#25309

# TALOS

## Engineering Portfolio


**Presented by**
KROS Robotics Research Group,
Korea Science Academy of KAIST

# Introduction



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TEAM TALOS
#5073

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#25309

## Who we are

TALOS is a FIRST® Tech Challenge (FTC) robotics team from the **Republic of Korea**. Our team is based in **Korea Science Academy of KAIST**, one of the most prestegious educational institute for gifted students. We've been participating in Korea Robots Championship (KRC) since the 2018-19 season, and this is our first time paricipating in the World Championships.

TALOS is consisted of 15 members of the robotics research group KROS at KSA.

**Talos** is the first ever robot in history, and is said to be created by Hephaestus according to the ancient greek mythology.

# Introduction

## Sponsors

Our work is supported by **Korea Science Academy of KAIST** and the **Ministry of ICT**. Such support and funds enable us to purchase necessary parts and utilities for building our robot.

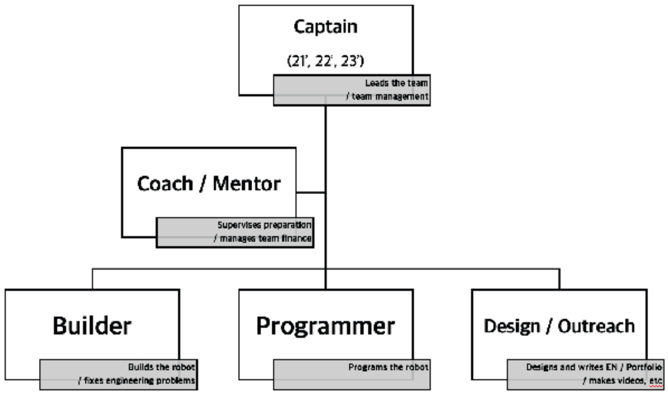
KAIST부설 한국과학영재학교

Ministry of Science and ICT

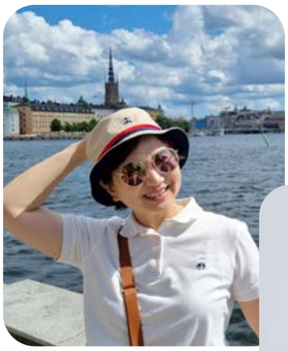
## Members

Our team currently consists of 15 members, with 13 builders and 2 programmers. All members are students of KSA, and are selected through individual interviews each year.

- **21st Batch** __ 4 Builders, 1 Programmer
- **22nd Batch** __ 7 Builders, 1 Programmer
- **23rd Batch** __ 1 Builder, 1 Programmer




Every member is skilled, and we make a great team. Cooperation and teamwork is also one of the most important aspects in preparing FTC, and we believe we have quite an advantage in doing so.



## Coach / Mentor

We have a coach and a mentor in our team.

**Dr. Hosook Kim**, currently the head of Department of Math and Computer Science at KSA, supervises and advises our preparation and work. She is very encouraging and helps the team move one step forward.

**Seungchan Lee**, a 19th batch alumni of KSA and its research group KROS, is a mentor of our team. With his prior experience in preparing for FTC, he guides us through problems and obstacles that we face.

# Meet TALOS

## Howon Chang

FTC Captain
Builder, 22nd batch

## Sugi Kim

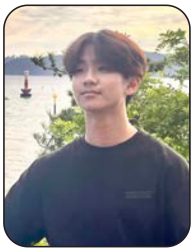
Builder, 22nd batch

## Gyujin Rieh

Builder, 22nd batch

## Mingwon Kim

Builder, 22nd batch



## Joonsung Kim

Programmer, 23rd batch

## Gyuseo Shim

Builder, 21st batch

## Minjun Oh

Builder, 21st batch

## Hi, nice to meet you.

TALOS consists of 15 bright minds, and seven of us will be participating in the FIRST Tech Challenge World Championships. We have 13 builders and 2 programmers.

## Taewoo Yoo

KRC Captain
Programmer, 22nd batch

## Jungwoo Hong

Builder, 23rd batch

## Sungbin Choi

Builder, 22nd batch

## Hyeonbeen Kang

Builder, 22nd batch

## Uijin Jung

Builder, 22nd batch

## Jihong Min

Programmer, 21st batch

## Chan Park

Builder, 21st batch

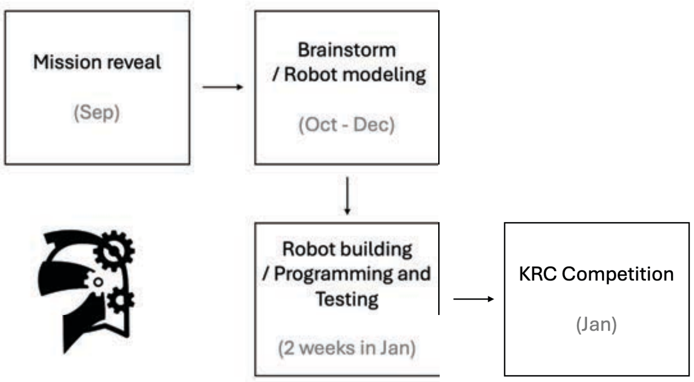
## Sanghyeon Park

Builder, 21st batch

## How does TALOS operate?

After the year's FTC mission is unveiled in September, we brainstorm and model the robot. We have discussed multiple structures and the advantages / disadvantages of each. We also watch and analyze match videos of foreign teams that are uploaded on YouTube, to obtain more information about different approaches for the same goal.

However, as highschool students, it is hard for us to continue are academic work and prepare for the competition simultaneously. Thus, we hold a 2-week long camp at school during our winter vacation and work on our robot.




**"Show and prove"** is one of the philosophies of our team. When building a robot, we may not agree upon which structure to apply to get the best result. Rather than to waste time arguing over, we divide groups to each work on the method that they proposed and let the proofs show which is the best.

This kind of approach has helped TALOS achieve a lot in a short period of time (2 weeks).

## A breif history of TALOS

TALOS has competed multiple times in KRC, also known as the Korea Robot Championship. We've participated since the 2018-19 season, and this is our fifth season.

We have been awarded the **Think Award** and the **Connect Award** in the past seasons.

**2018-19**

ROVER RUCKUS

**2019-20**

SKYSTONE PRESENTED BY Qualcomm

**2021-22**

FREIGHT FRENZY

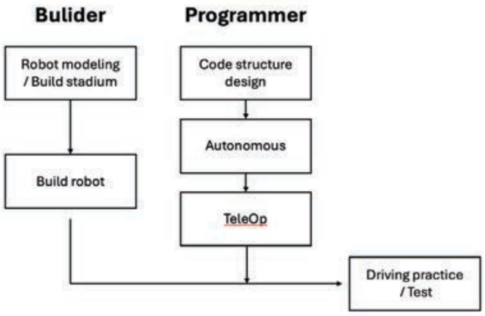
**2022-23**

POWER PLAY

FIRST TECH CHALLENGE

KRC

# KRC Preparation




## TALOS Workflow

Our team workflow is divided into two: Builder and Programmer. Each team works separately until the robot is finished, then work together to port the code onto the robot.

Then, we practice driving the robot and finalize.

### KRC Robot Showcase

We had the team number #5073 in KRC, and built our robot "Ui".

It used a pincer to grab the pixels, and could remove pixels from the bottom of the stack.

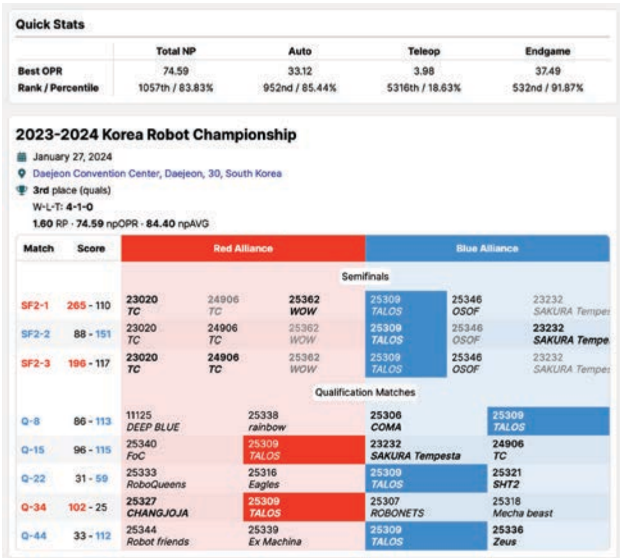


## KRC Results

Awards at KRC are significant to us, since its results decide whether if we are given the opportunity to participate in the FIRST Tech Challenge World Championship.

We won four times at the Qualification Matches, thus taking the third place and continuing to the semifinals. We had the highest individual scores in each game.

This year, we won the **1st Inspire Award** at KRC. We also scored well with our individual robot, with our stable Autonomous Period and Endgame scores.



Quick Stats

| | Total NP | Auto | Teleop | Endgame |
|---|---|---|---|---|
| Best OPR | 74.59 | 33.12 | 3.98 | 37.49 |
| Rank / Percentile | 1057th / 83.83% | 952nd / 85.44% | 5316th / 18.63% | 532nd / 91.87% |

2023-2024 Korea Robot Championship

January 27, 2024
Daejeon Convention Center, Daejeon, 30, South Korea
3rd place (quals)
W-L-T: 4-1-0
1.60 RP · 74.59 npOPR · 84.40 npAVG

| Match | Score | Red Alliance | | | Blue Alliance | | |
|---|---|---|---|---|---|---|---|
| Semifinals | | | | | | | |
| SF2-1 | 265 - 110 | 23020 TC | 24906 TC | 25362 WOW | 25309 TALOS | 25346 OSOF | 23232 SAKURA Tempe |
| SF2-2 | 88 - 151 | 23020 TC | 24906 TC | 25362 WOW | 25309 TALOS | 25346 OSOF | 23232 SAKURA Tempe |
| SF2-3 | 196 - 117 | 23020 TC | 24906 TC | 25362 WOW | 25309 TALOS | 25346 OSOF | 23232 SAKURA Tempe |
| Qualification Matches | | | | | | | |
| Q-8 | 86 - 113 | 11125 DEEP BLUE | 25338 rainbow | | 25306 COMA | 25309 TALOS | |
| Q-15 | 96 - 115 | 25340 FoC | 25309 TALOS | | 23232 SAKURA Tempesta | 24906 TC | |
| Q-22 | 31 - 59 | 25333 RoboQueens | 25316 Eagles | | 25309 TALOS | 25321 SHT2 | |
| Q-34 | 102 - 25 | 25327 CHANGJOJA | 25309 TALOS | | 25307 ROBONETS | 25318 Mecha beast | |
| Q-44 | 33 - 112 | 25344 Robot friends | 25339 Ex Machina | | 25309 TALOS | 25336 Zeus | |

## Reflections

1. Accuracy

- **Sensors** __ In AutoOp, the two sensors (front, right) sometimes couldn't detect the object.
- **Odometry** __ IMU wasn't accurate enough, so we considered using odometry wheels.
- **Pincer / Rotor** __ Using pincer mechanism required time and accuracy when picking up pixels.

2. Chasis

- **Guard** __ Pixels were sometimes stuck inside the robot without the guard.

# Team Overview

## Budget / Expenses

We purchased parts (including a 4-stage linear) in 2023 and 2024, using our school research group's budget. Also, we paid $2,500 for the registration fee for FIRST Tech Challenge World Championship.

| Expense | Cost |
|---|---|
| Parts purchase (2023 – Q3,4) | 770.58 |
| Parts purchase (2024 – Q1,2) | 511.16 |
| Registration Fee | 2,500.00 |

**Total Expense : $3,781.14**

## Goals / Missions

"Empowering innovation, shaping tomorrow."

Mission at TALOS is to inspire young minds to pursue careers in science, technology, engineering, and mathematics (STEM) through hands-on, collaborative robotics challenges. Our goal is to cultivate critical thinking, creativity, and teamwork skills while competing at high levels and fostering a love for innovation and learning in our community.

**STEM Development / Experience**

***Improving understanding of STEM education through the construction and operation of robots.***

The mission is to provide practical, project-based learning experiences that complement theoretical education, helping students grasp complex concepts in a tangible way.

**Community / Outreach**

***Workshops for younger students, participating in community events, and collaborating with educational institutions.***

The mission is to promote STEM education broadly, encouraging more students to consider STEM careers and spreading awareness about the benefits of technology and engineering.

**Teamwork / Leadership**

***Building a collaborative team where every member contributes to problem-solving and decision-making.***

The mission is to build leadership qualities in students, such as communication, resilience, and strategic thinking, through the challenges of planning, building, and competing with robots.

## Future Plans

### 1. Outreach

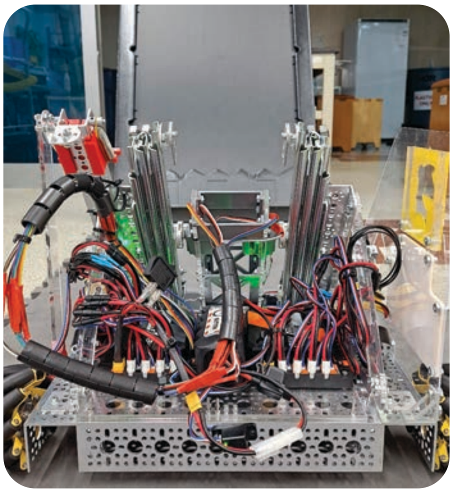
Outreach is an important part of our robotics community, enabling us to share our vision and enthusiasm with others. Until now, we were focused on robot building and our work inside our team. In the next season, we are planning to go outside and meet others who are also interested in FTC and robotics.

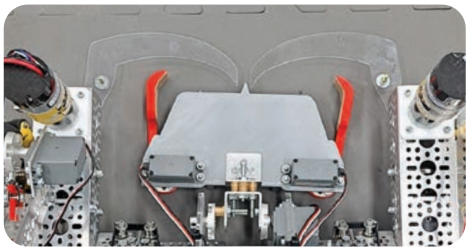
### 2. Sponsorship

We are currently only sponsored by our school. But preparing for FTC, we found ourselves limited by our relatively small budget. Thus, we plan to contact and apply for sponsorships from companies.

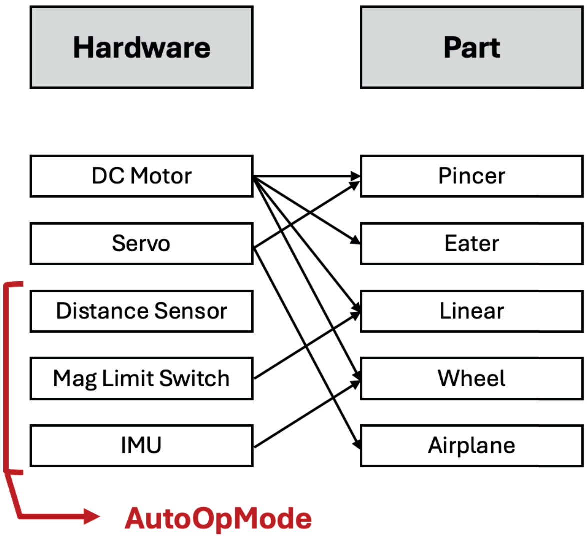
## KRC Robot

Our robot, “Ui” was first built for KRC. Shown below are the photos of our robot, with the team number #5073. It was later changed to #25309.



Our robot used a eater and a pincer to grab pixels. However, grabbing pixels with pincer required a long time and high accuracy during the driver controlled period.




Key hardwares used in our robot include **DC Motor, Servo, Distance Sensor, Magnetic Limit Switch, and IMU.** Each of these hardwares make parts, such as **Pincer, Eater, Linear, Wheel,** and **Airplane Launcher.**

Sensors and IMU are used in the autonomous period to calculate the current location of the robot and detect the randomization object.

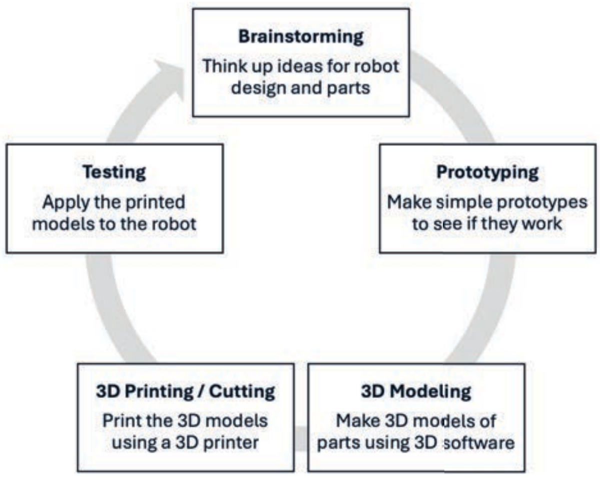
We use the eater to remove pixels from the bottom of the stack while not breaking it. Then, the pixel is loaded onto the pincer.

## Design Principles

**1. Philosophy** : Less weight, function over form

**2. Software** : Fusion 360, Blender

**3. Hardware** : UltiMaker 3D Printer, CNC, etc.

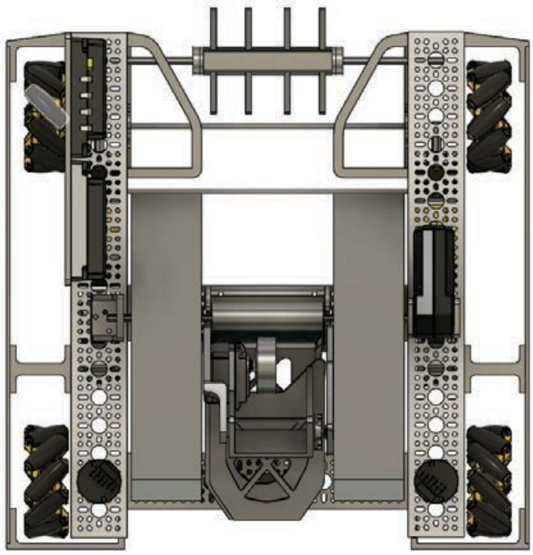


# Robot for FTC - Chasis



## Chasis

Our chasis is built with aluminum frames. Although quite heavy, these frames enable us to have a stable robot body that doesn't break easily.



### Mecanum Wheels

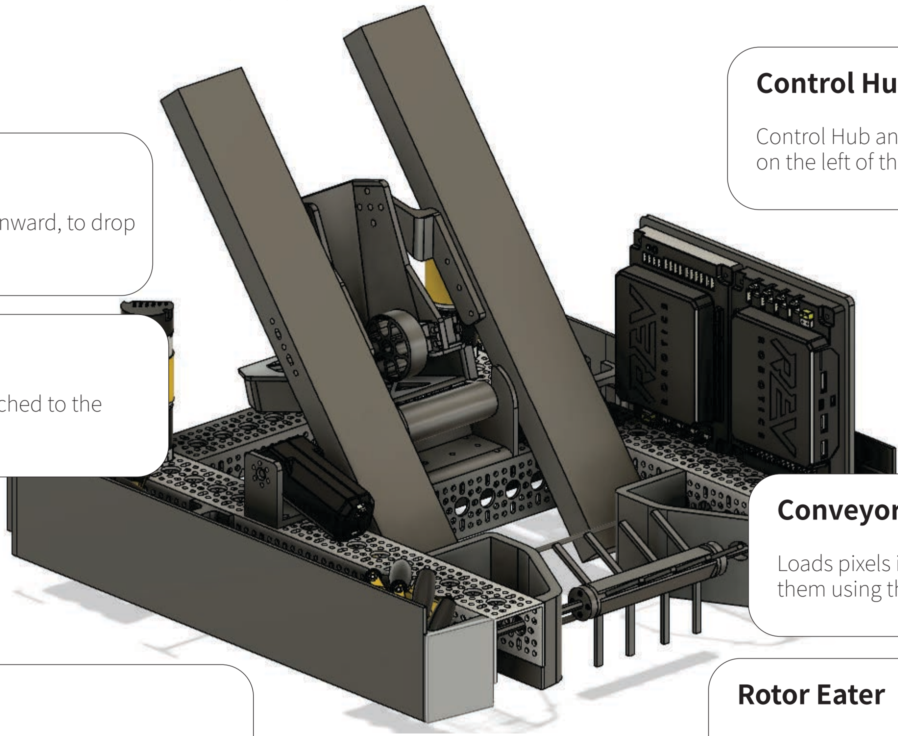
The mecanum wheel is an omnidirectional wheel design for a land-based vehicle to move in any direction.

### Odometry Wheels

Odometry is the use of data from motion sensors to estimate change in position over time, and is used for accurate movement of the robot.

## Hardware

**Linear** : 4-Stage Viper Slide (goBUILDA)
**Motor (wheel)** : 5202 Yellow Jacket Planetary Gear (goBUILDA)
**Motor (conveyor)** : Core HEX Motor (REV)



### Control Hub

Control Hub and Expansion hub are aligned on the left of the robot.

### 4-Stage Linear

Moves the bucket up and downward, to drop pixels on the backdrop.

### Bucket Part

Stores and drops pixels, attached to the 4-stage linear.

### Conveyor Belt

Loads pixels into the bucket after eating them using the Rotor Eater.

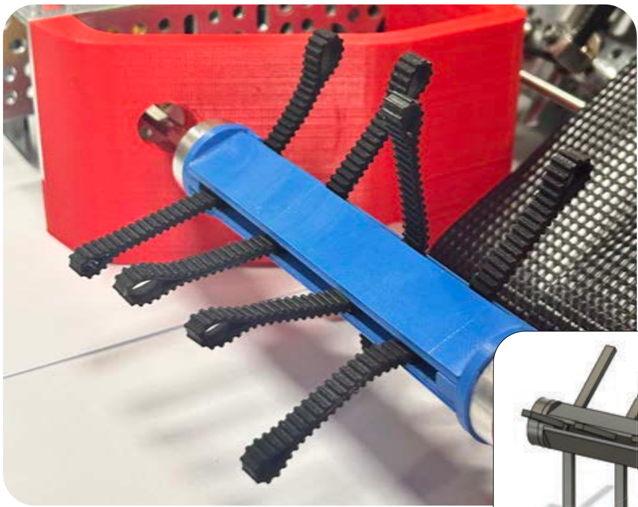
### Side Panel

Prevents pixels from getting stuck inside the robot white moving.

### Rotor Eater

Loads pixels into the robot using a rotor connected to a DC motor.

## Rotor Eater / Conveyor



### Rotor Eater

Rotor eater loads the pixel onto the conveyor. It is rotated with a 5202 Yellow Jacket Planetary Gear (goBUILDA), and has "fingers" made from belts used in the linear slide. These fingers are flexible while having enough friction to move the pixels.

The body of the rotor was 3D printed to hold the fingers, as shown on the left. It is attached to a metal rod that is connected to the motor on the frame.

**PROs of this method**

1. **No accuracy** needed
2. **Fast** eating process
3. **Continuous** eating

**CONs of this method**

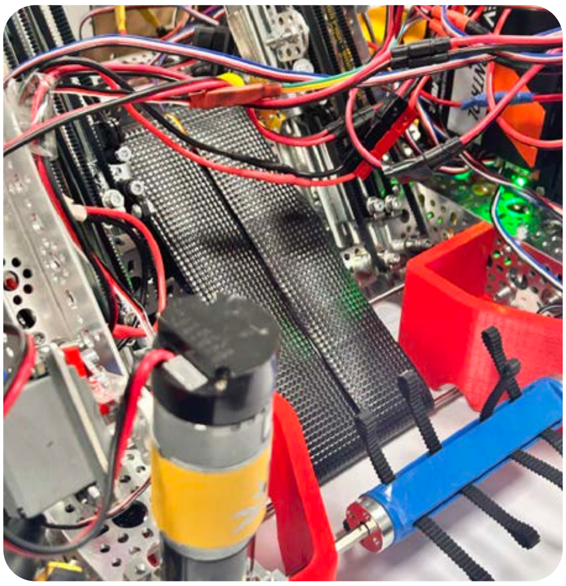
1. Have to **break stack**
2. Not stable enough

**> Better than Pincer!**

### Conveyor Belt

Conveyor belt then loads the pixel onto the bucket. It is rotated with a Core HEX Motor (REV Robotics) to create large torque force. The belt has enough friction to keep the pixel on top while moving.

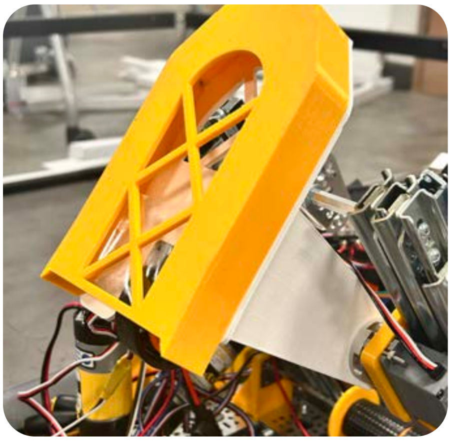
Although quite slow, conveyor is quite stable.

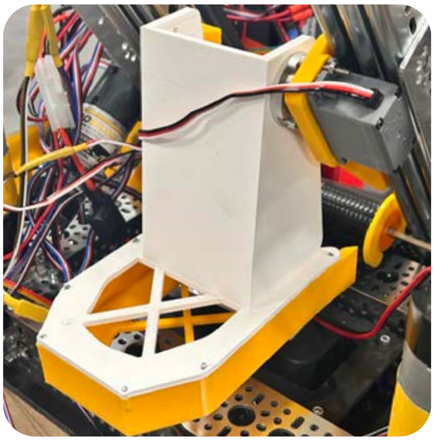


# Bucket / Linear

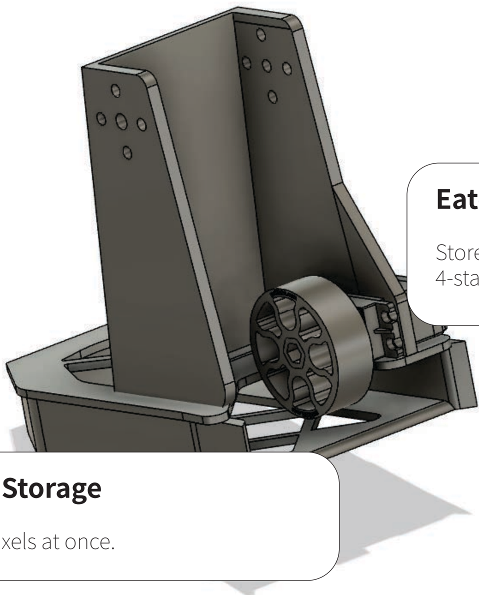


## Bucket Part





The bucket is 3D printed, and has a servo motor that can either drop or eat pixels inside. It is much more lighter than the previous pincer, thus requiring less torque on the linear lift's servo.



**Eater Servo**

Stores and drops pixels, attached to the 4-stage linear.

We programmed the servo to act as a Continous Rotation Servo, so that it could continously rotate in both directions.

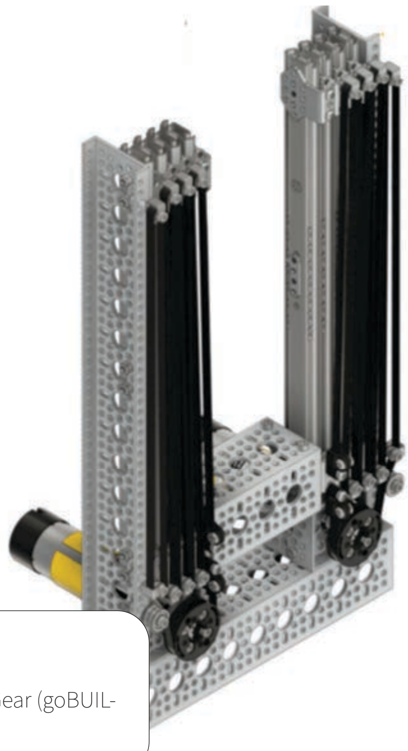
**Bucket Storage**

Stores 2 pixels at once.

## Linear Lift

The linear lift is slantly fixed to the body of the robot. It is made from a 4-Stage Viper Slide from goBUILDA, and the Bucket Part is connected to it.

Linear lift is strong enough to lift the full robot for the endgame. Each motor has about 13kgf of torque.



**Motor**

5202 Yellow Jacket Planetary Gear (goBUILDA), rotates the belt.

## Game Strategy

### Autonomous

Our AutoOp is stable, and reliably scores 50 points.

- **20 points :** Object detection
- **20 points :** Backdrop pixel
- **5 points :** Parking

Coordination with alliances is necessary, in order to not crash into each other's robots.

### Driver Controlled

If our alliance agrees to break the stack, we take pixels from the nearest stack.

If not, we take them from the human player.

We will prioritize making mosaics over stacking them high, since we have limited time. Also, we will coordinate our path with our alliance so the robots do not collide.

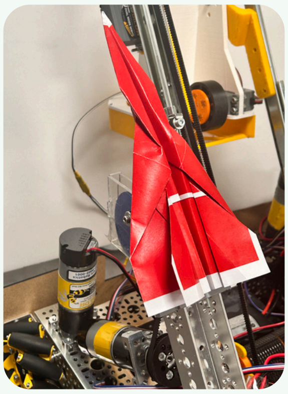
### Endgame

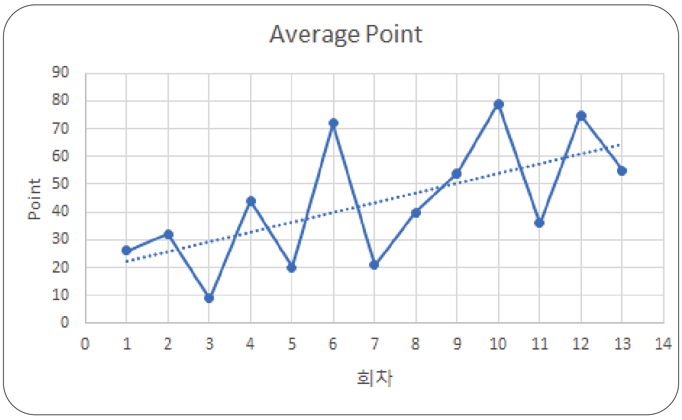
We can stabely score 50 points in Endgame.

- **30 points :** Drone
- **20 points :** Hanging

Our paper airplane (drone) always lands in the 30 point zone, which was possible through numerous tests and experiments.

Also, our linear slide is strong enough to hold our robot on the truss.



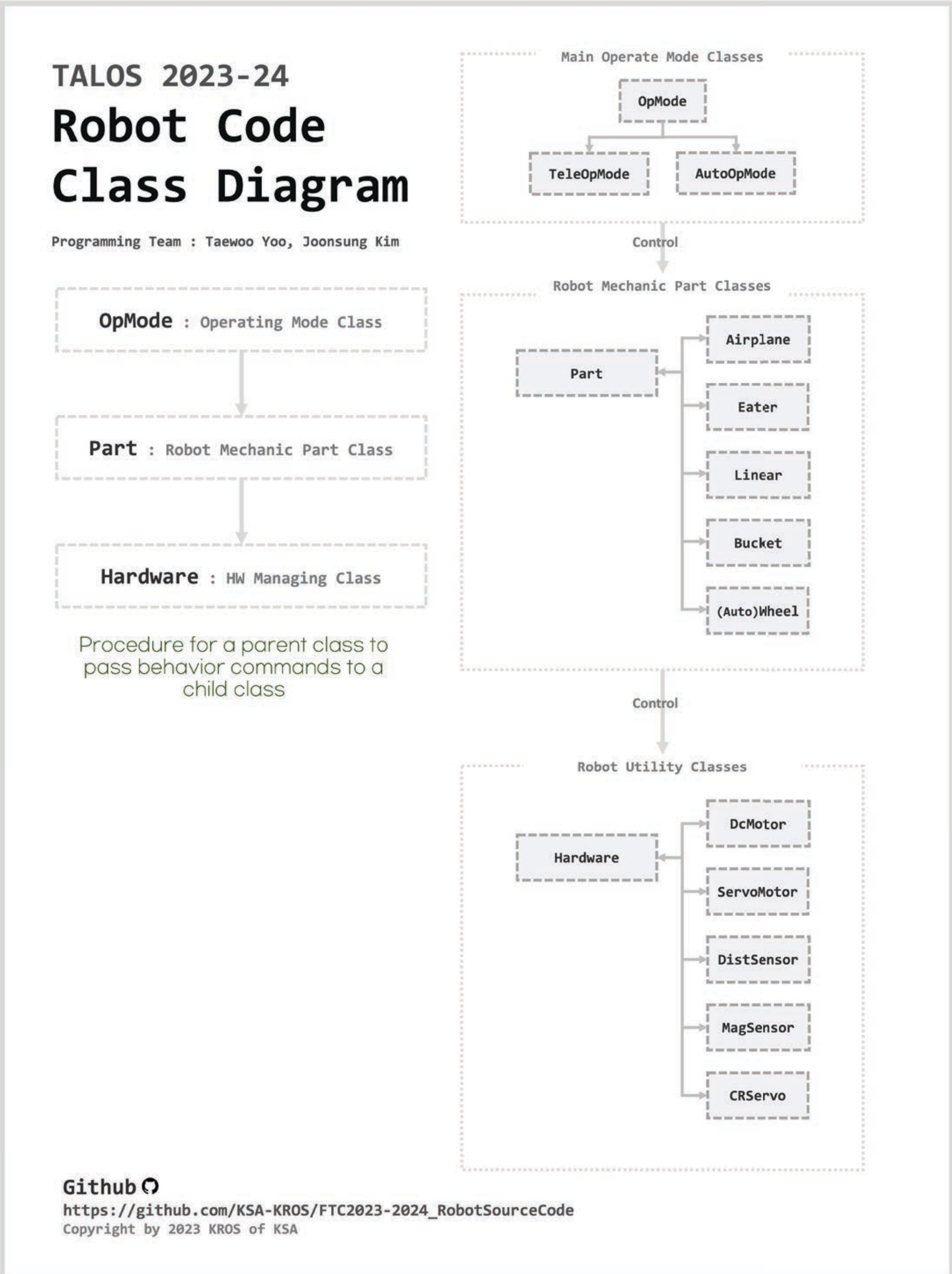



## Practice & Training

Practice makes perfect.

We practiced the full game multiple times, and was able to improve our average score. Drivers and Human Players also practiced controlling the robot and coordinating with each other.

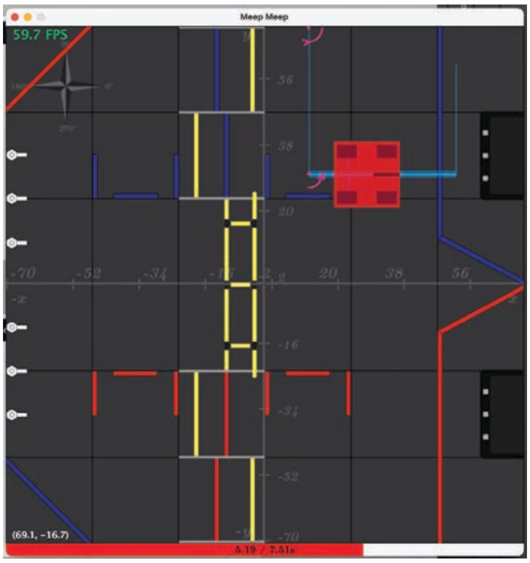
# Code Structure

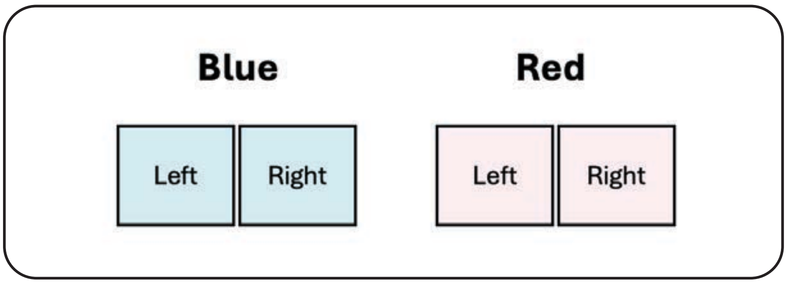


# Autonomous Period

## Robot Movement

We visualized our robot's movement with MeepMeep, an open-source tool on GItHub. We developed 4 different AutoOpModes for different starting locations.



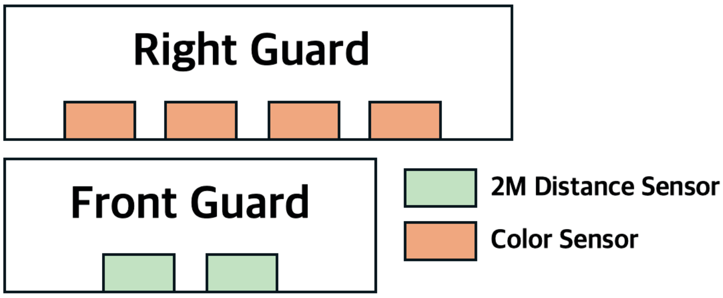

### Randomization Objects

We used red and blue cubes made from foam boards, to keep it light-weight but still rigid.


## Sensor Placement

In the autonomous period, we depend on sensors to locate our robot and detect randomization objects.

We use 2M distance sensors and color sensors attached on sides to detect objects. Placement of the sensors is shown on the right.




## Autonomous Scores (KRC)

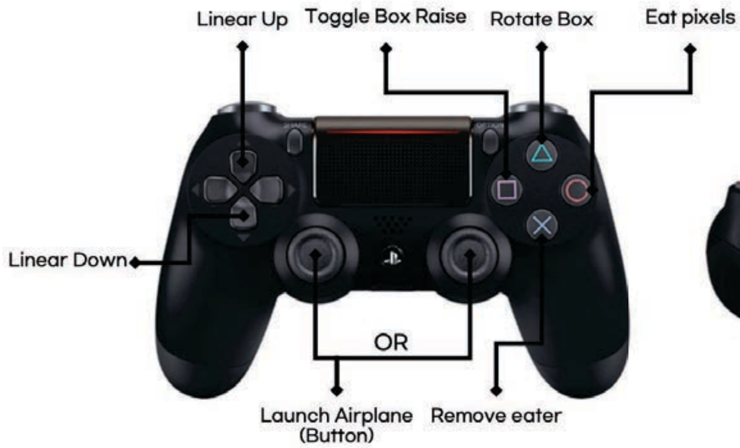
| | Q1 | Q2 | Q3 | Q4 | Q5 |
|---|---|---|---|---|---|
| **Navigation Points** | 20 | 20 | 0 | 20 | 20 |
| **Pixel Points** | 5 | 5 | 0 | 5 | 5 |
| **Purple Bonus Points** | 5 | 5 | 0 | 5 | 5 |
| **Yellow Bonus Points** | 20 | 0 | 0 | 0 | 20 |
| **Total** | 50 | 30 | 0 | 30 | 50 |

# Driver Controlled

## Controller Guidebook
## DRIVER #1 : Robot Movement



## Controller Guidebook
## DRIVER #2 : Linear, eater, bucket





## Controller Guidebook
## EMERGENCY MODE


#25309

# TALOS

**Presented by**
KROS Robotics Research Group,
Korea Science Academy of KAIST