk and the burden of the driver for example using a long-hold button.

Testing

Testing	Objectives of Testing	Process	Results
Constant Peed Movement	Explore the impact of speed on straight and lateral movement to find the most suitable speed for movement.	Walk straight and traverse for 20 centimeters at different speeds, and compare the difference between the actual distance and 20 centimeters.	• The faster the robot go straight, the greater the error. • The slower the speed when traversing, the greater the error.
Acceleration and Deceleration Movement	Explore the impact of speed on straight and lateral movement to find the most suitable speed for movement.	Go straight and laterally for 20cm in a trapezoidal acceleration and deceleration method at different starting speeds, and compare the difference between the actual distance and 20cm.	• The faster the robot go straight, the greater the error.When traverse power equal 750 ~ 1000, it it is stable. • The standard deviation is almost all less than 1, and the chassis movement stability is good.
Sensor Navigation	Move a fixed distance to see if the error is the same each time.	Move the same distance and test the error values at different speeds.	• The error value changes each time not more than 3 centimeters (cm). • The distance moved will not increase the error value.
Laser Ranging	Because the backdrop is a slope, we explore the difference between the actual distance and the laser measurement value and make corrections in the program.	Change the distance between the laser sensor and the backdrop and observe the value measured by the laser.	• The value measured by the laser is about 10 cm greater than the actual value. • The standard deviation between laser measurement values is 0.3, which has a good stability.
Pixel Drop Position	The yellow pixel needs to be placed during the Autonomous Period, but if the ally has already placed the pixel, the pixel placed later may bounce off due to hitting the pixel.	Pixels are dropped at different angles and heights to see if they can land where we expect them to be.	• The lower the height, the higher the success rate of placing it in the correct position. • The angle with the flat surface facing downwards has a higher success rate.
Drone Drop Position	Test whether the landing point of the drone will deviate after multiple launches.	Stop the robot at a fixed point and launch the same drone 50 times in succession.	• The launch track of the drone will not be shifted by launching too many times. The landing spots are densely packed and the launch track are almost the same.

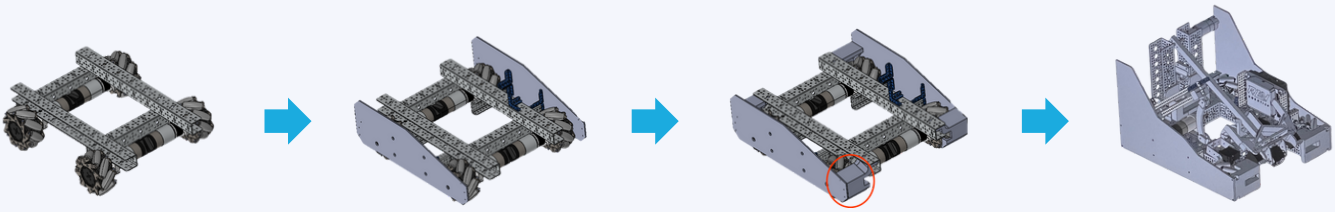
Designing Process

Gripper



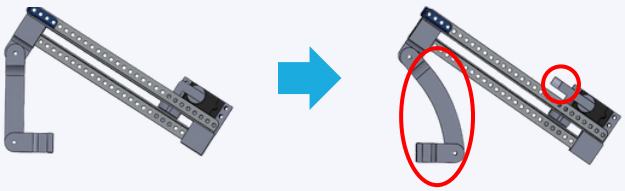
- Hard to place the pixels to the backdrop.
- Pixels fall out easily because of these gaps.
- The thick gripper makes it hard to place pixels at the edge.
- The curved front side restricts the range for pixel clamping.
- The slope facilitates the sequential descent of pixels.
- An upper arc to knock out wrong color pixels.
- Contains a color sensor.

Chassis



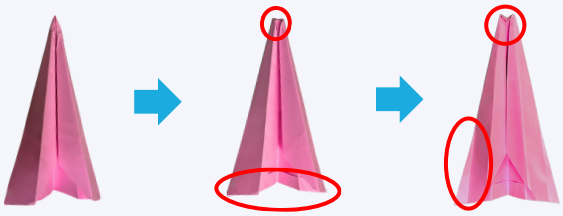
- Fixed in one direction, the pixels would loosen after a period of time.
- The pixels and team prop may affect movement.
- The pixels still affect movement because the baffles didn't touch the ground.
- The panels can protect the robot.
- The baffles touch the ground and prevent interference from pixels.

Launcher



- Large installation space.
- Drone has occasionally fall out.
- Reverse the servo motor to reduce installation space.
- The platen fixes the drone and prevent it from falling.

Drone



- Common drone
- Occasionally glides to Zone2.
- Top-heavy and small wing to reduce glide.

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