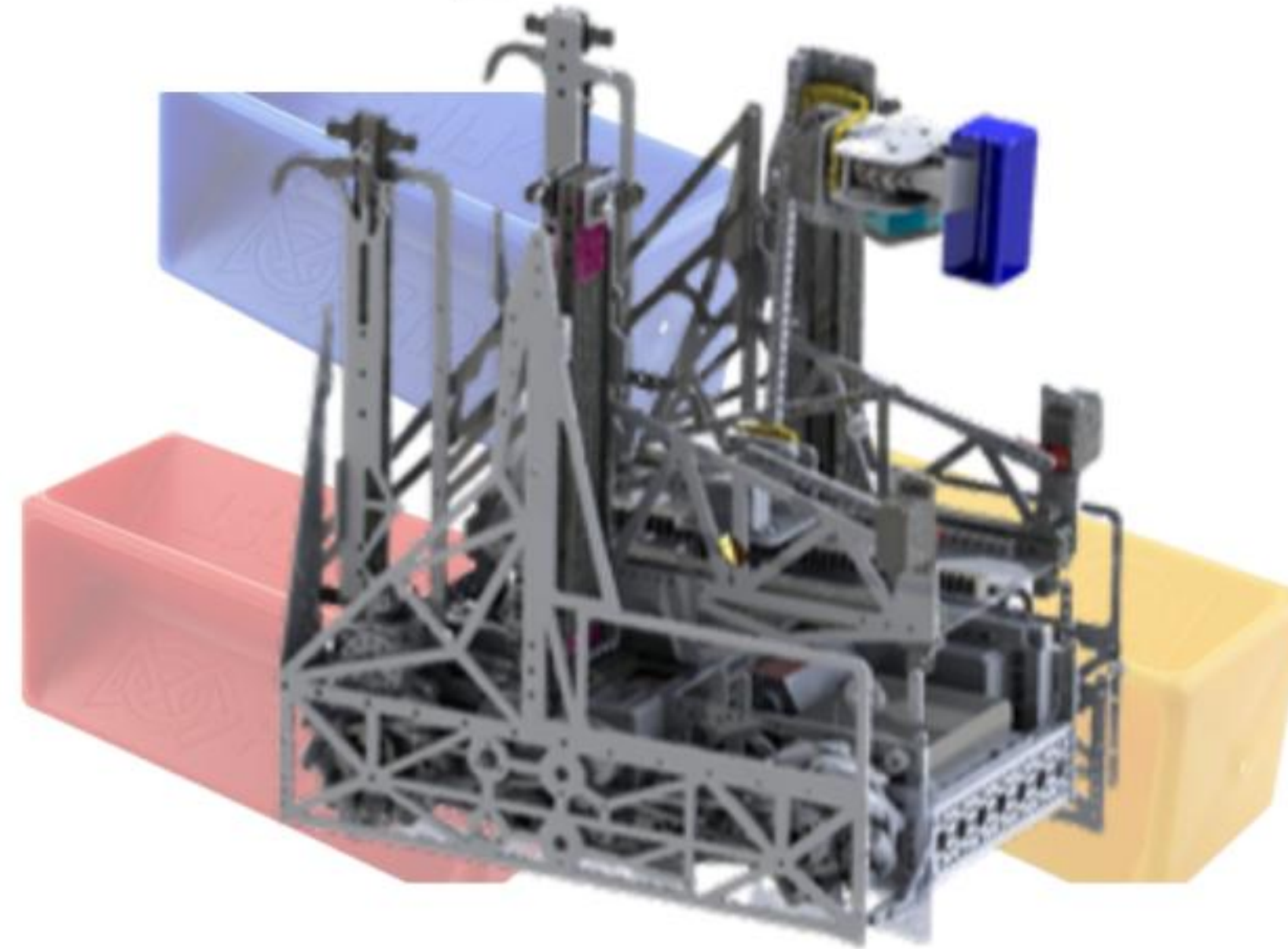


PARADUCKS



TEAM 22985



MUMBAI, INDIA

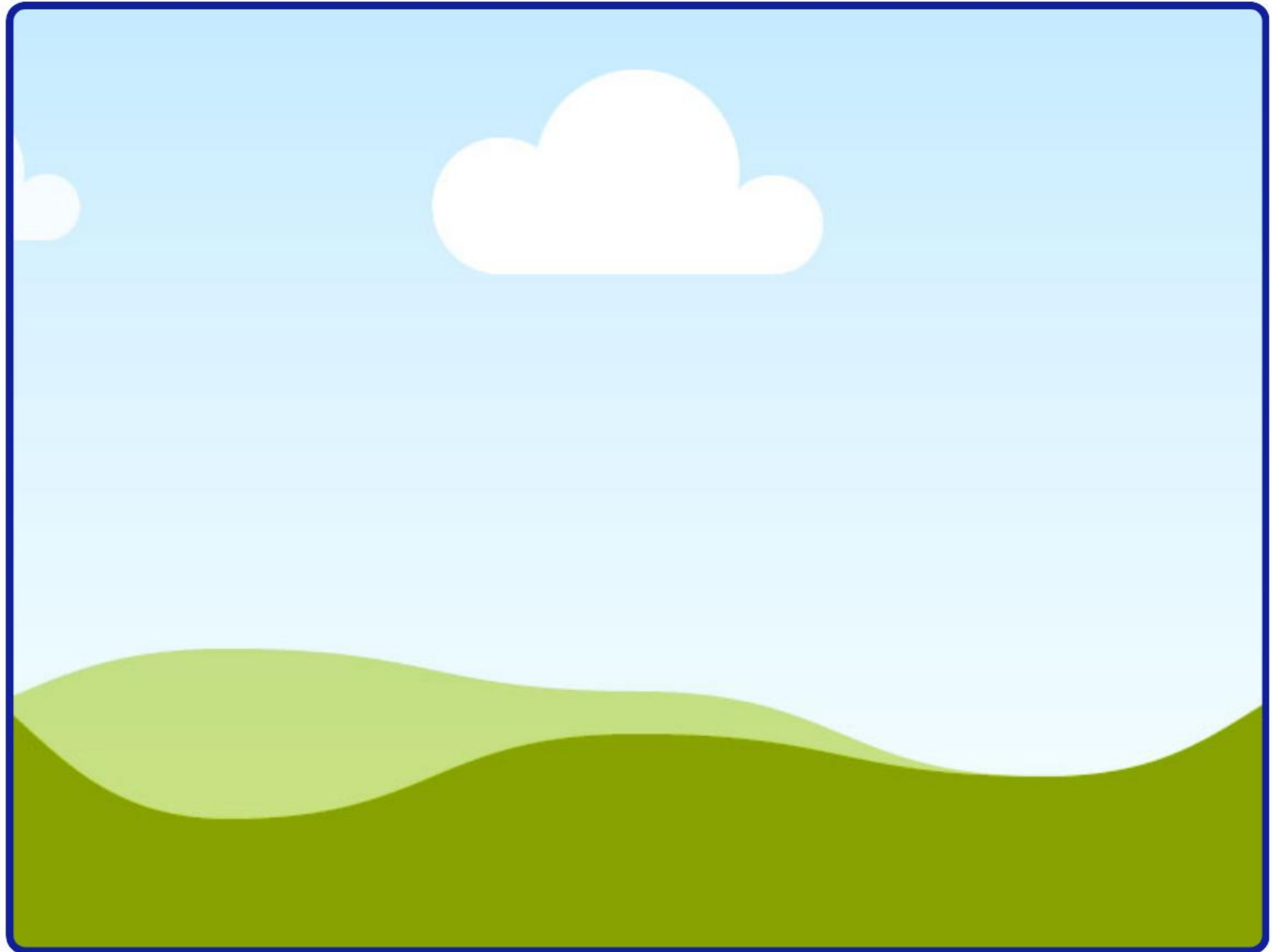


PRESENTED BY  RTX

THE TEAM

Our team consists of 12 members, divided into 2 sub-teams - **CAD** and **Construction** as well as **Programming** covered in detail ahead.

Regardless of one's assigned department, every teammate **contributes** to **constructing** the robot and helping other departments to the **best** of their **abilities**.



All team members are from grades 7-11
(ages 12-17) of 9 different schools



Meet our Team!



SHIVEN SHAH

Hi, I'm Shiven Shah. I am a student at Ascend International School. I am the driver of team Paraducks and a part of the programming team. I have always had a passion for robotics and FTC has been my platform for me to showcase my skills. This is my second season. I really enjoy the thrill that driving gives and participating in scrimmages

Hello, I am Kiaan Shah. I study in Don Bosco International School. For me, robotics is more than just a hobby - it's a way to apply and expand my programming skills while sharing my knowledge with others. It's not just about building robots; it's about honing the skills I'll need for the future while enjoying every moment of it. I My role is a programmer and the backup driver.



Kiaan Shah



MAITHILI AGARWAL

Hi, I'm Maithili Agarwal. I am a student at St. Gregorios high school. I am the team captain. I am thrilled and very grateful to have led this amazing team throughout the season. I believe my team has what it takes to succeed, and I couldn't be prouder of how far we've come. Being a part of the Paraducks team makes me very happy.

Hi, I'm Vaanya Kumbhat. I am a student at JBCN International School, Parel. I am the human player for Paraducks. It's amazing how robotics enhances my academic journey, providing a tangible way to visualize concepts learned in school and pushing me to strive for higher levels of understanding. The satisfaction I get from seeing my creations come to life in unmatched.



VAANYA KUMBHAT



KAHAAN SHAH

Hi, I'm Kahaan Shah. I am a student at Don Bosco International School. I am a mechanical member of the pit team for Paraducks. I truly love construction because I like having hands on work and actually building things and seeing them come together. Robotics has helped me massively by increasing my problem-solving skills and helping me develop skills I can use in the future!

Hi, I'm Mihan Mehta. I am a student at Cathedral School. I am a part of the construction team. I love construction because when the bot is running I can know that I helped build and that's why I love robotics. Robotics isn't just about technical skills; it's about problem-solving, and the thrill of competition, making it an intellectually fascinating and incredibly fun pursuit.



Mihan Mehta



Saksham Loonker

Hi, I'm Saksham Loonker. I am a student at JBCN International. I actively contribute to the CAD and construction team, when we bring our robot to life through meticulous 3D designs and hands-on building processes. Alongside, I engage in scouting, strategy development for competitions, and outreach activities.

Hello I am Vivan Jhaveri. I am from Goldcrest International School. I do scouting and CAD. Robotics has helped me learn how to work with better collaboration and how to work in a team. I really enjoyed designing the bot on solid works as well as constructing the bot because it helped me learn many skills.



VIVAN JHAVERI



AAHIR

Hi ! I am Aahir Seth. I am a student of Hillspring international school. I am part of the pit team and the outreach team. I have enjoyed robotics since I was 8 years old. I am thrilled to be a part of this team. Robotics has provided me with a platform to express my creativity and ideas in real-world scenarios.

Hi, I'm Anant Mehta. I am a student of Bombay International School. I am part of the Pit and Outreach team and a backup human player. I am excited and thrilled to be taking part in this team and competition. I have a love for robotics since my young age and I am grateful to be a part of this team



ANANT

Hello, I am Arush Warty. I am a student at NEXT school. I am on the mechanical team. Robotics truly fascinates me, it brings me immense joy to construct and build and after a lot of handwork, seeing the final result come to life captivates me. I know our bot would be up to the task this year, because we built it to be that way.



ARUSH

Hello! My name is Vivaan Patil, and I am a student at Don Bosco International School. I actively participate in both the scouting and construction teams. My passion for robotics ignited when I was just four years old, and by the age of five, I had already won my first robotics award. Since then, I have taken part in numerous robotics competitions, including FLL, WRO, WSRO, and now FTC.



VIVAN PATIL

MEET OUR MENTORS!



AYUSH KAITHWAS
PROGRAMMING



PRATIK PANCHAL
CAD & CONSTRUCTION



GRACIOUS PROFESSIONALISM®

A WAY OF LIFE FOR TEAM PARADUCKS

Gracious Professionalism®, coined by FIRST itself, is about maintaining a perfect balance of tense competition and sportsmanship - something that Team Paraducks wholeheartedly supports. We enthusiastically participate in our scrimmages- all our emotions riding on one little robot within an 18" cube - but regardless of the outcome, our competitors remain our equals whom we treat with the utmost respect. In our team, we make sure that we each help one another and that all of us contribute equally. This is Team Paraducks's third season, and through our experiences and learnings from last year, we have been able to progress better this time. We are great ambassadors of FIRST and highly advocate inclusivity, teamwork and cooperation.

CORE VALUES

TEAMWORK

Collaboration and teamwork is paramount for a team to succeed. Our team has allocated various responsibilities to members based on each person's abilities and interests. We keep each other informed on everything we do and join forces for all events, and of course, we always help a teammate in need.

RESPECT

Respect is imperative for all team relationships - valuing every member's hard work, appreciating the mentors for their constant efforts to help lead the team to victory, and towards our allies and opponents regardless of the result of the match.

EQUALITY

Being a part of the FIRST family, we believe in treating everyone with equality without unfair judgement and consider our fellow teams equal without exception. Additionally, we are also a FIRST Ladies Regional Partner and spreading awareness of the contributions of girls in STEM.

SPORTSMANSHIP

We make sure to be respectful to our opponents and allies even in defeat. We consider each loss a learning experience - taking note of the technical issues/errors that could have led to any obstacles to prevent them from happening again.

SEASON GOALS



CAD and Construction

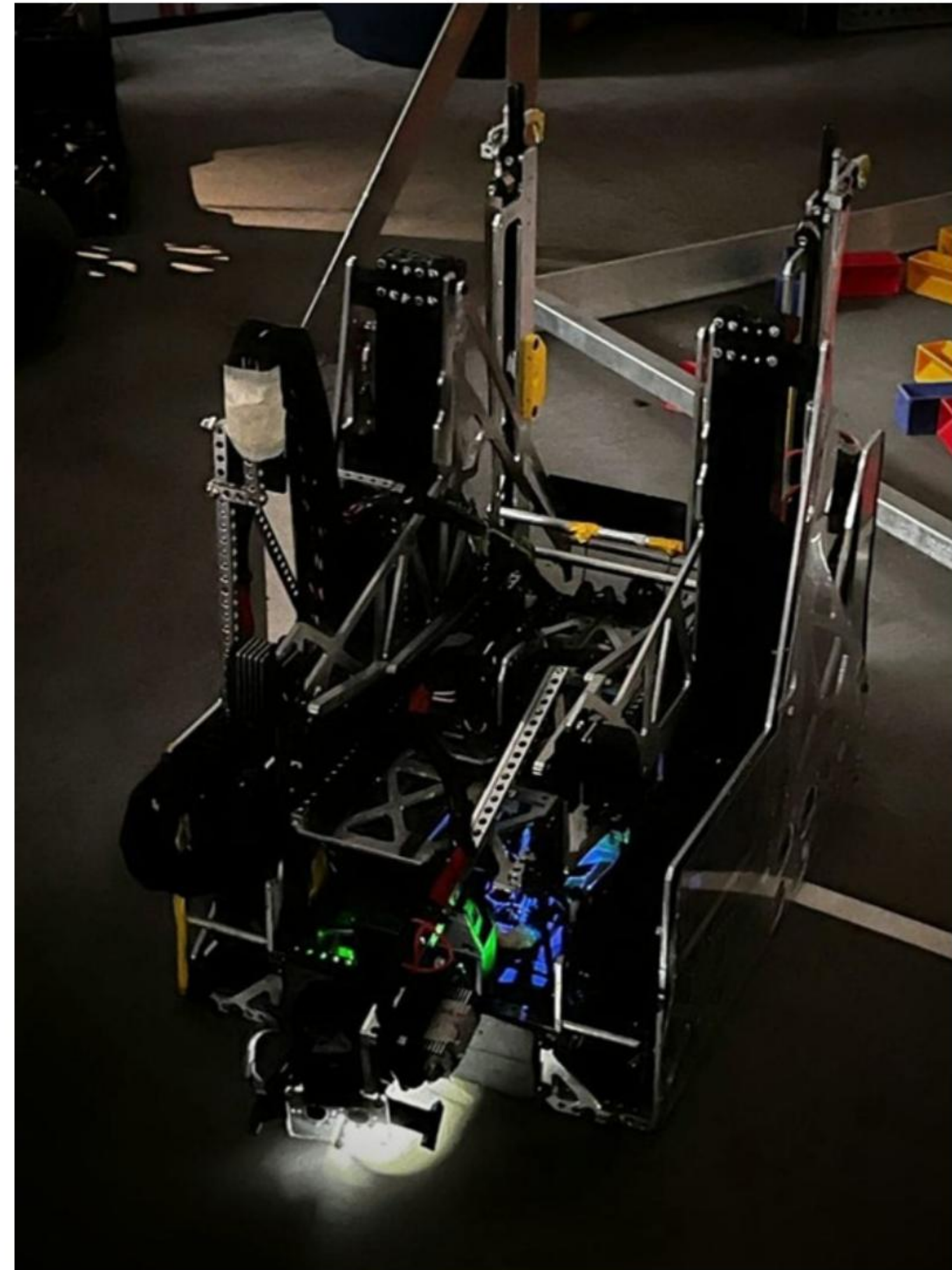
- Design a strong **mechanism** for **efficiently** picking up samples for the intake which has **minimal flaws**.
- Through **3D printed** and kit parts, make a successful intake and outtake mechanism.
- Ensure the robot moves **smoothly** and **fastly** and the chassis is **stable** and **strong**.

Programming

- **Precise, error-free, autonomous programming** for **mecanum drive**.
- **Trouble-free** control for **drivetrain**, along with custom **PID**.
- Ensure all the mechanisms work **seamlessly** and **efficiently** and implementing Command based code **efficiently** in our bot.

The team

- Create a **sustainable** pipeline for new members and our **FTC** team.
- Pair members at different **skill** levels in **construction** and **coding** for them to be able to develop skills.
- Have **every member** of our team **pitch ideas** and **participate** in **outreach**



OUR ACHIEVEMENTS



Indian Championship Finalist
Alliance 2022



Indian Championship Finalist
Alliance 2023



APOC Finalist Winning Alliance
2023

- **APOC Finalist Winning Alliance 2023**
- **Indian Championship Finalist Alliance 2023**
- **APOC Finalist Alliance 2022**
- **Indian Championship First Choice Alliance 2022**

TIMELINE

JUNE-AUGUST

We had just about started to learn about the basics of Robotics and were being educated on what FTC is, we were starting to know each other better as well. During the first month most of us didn't improve but spent a lot of time just understanding the basics of FTC.



AUGUST-SEPTEMBER

We had long lectures every weekend teaching us about wheels, gears and the basics of constructing robots. We also did presentations on each topic we learnt to reflect on what we had learnt.



MARCH

- India Championship

OCTOBER- NOVEMBER

We learnt about Java and how an object-based language works. We also split up into a CAD and a coding team and dived deeper into each department. We began prototyping and studying the game manual.

DECEMBER

We continuously test our robot to refine control, improve maneuverability, and identify issues. Through drive practice, we define problems, make necessary changes, and document progress. This cycle of testing, troubleshooting, and improving ensures a high-performing and reliable robot.

CAD AND CONSTRUCTION TEAM



CAD AND CONSTRUCTION SKILL BUILDING



- We began our construction journey with introductory lectures on various mechanisms.
- Previous members taught the rookie about tapping, proper procedure of drilling, how to use CNC and 3D printer
- We also learned how to use SolidWorks and explored its features. The skills we developed improved our ability to design, plan, and build our robot.
- This helped us to apply mathematics in real life as we used ratios to determine designs.

8 ROOKIES



- We used the **newfound** knowledge to design our chassis.
- We went on to learn; to **design** other parts of the robot, from the **gripper** to planning the **hanger**.
- With the basics done, we went on to the **construction** of the robot.
- We also made a Ring Shooter from **Ultimate Goal Season**.
- We also constructed the bot using the FTC **starter kit**.

SOLIDWORKS

1.

Easy edit making

Making mistakes or last-minute changes in **CAD** is pretty common. In other CAD software, we would have to go back and edit the steps 1 by 1, and still, the body would have errors. To avoid this, **Solidworks** ensures **100% accuracy** and mistake-free edit-making.

2.

Practical Usage

We can **easily** construct components on **SolidWorks** as the practical features such as sheet metal, surfacing, mold and die design, and routed systems make it easy.

3.

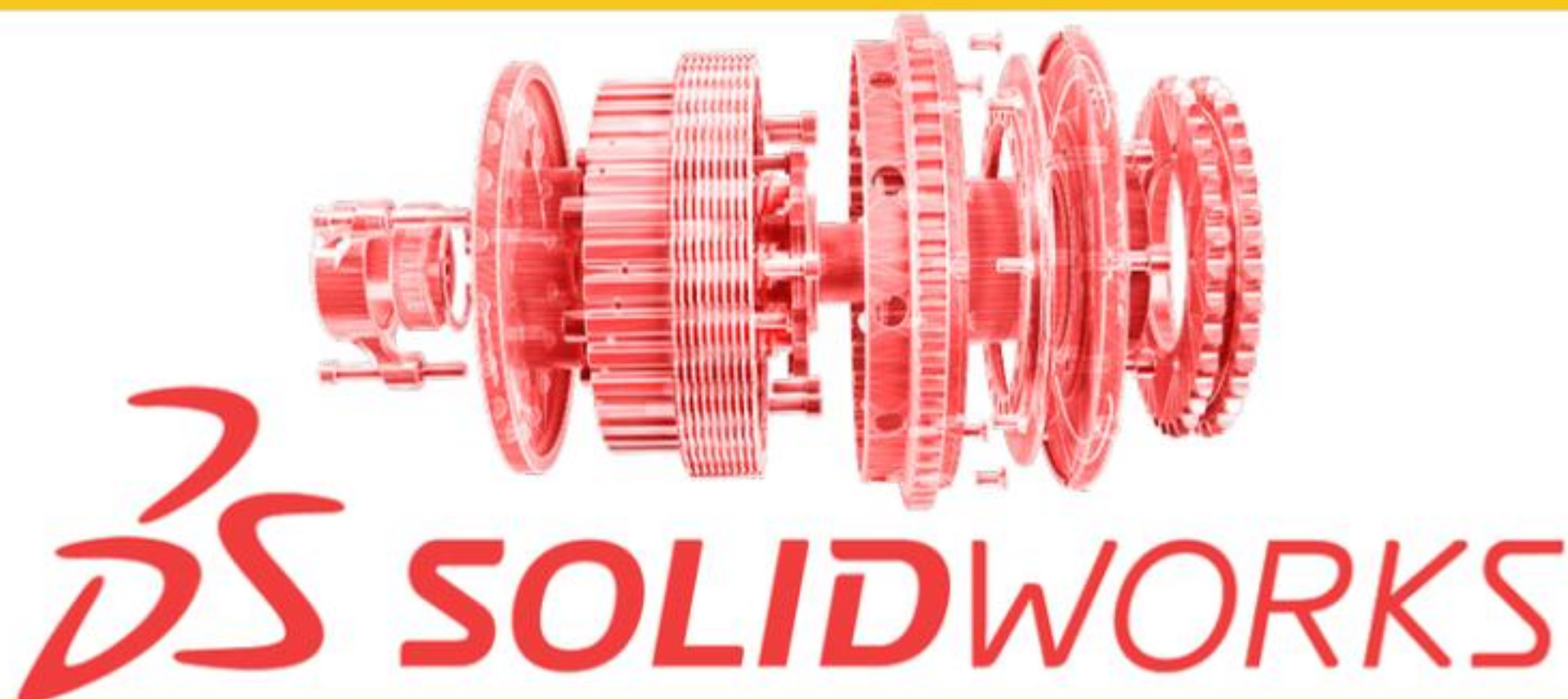
Testing

Before starting to **construct** components in real life, we can use the environment testing feature on the application to test its **practicality**.

4.

Easy assembling

Assembling components is easier than expected in Solidworks. Assembling also has a wide array of joints, which makes the CAD 100% accurate.



Materials

1. CNC Machining

We design custom parts using SolidWorks and manufacture them with CNC machining for high precision and durability. This allows us to create strong, lightweight, and precisely engineered components tailored to our robot's needs. Some examples of CNC-machined parts we use include side plates, hooks, and the rack, which contribute to the robot's structural integrity and functionality.

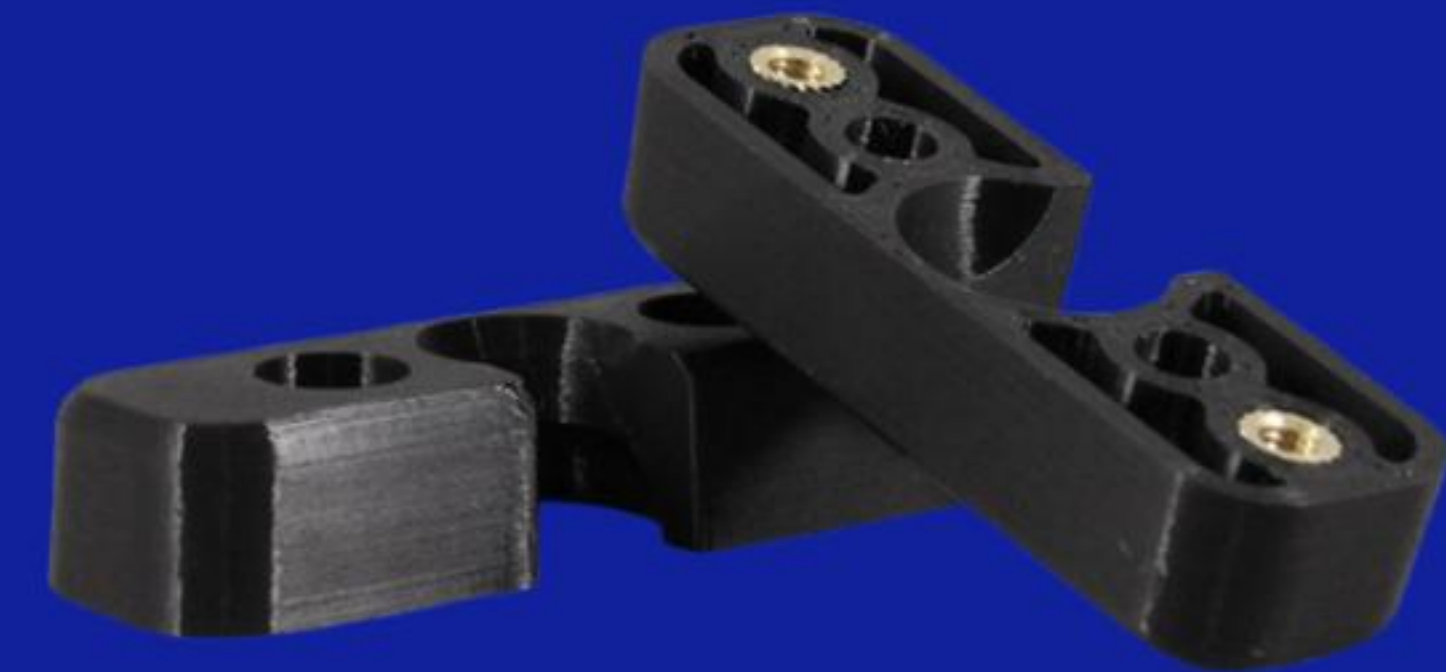


CNC Machining Of Plates

2.

PLA Filament

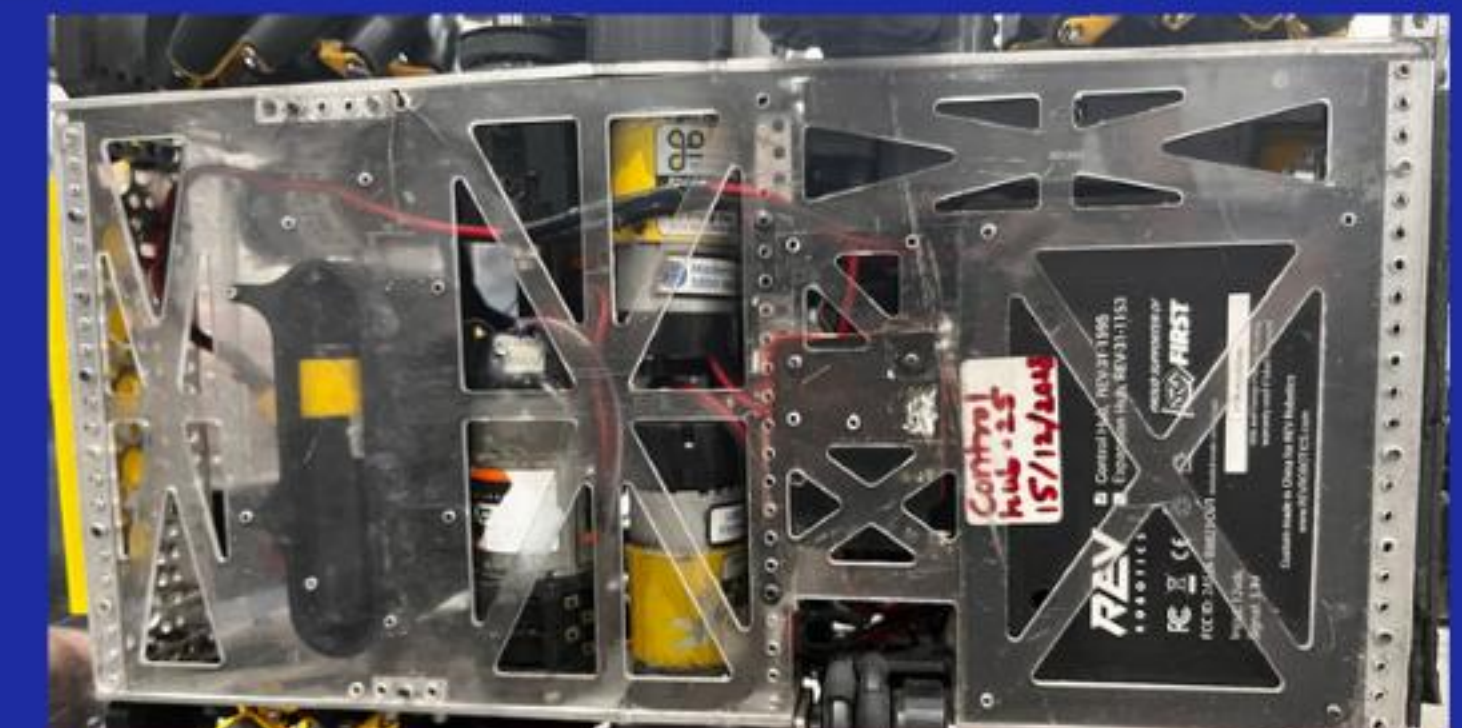
PLA filament is a highly accessible and widely used material, making it an excellent choice for our robot. With the help of 3D printing and CAD software, we can design and manufacture precise, custom components tailored to our bot's needs. We have successfully used PLA to print essential parts such as the battery holder, gripper, and rack, ensuring durability and efficiency. Additionally, we experimented with flexible TPU filament to print parts for our gripper, enhancing its flexibility and adaptability.



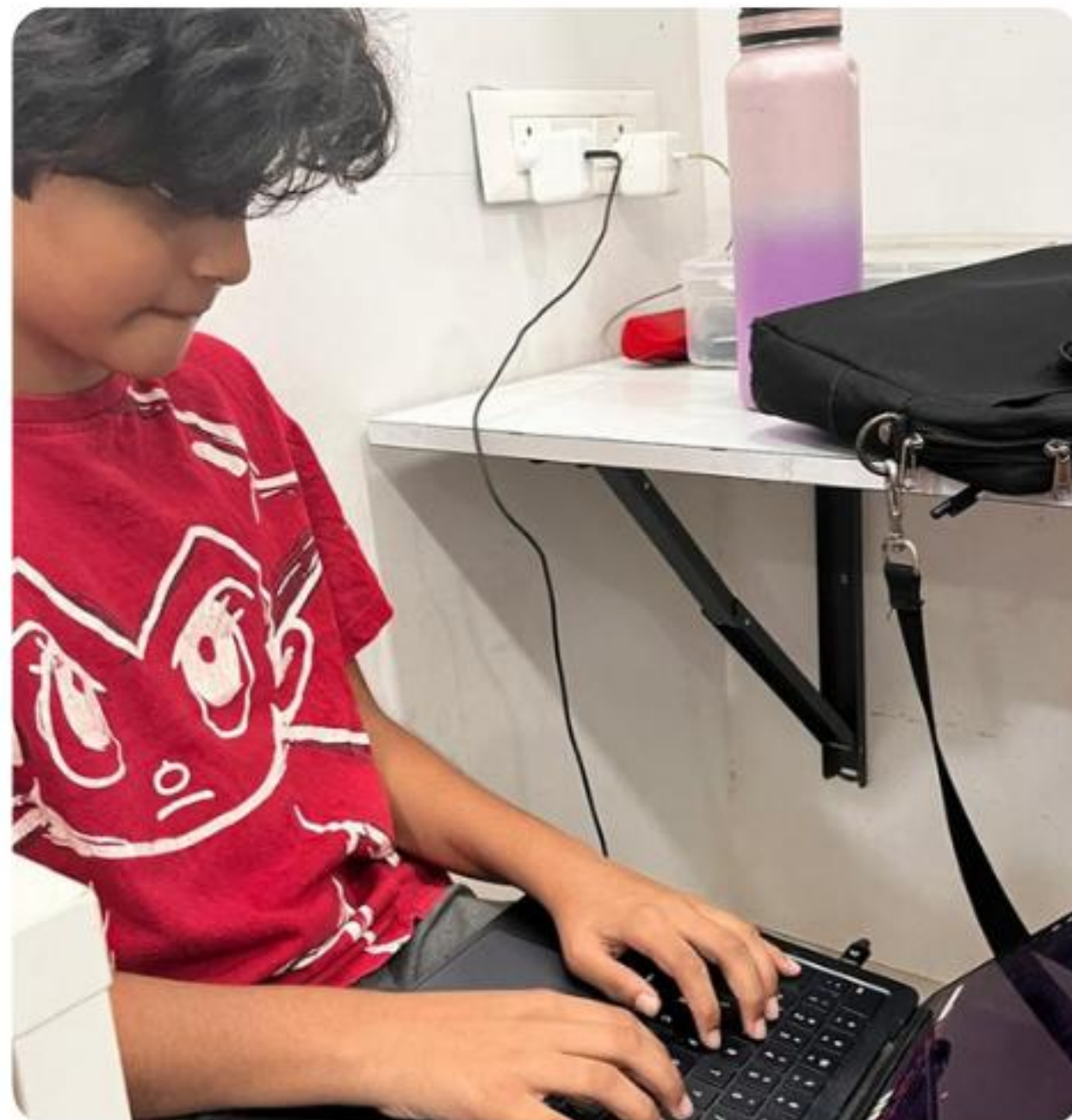
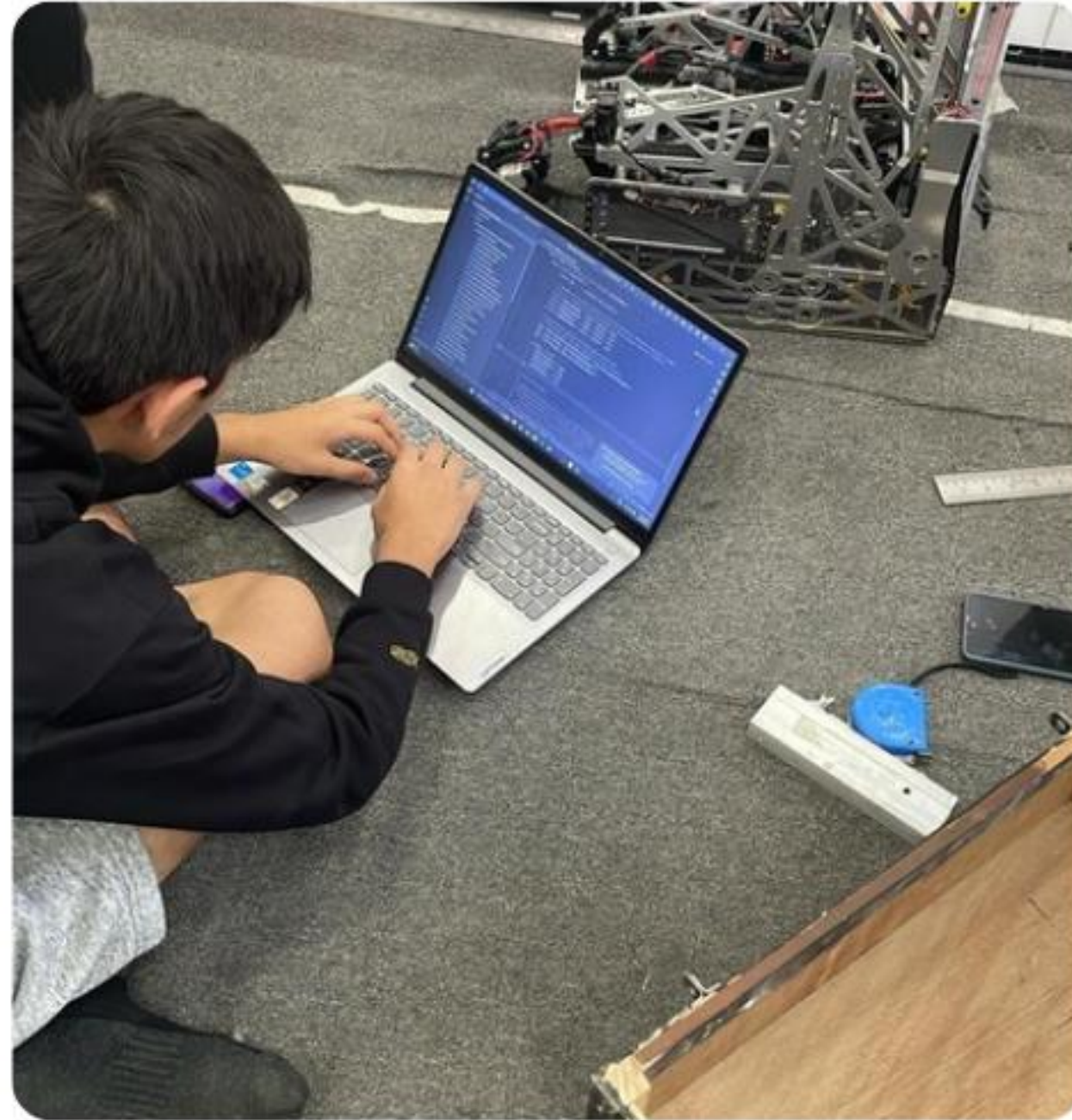
3.

Polycarbonate (plastic)

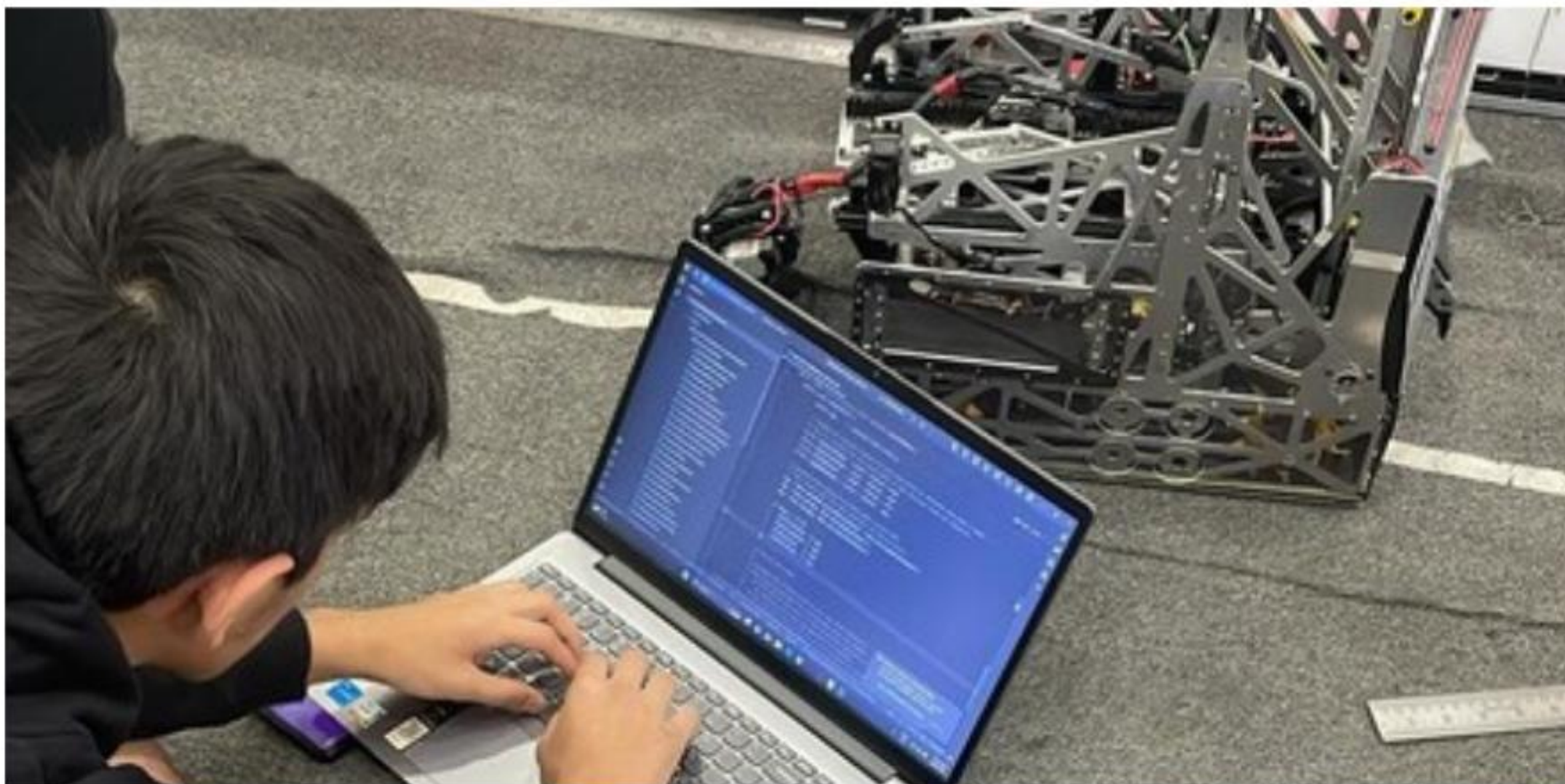
- We use polycarbonate for our baseplate because it is tough and can spread any impacts to the bot.
- We also use it in other parts like side plate and gripper plate.



PROGRAMMING TEAM



PROGRAMMING



5 programming members

WHY JAVA AND ANDROID STUDIO?

FIRST Tech Challenge robots are usually programmed using either Blocks, a drag-and-drop graphical language based on Google's Blockly, or Java. Java is supported in two forms: OnBot Java and Android Studio. Using Android Studio involves a fairly complex installation process and learning a sophisticated set of software tools as well as certain aspects of Android programming libraries. It is a good choice for teams with strong skills in Java and want to learn how to use professional software development skills.

Since most of our members were very well versed in Java after the skill building lessons, we decided to use Android studio.

HOW DID WE COLLABORATE?



We used Github. It is a web-based interface. It allows the team to have a collaborative work. It permits multiple people make separate changes at the same time. It is used to handle small to very large projects efficiently. It helps developers to store, help, manage, track and control changes. This is why we used git hub to make our work collaborative efficient and seamless and to have a sense of teamwork among the members.

ANDROID STUDIO

Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.

PROGRAMMING

SESSION 1

The most intense brainstorming sessions were during our programming classes. We had to grasp calculus concepts to apply them in our coding. We started with the basics, working in the Android app to code motors, connect hardware, and learn about encoders and sensors.

At first, coding felt fun and easy, but as we progressed, we had to dive deeper into mechanical engineering concepts. The biggest challenge was mastering PID (Proportional-Integral-Derivative) control, which played a crucial role in our robot's precision and performance. It demanded the most effort but was also the most rewarding part of our journey.

```
public static void goAutoTop  
wristState = "TOP";  
WristServo.setPosition(T  
}
```

SESSION 2

Road Runner is a motion planning library designed for the FTC robotics competition. It is primarily used for autonomous movement, allowing for precise path generation and following while controlling velocity and acceleration. This enables robots to achieve greater accuracy and efficiency in executing complex paths.

In Road Runner, routes are built using two key data structures: paths and trajectories.

- Paths define the overall route using waypoints, which can be straight lines or smooth splines.
- Trajectories build on paths by incorporating motion profiling, mapping the velocity and acceleration of the robot throughout the route. This ensures smooth and controlled movement.

```
public static double WHEEL_RADIUS = 1.49508/2; // in  
public static double GEAR_RATIO = 1; // output (wheel) speed / input (encoder) speed  
  
public static double PARALLEL_X = 1.25; // X is the up and down direction  
public static double PARALLEL_Y = 0; // Y is the strafe direction  
  
public static double PERPENDICULAR_X = 1.75;  
public static double PERPENDICULAR_Y = 0;  
  
// Parallel/Perpendicular to the forward axis  
// Parallel wheel is parallel to the forward axis  
// Perpendicular is perpendicular to the forward axis  
private Encoder parallelEncoder, perpendicularEncoder;  
  
private SampleMecanumDrive drive;  
  
public TwoWheelTrackingLocalizer(HardwareMap hardwareMap, SampleMecanumDrive drive) {  
    super(Arrays.asList(  
        new Pose2d(PARALLEL_X, PARALLEL_Y, 0),  
        new Pose2d(PERPENDICULAR_X, PERPENDICULAR_Y, Math.toRadians(90))  
    ));  
}
```

PROGRAMMING SKILL BUILDING



- We began our coding journey with introductory lectures on how to use basic java for FTC.
- We also learned how to use Replit and explored its many features. The skills we developed improved our ability to code, debug, and build logic in our code.
- This built our confidence to program the actual FTC bot.



PROGRAMMING SKILL BUILDING



“Coding is like humor, when you have to explain it, it’s bad.”

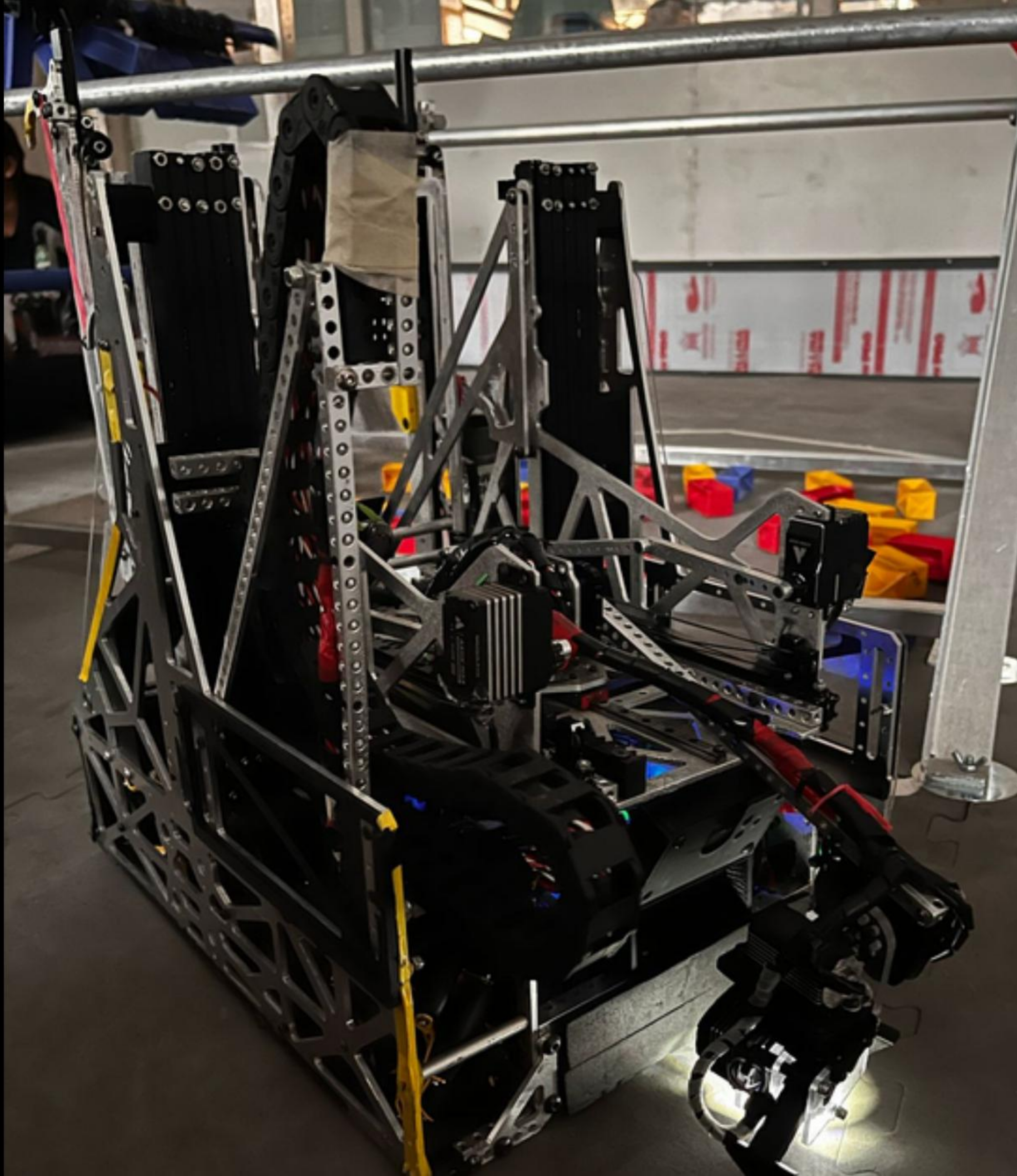
The students of FTC got their first taste of Java with the online classes which they signed up for. They started at the base, learning how to give output in the first class, to learning about objects, classes, and inheritance. The very first session plunged the students into the world of Java by installing Eclipse and Blue-J is the main IDE to work on. They were first taught what all beginner programmers learn – printing “Hello world!”. Then they took input and learnt simple arithmetic: addition, subtraction, multiplication, division, and modulus (remainder) along with operators such as AND, OR, NOT and more. This is later used in all the sessions.

```
System.out.print (" enter your name: ");
a = sc.nextLine ();
int c, d, e, f ;
System.out.print (" enter your age: ");
c = sc.nextInt ();
System.out.print (" enter your marks in english: ");
d = sc.nextInt ();
System.out.print (" enter your marks in maths: ");
e = sc.nextInt ();
System.out.print (" enter your marks in science: ");
f = sc.nextInt ();
double avg;
avg = (d+e+f)/3;
```

MORE ABOUT PROGRAMMING SKILL BUILDING

- We used the newfound knowledge and calculated the area of 2D shapes and simple interest.
- We went on to learn: if, else if, for, switch-case, and do, while loops along with ternaries. With this, they made a calculator for the five symbols with two numbers for inputs.
- With the basics done, they went on to make multiple programs such as the greatest of three, divisibility tests, and the calculations of factorial.
- Concept learnt, they moved on to logic-based programs, i.e., finding prime factors, number of factors of a number, summations, prime numbers, Armstrong number, the Fibonacci series and many more.

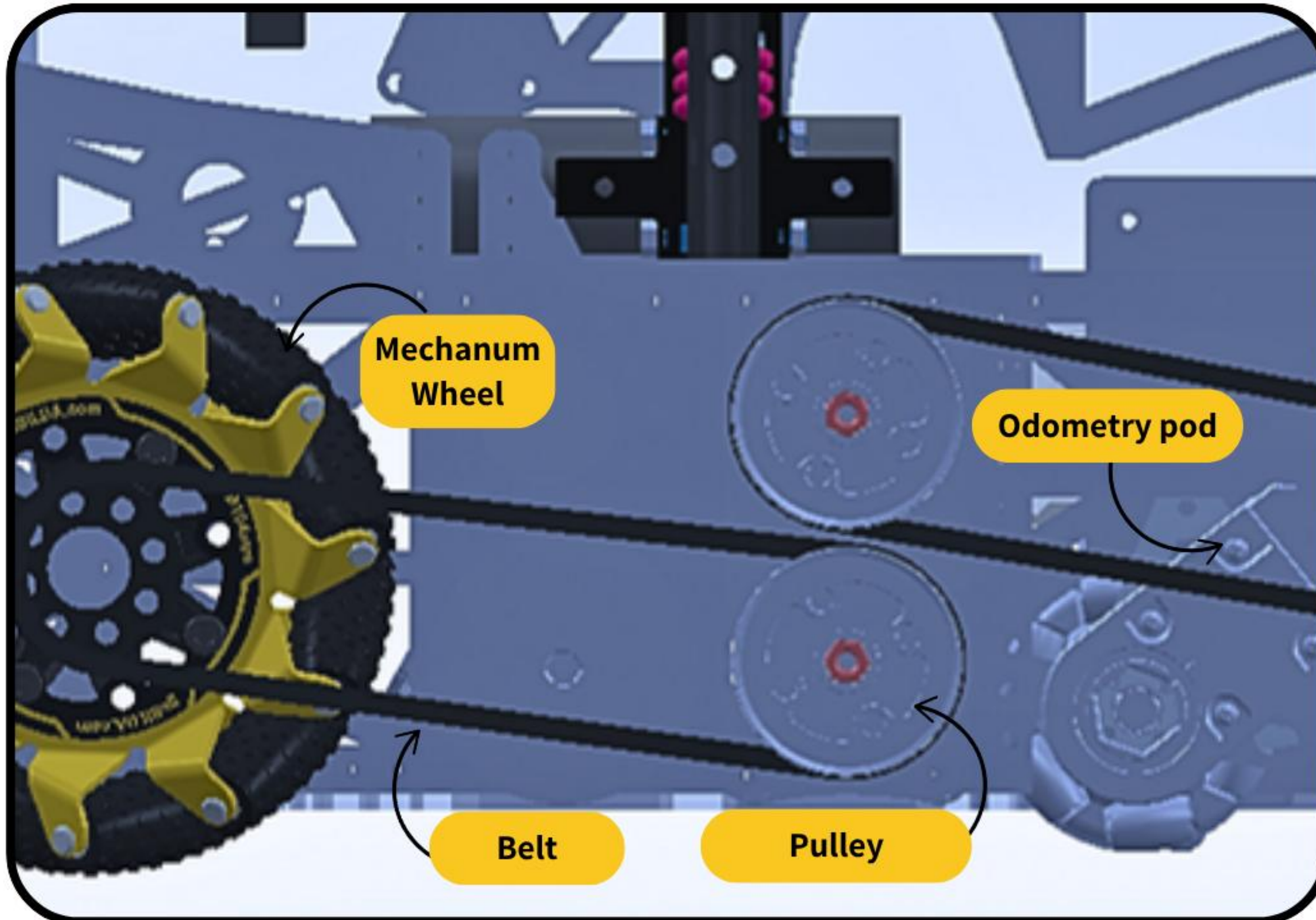
- With these programs out of the way, they moved to application-based programs. They created smart electricity and taxi bills, a menu for a restaurant, and for a break, a random number game.
- With the basics learnt and applied, they went to learn advanced concepts like arrays and string functions, along with their applications.
- With all of this into their heads, they finally moved on to the most important concept: Classes and objects. The most amount of time was spent on this concept.
- Finally, to end it all off, error catching was used to clear all our programs from errors.



OUR BOT **THE AQUADUCK**

MECAHNISMS

DRIVETRAIN



4 wheel mecatanum holonomic drivetrain.

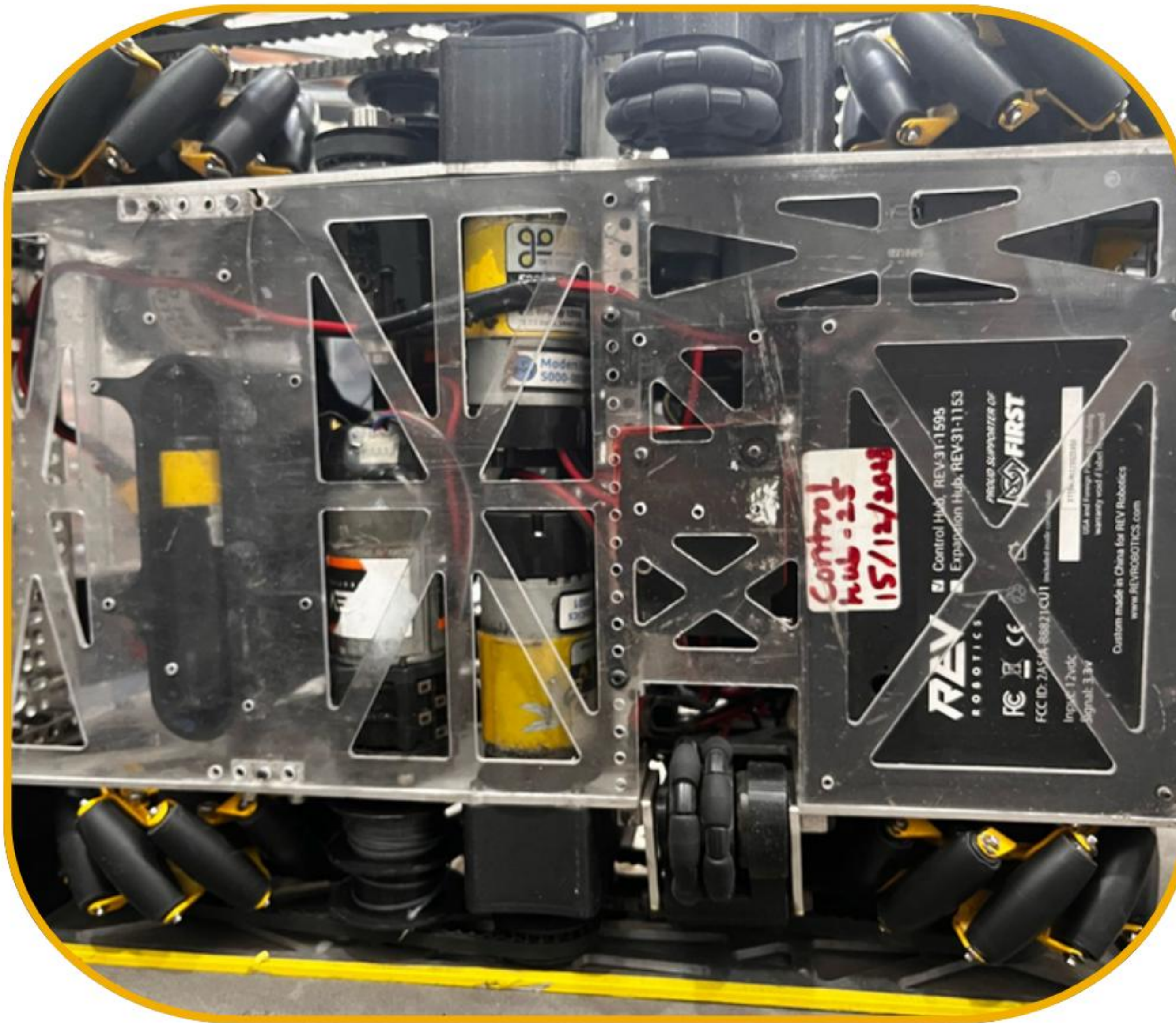
The **meatanum drive** wheel setup saves significant amount of time as it can easily strafe left and right without changing its heading.

- 4 Gobilda Mechanum wheels
- 4 3D printed pulley
- 4 Belts
- 4 CNC plates
- 4 Gobilda series 5203 motors with gear ration 13.7:1

- Nav-X
- 2 Custom Odometry pods

The wheels are connected to the motors via **belts and pulleys**.

BASE PLATE

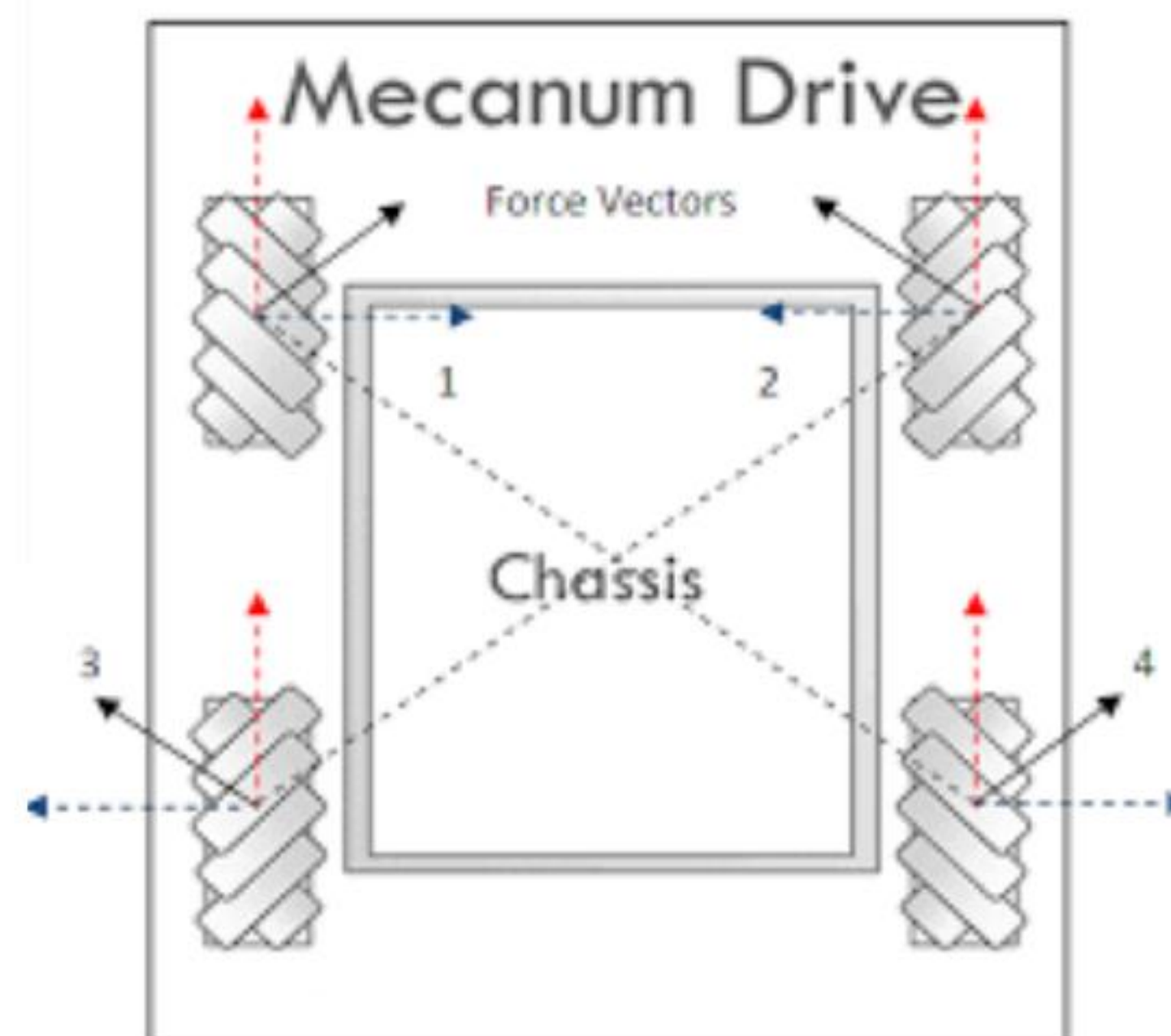


Polycarbonete base plate

- This is the polycarbonete base plate.
- Polycarbonete was chosen for being lightweight and strong.
- It adds durability without increasing weight.
- The material gives the bot extra strength and impact resistance.
- The base plate is crucial as it forms the foundation of the bot.
- It ensures all elements are securely housed inside.
- This minimizes the risk of electrical components loosening and falling.
- We also have custom 3D printed parts to be able to secure the expansion hub and control hub as well as the battery to keep it secure.

MECANUM DRIVE

- The robot uses a Mecanum Drive system for movement.
- Powered by GoBilda motors with a precise RPM and a 13.7 gear ratio.
- The gear ratio ensures optimal performance and efficient control.
- Mecanum Drive allows for movement in all directions, including sideways and diagonally.
- Gearboxes are arranged perpendicularly to maximize the limited underbody space.
- This perpendicular arrangement ensures efficient power transfer and compact design.





DRIVE

WHEELS?

1.

Mecanum Drive:

- Mecanum drive offers holonomic movement, enabling robots to move in any direction—forward, backward, sideways, diagonally, and even translate while rotating. Unlike omni wheels, mecanum wheels face forward, providing better obstacle handling and stronger ground contact. Their design features angled rollers at 45 degrees, which minimize ground friction, reduce torque, and enable smooth in-place rotation. By adjusting the spin direction of each wheel, mecanum drivetrains achieve versatile movement using a standard chassis shape, making them ideal for creating fast, agile robots with efficient movement systems.

2.

OMNI

- We can easily construct components on SolidWorks as the practical features such as sheet metal surfacing, mold and die design, and routed systems make it easy.

2.

Swerve Drive:

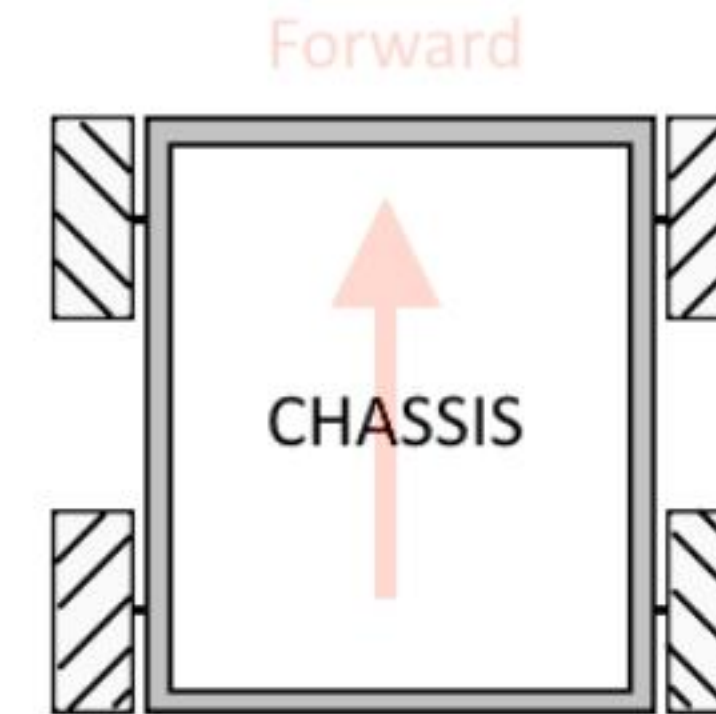
- Omnidirectional Movement: Can spin on the spot, drive sideways, diagonally, and at various angles.
- Performance Benefits: Offers faster speeds, more power, better obstacle handling, and higher maneuverability.

1.

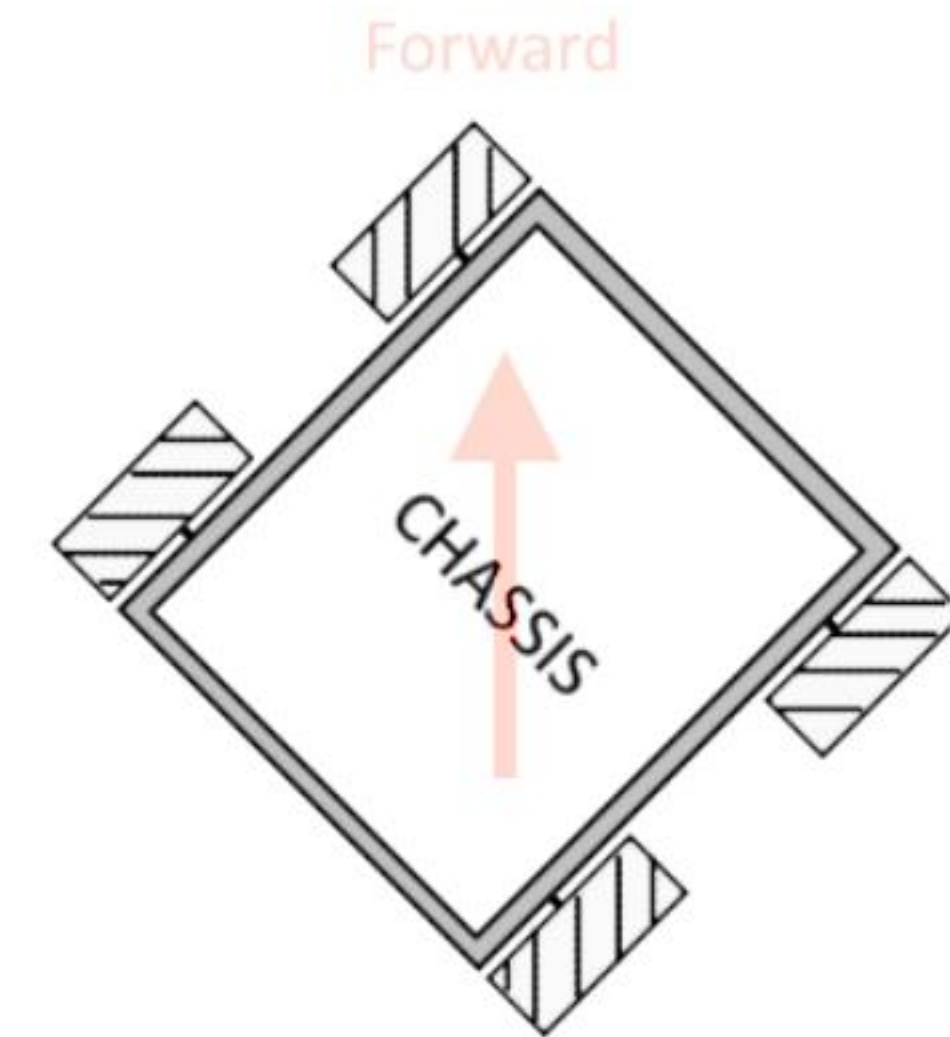
Field Centric VS Robot Centric

- Field Centric: Controller joysticks instruct robot to move in same direction regardless of bot's orientation.
- Robot Centric: Controller joysticks instruct robot to move relative to the bot's orientation.
- Field centric proves to be more useful for our driver as robot rotations change the heading direction, which can be confusing. Field Centric avoids it as robot rotations do not affect the heading direction.
- It moves about the field, not its chassis direction. This could be likened to a compass, where the directions will never change, so moving the joystick left will always move the robot to the left of the field. This is far easier for driving and enables simultaneous rotation and movement.
- **To make it field centric we use NAV-X**

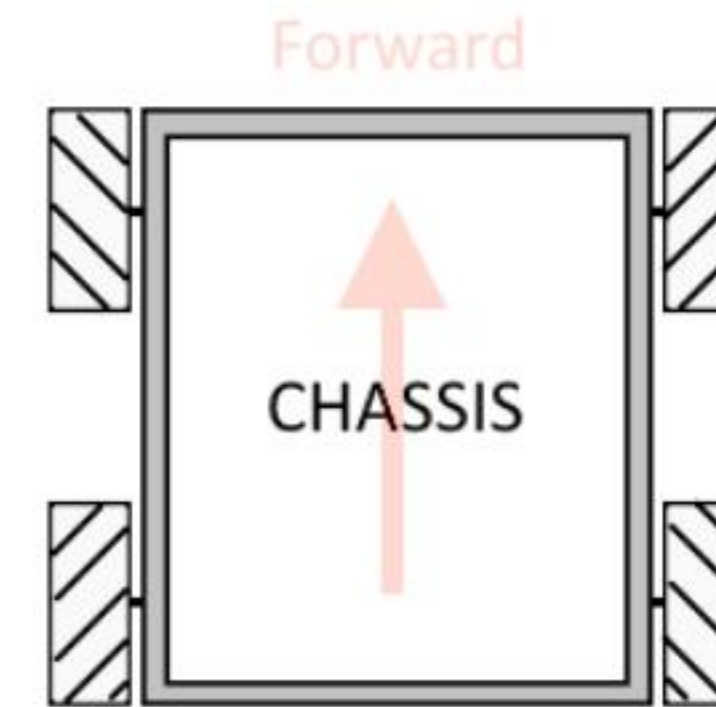
Field Centric



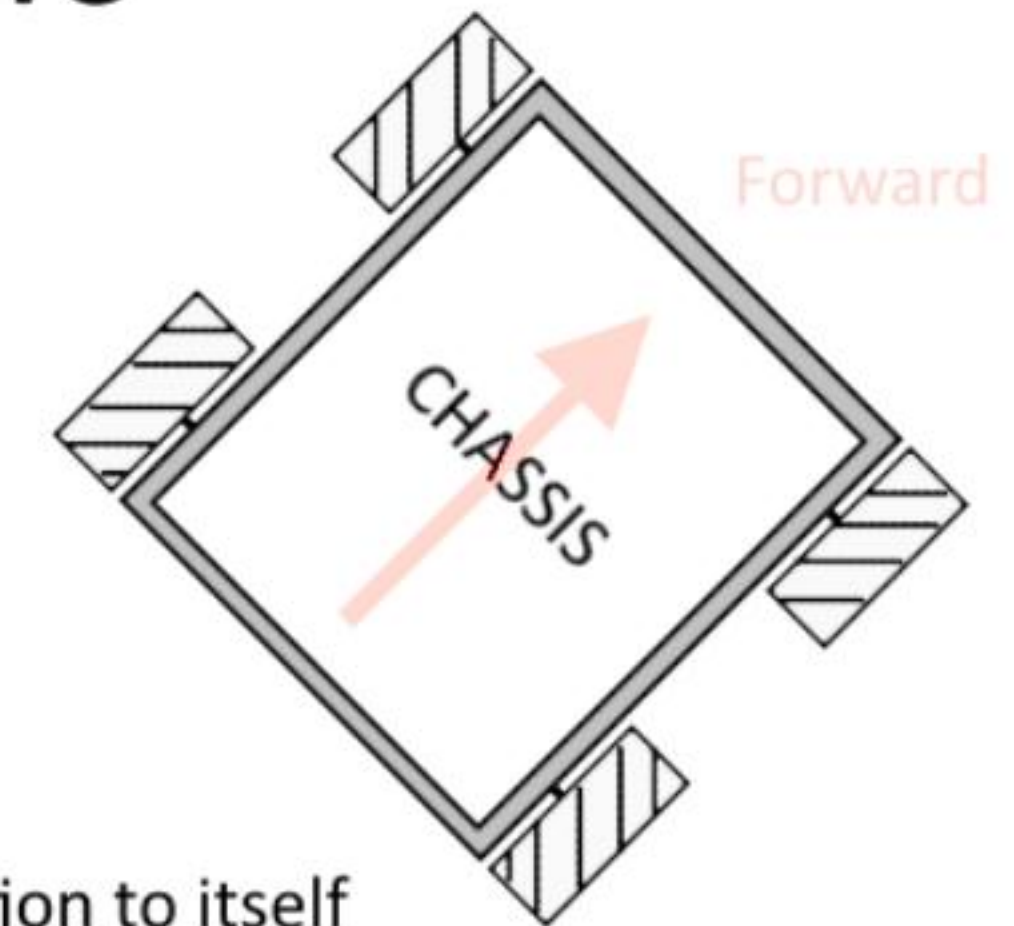
The Robot uses absolute orientation



Robot Centric



The Robot uses relative orientation to itself



TORQUE REQUIREMENTS - DRIVE CALCULATION



TOTAL DRIVE REDUCTION = 13.7

TORQUE ON ONE WHEEL = 18.7... [TORQUE OF GOBILDA MOTOR IS 13.7 kg cm]

WHEEL ROTATES WITH 425 RPM... [NO-LOAD SPEED OF MOTOR]

PUSHING FORCE AT WHEEL PERIMETER = $\frac{18.7}{4.8} = 3.8958 \text{ kg} \dots \textcircled{2} \dots$
[DIAMETER OF WHEEL = 96 mm = 9.6 cm]

TOTAL WEIGHT OF ROBOT = 12 kg

LOAD CARRIED BY EACH WHEEL = $\frac{12}{4} = 3 \text{ kg} \dots \textcircled{1}$

REQUIRED TORQUE = $\textcircled{1} = 3 \text{ kg}$

OUR TORQUE = $\textcircled{2} = 3.8958 \text{ kg}$

HENCE, TORQUE REQUIREMENTS ARE FULFILLED.

SOFTWARE COMPONENTS- NAVX

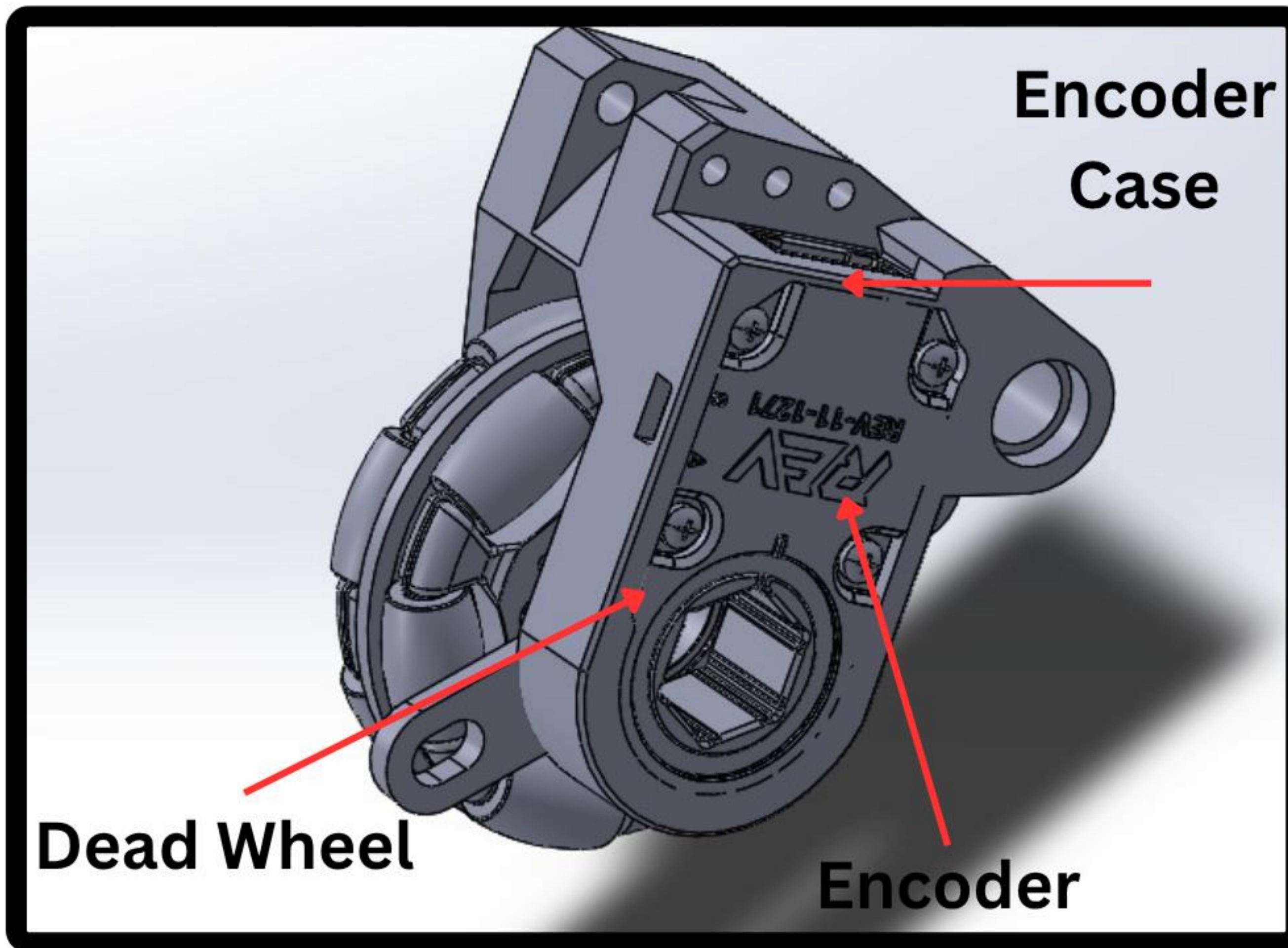


We have a Nav-X at the bottom of our robot to help us find the current direction in which the robot is facing.

The Nav-X consists of an IMU (inertial measurement unit with a gyro sensor), which gives us values based on the change in direction from the initial position. This is important for our field-oriented drive, making it easier for the driver.

The navigation and heading of the drive system are regulated by NavX, an external IMU, integrated with the Control Hub.

ODOMETRY POD



ODOMETRY PODS

Odometry pods are a combination of a dead wheel and an encoder to get an accurate representation of the robot's current position on the field.

DEAD WHEELS

- Dead wheels are non-driven wheels which use an elastic system to ensure their contact with the ground at all times. They move with the robot throughout the match.

ENCODERS

- Encoders are used to calculate the distance moved by a dead wheel using light.

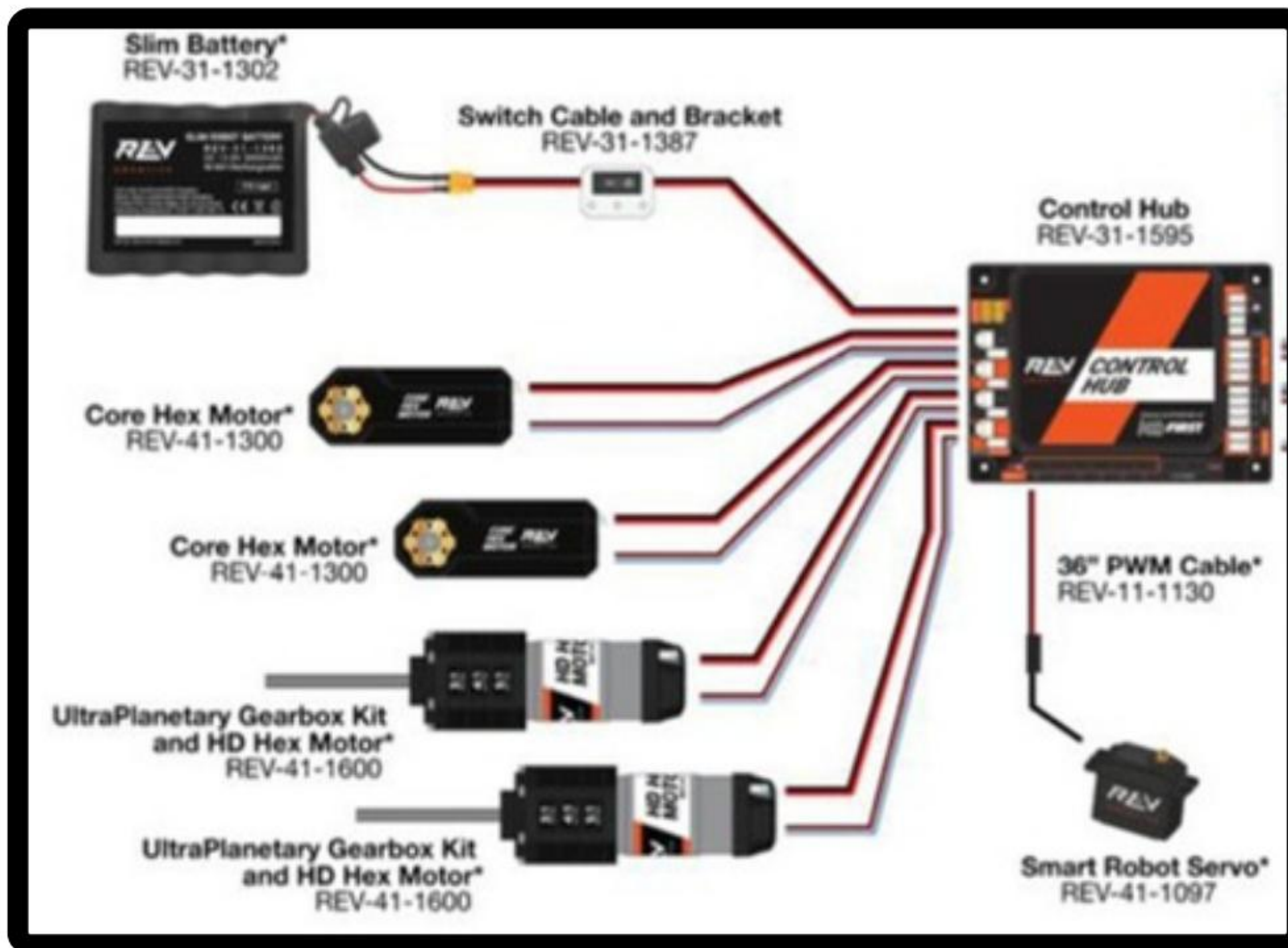
USAGE

Odometry pods are used in the autonomous period as sensors to help the robot accurately move to a specified set of coordinates. These are extremely helpful for the accuracy and reliability of the autonomous period.

IMPLEMENTATION

We utilize two odometry pods—one for the X-axis and one for the Y-axis—to accurately determine the robot's current position and movement.

CONTROL HUB



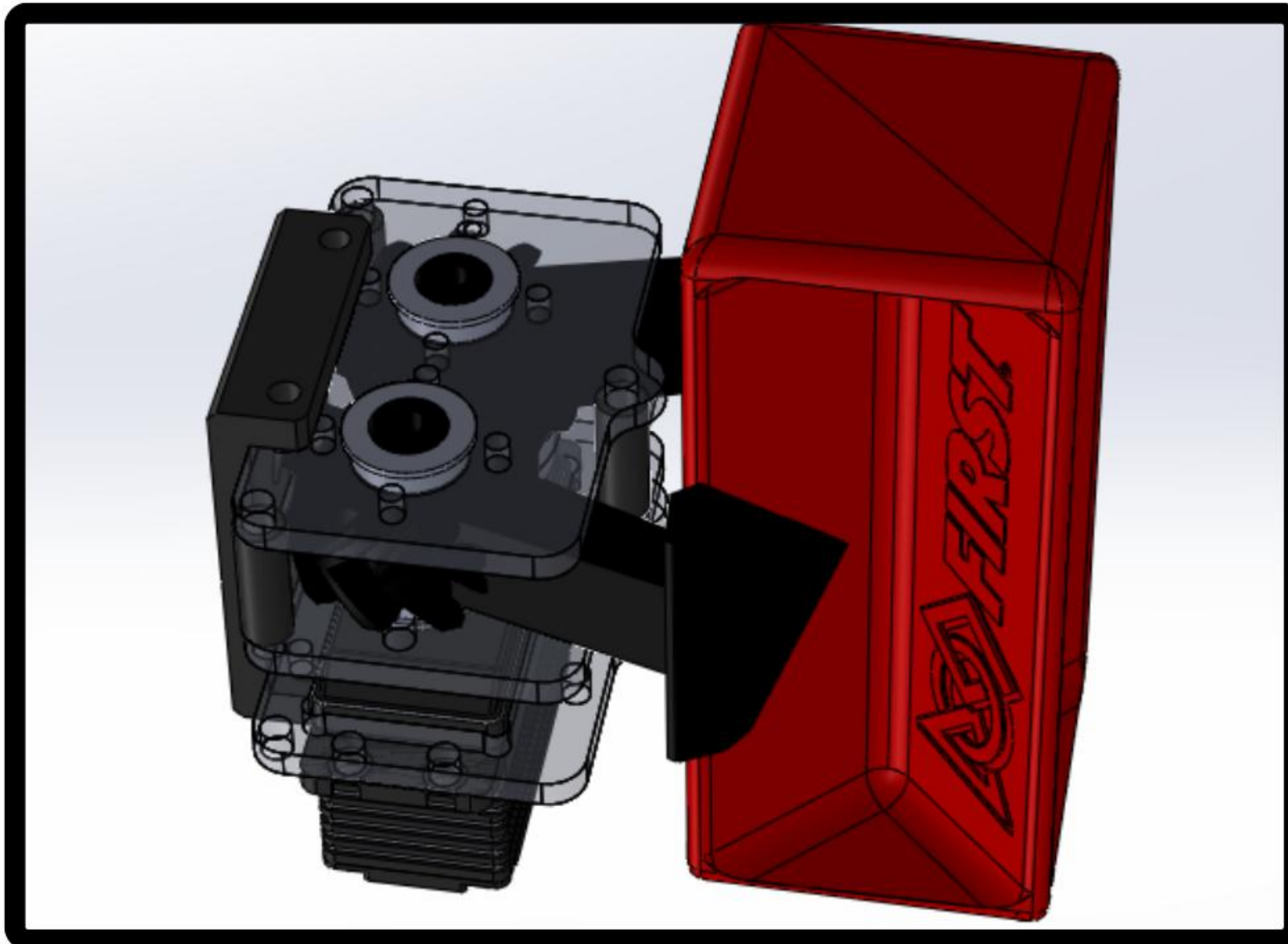
The control hub is designed to allow us to interface, and control all the motors. It reacts to the feedback provided by the encoders using the given program. The maximum capacity of the control hub is 4 motors, and 6 servos (Out of which we used 4).

We've also added an expansion hub to accommodate the 4 other DC motors we are using. We have also used adhesive to ensure the wires remain fastened in their ports.

We are using a REV-31-1595

We are using a NavX - an external IMU, that makes use of a 3 axis gyroscope to give the heading direction of the robot. This is being used for the two--wheel odometry system, and also the field centric driver controls.

GRIPPER



Our gripper design allows for our gripper to be compact while not sacrificing on efficiency and accuracy in picking up samples and specimens

We are using 3 Axon Max servos for the gripper, one for opening and closing the claw, one for rotating the gripper, and one for going up and down.



We are also using a stripped down colour sensor in the gripper to analyse the distance between the sample and the gripper

COMPONENTS

- 2 herringbone gears
- 3 Axon max servos,
- REV Color Sensor
- Polycarbonate Plates
- Everything bearing

GRIPPER

ITERATIONS

1.

Key Features

- Color sensor in the middle

Areas for Improvement

- Color sensor strikes the sample first displacing it making pick inaccurate



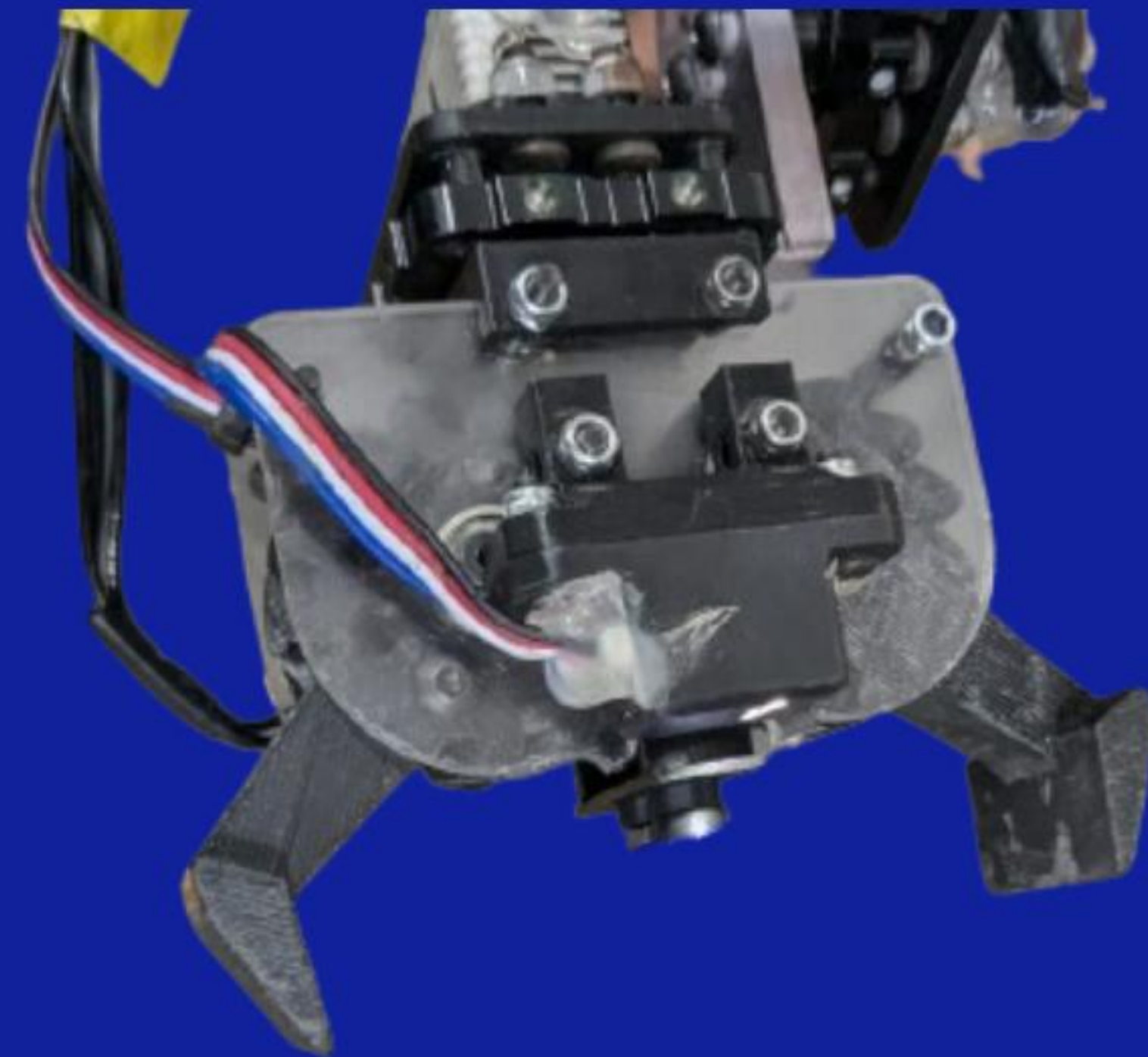
2.

Key Updates

- Repositioned color sensor
- Optimized space

Areas for Improvement

- It was interfering with the clip of the specimens.



GRIPPER

ITERATIONS

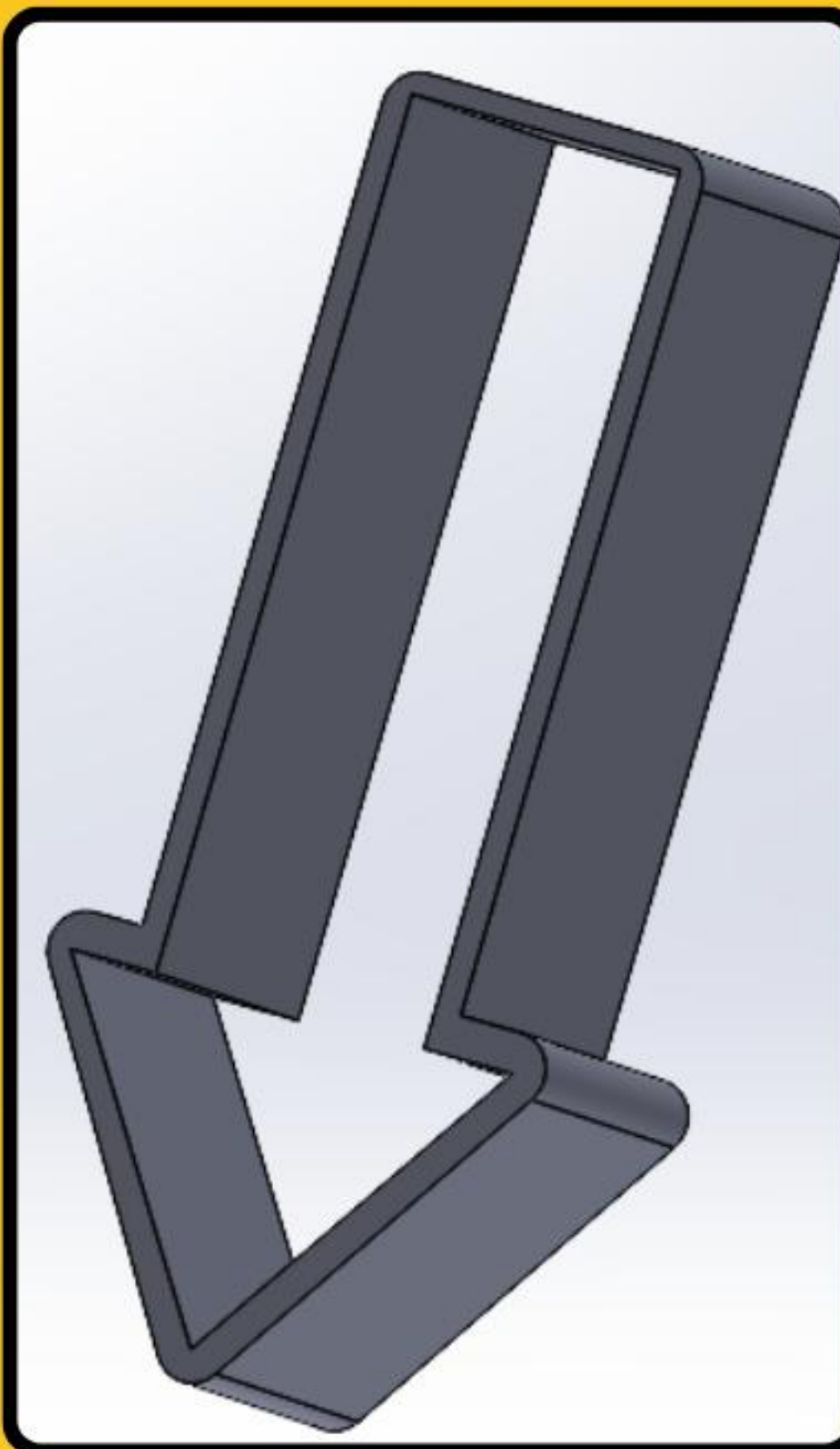
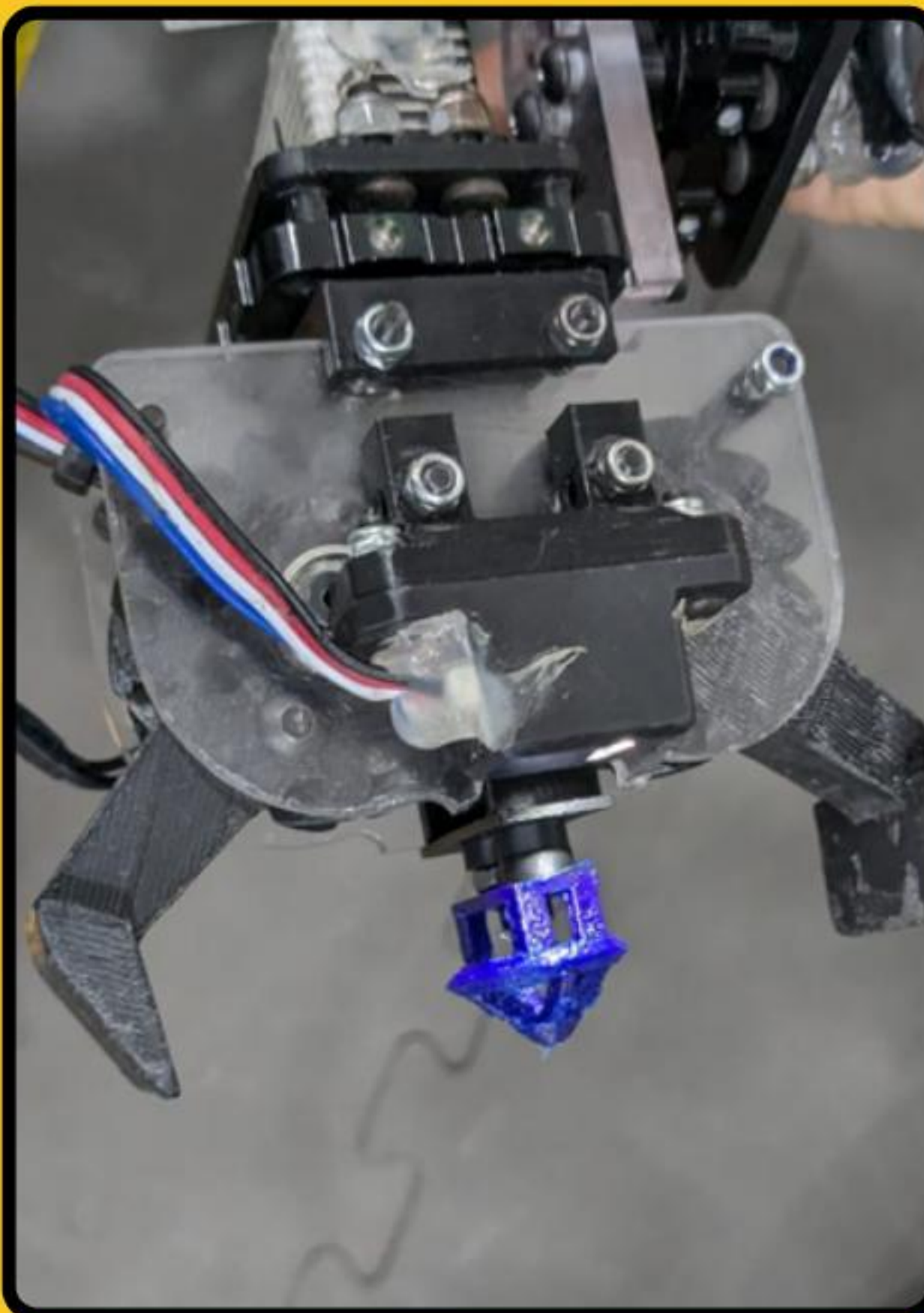
3.

Key Updates

- Added a flexible TPU 3D printed part to align it better in Teleop.

Areas for Improvement

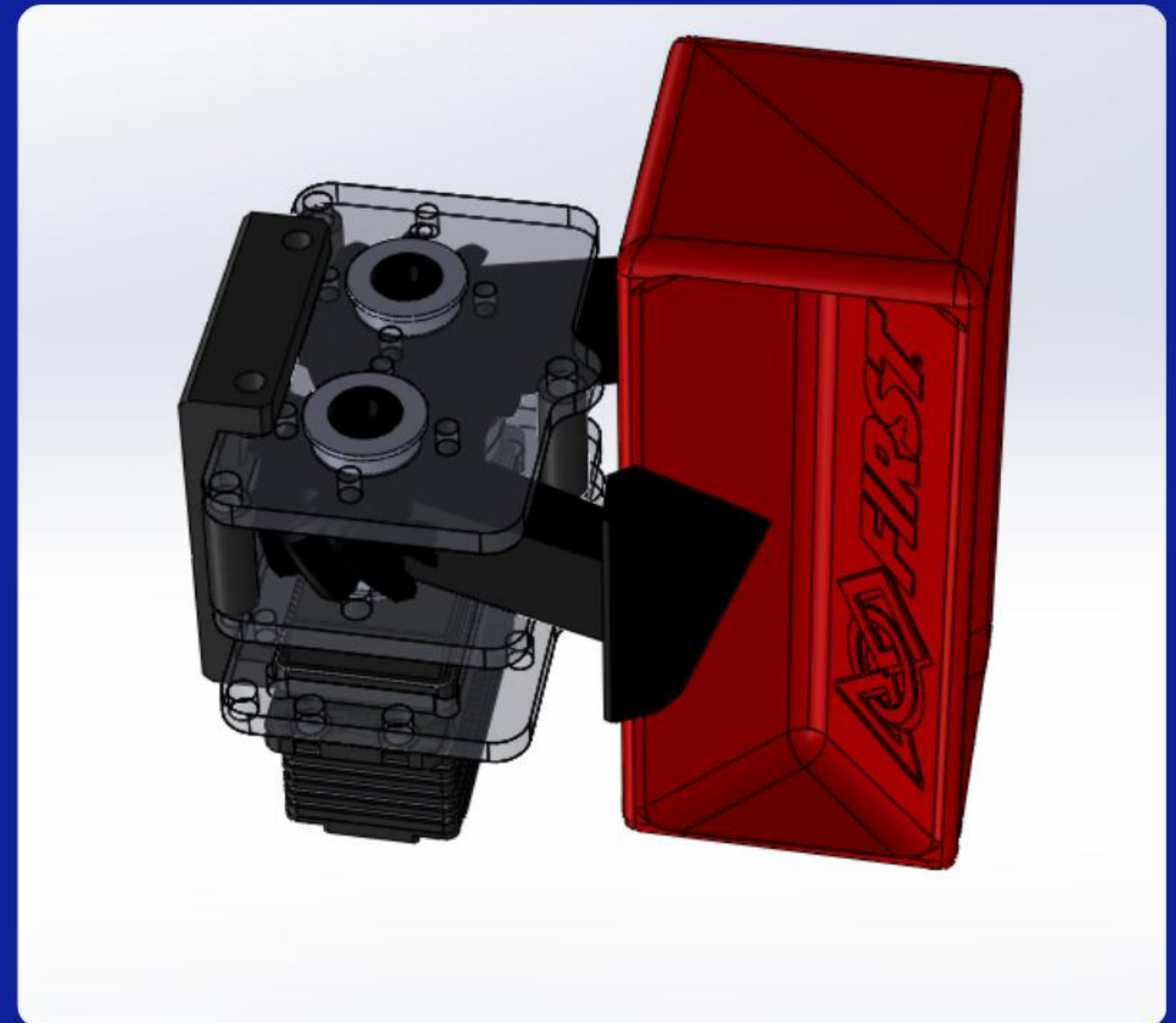
- Requires more precision and had issues in Auto



4.

Key Updates

- Smaller gears
- Bigger jaws
- Removed the 3D Printed part
- Optimized the gripper size



REV COLOR SENSOR



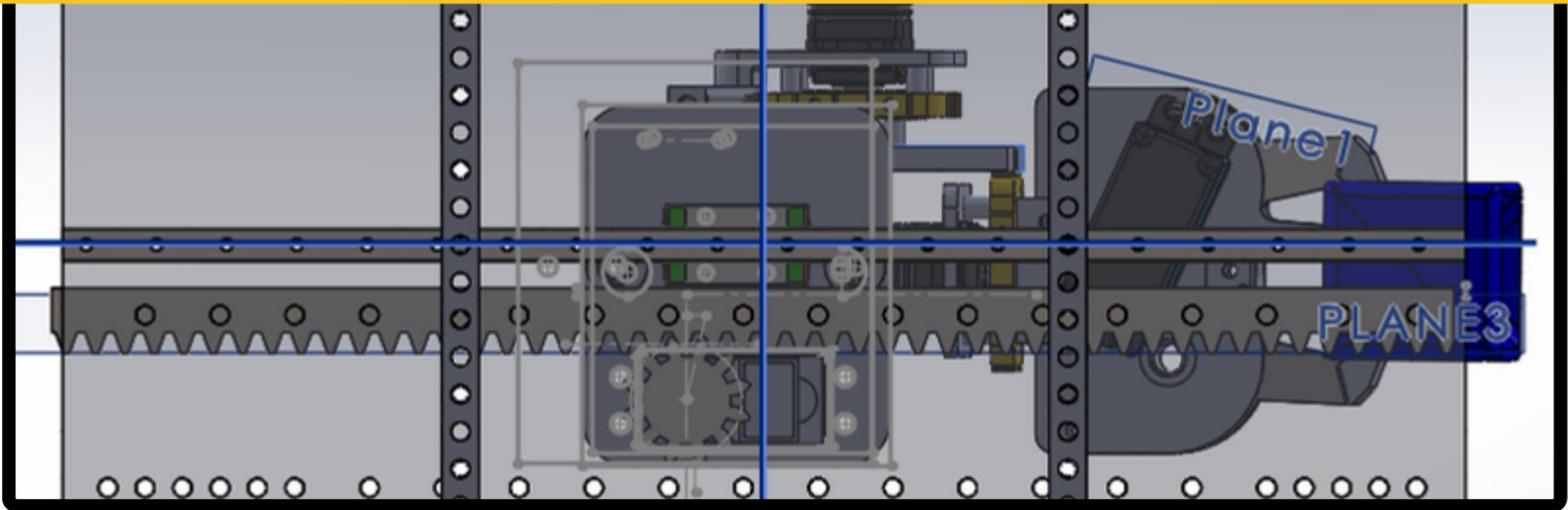
The Color Sensor helps us detect and identify colors by shining light on the object and measuring the reflected light across red, green, and blue (RGB) channels.

This sensor can be used for various tasks in robotics, such as line following, object detection, and color-based decision-making, where it helps the robot respond to different colors on the field or detect specific color markers.

We use the colour sensor's unique ability of detecting distance to aid us in picking up specimens from the observation wall enabling us to automate the process.

We use the colour sensor's unique ability of detecting distance to aid us in picking up specimens from the observation wall enabling us to automate the process.

RACK AND PINION



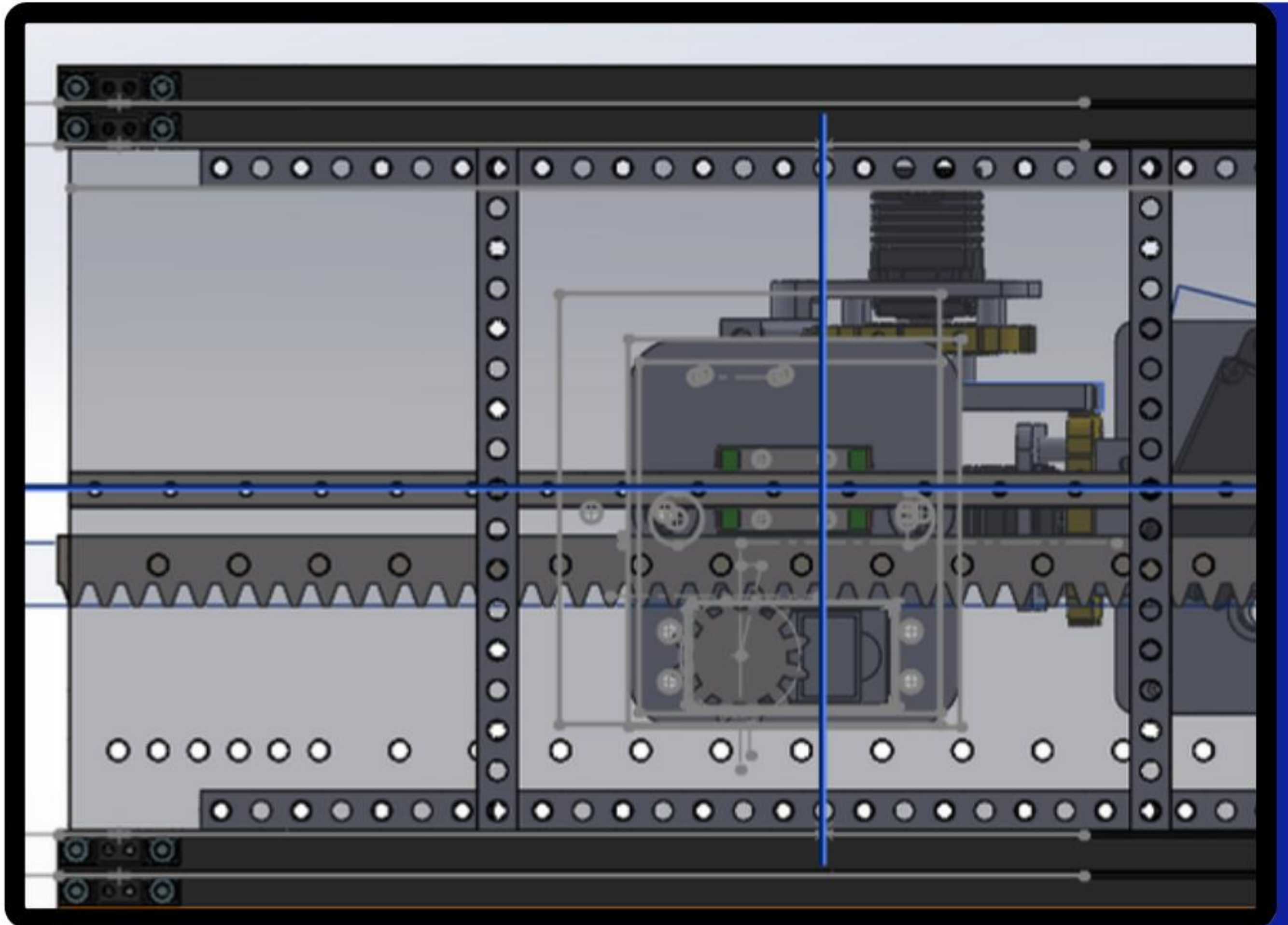
We are using 2 servos for the rack and pinion and 2 for the vertical extension.

Our first iteration had a problem of gear slipping, so we switched to a bigger gear for strength and grip on the rack

We tried using a pulley earlier instead of rack and pinion but found out that rack and pinion is more efficient.

We are using the rack and pinion to extend the tray on top of the rack forward into the submersible to grab samples.

WHY RACK AND PINION?



We are using rack and pinion because of its precision and control in mechanical applications. The design consists of a circular gear (the pinion) that engages with a linear gear (the rack) to convert rotational motion into linear motion.

The straightforward design also reduces the chances of mechanical failure, contributing to longer operational lifespans and lower maintenance costs.

The mechanical simplicity of the gear-to-rack interface minimizes energy losses, allowing for efficient power transfer. Additionally, these systems are known for their durability and ability to handle high loads, offering reliable performance in demanding environments.

This direct engagement ensures minimal play and backlash, providing smooth and accurate positioning. This makes rack and pinion mechanisms ideal for applications requiring precise linear movement, such as in CNC machines, automotive steering systems, and industrial automation.

Rack & Pinion

ITERATIONS

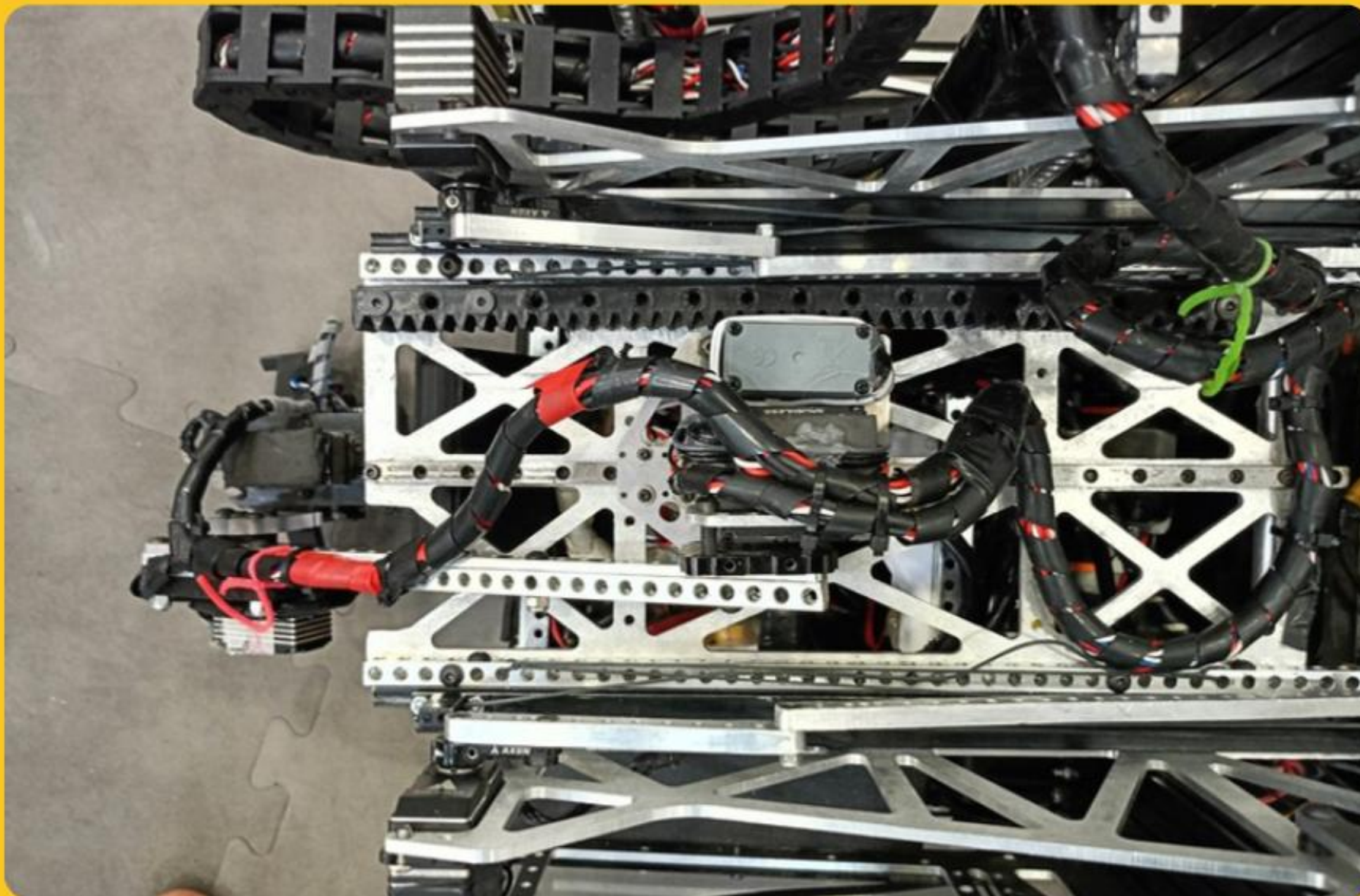
1.

PROBLEM

- The rack and pinion gear used to slip a lot and move horizontally from one side to another

SOLUTION

- A 3D printed part ensured that there was no slippage of the gear.
- This also reduced wear and tear of the gear teeth



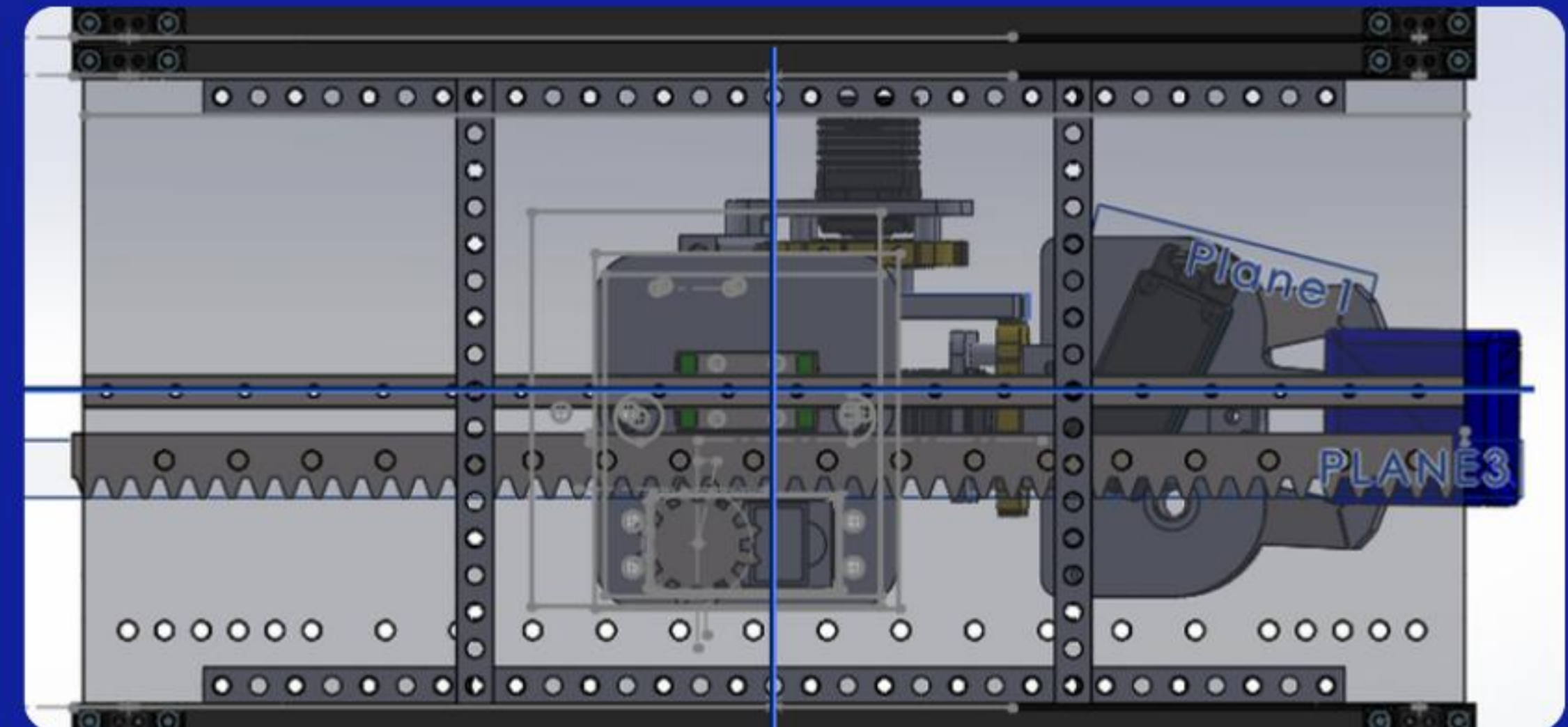
2.

PROBLEM

Making mistakes or last-minute changes in CAD is pretty common. In other CAD software, we have to go back and edit the steps 1 by 1, and still, the body would have errors.

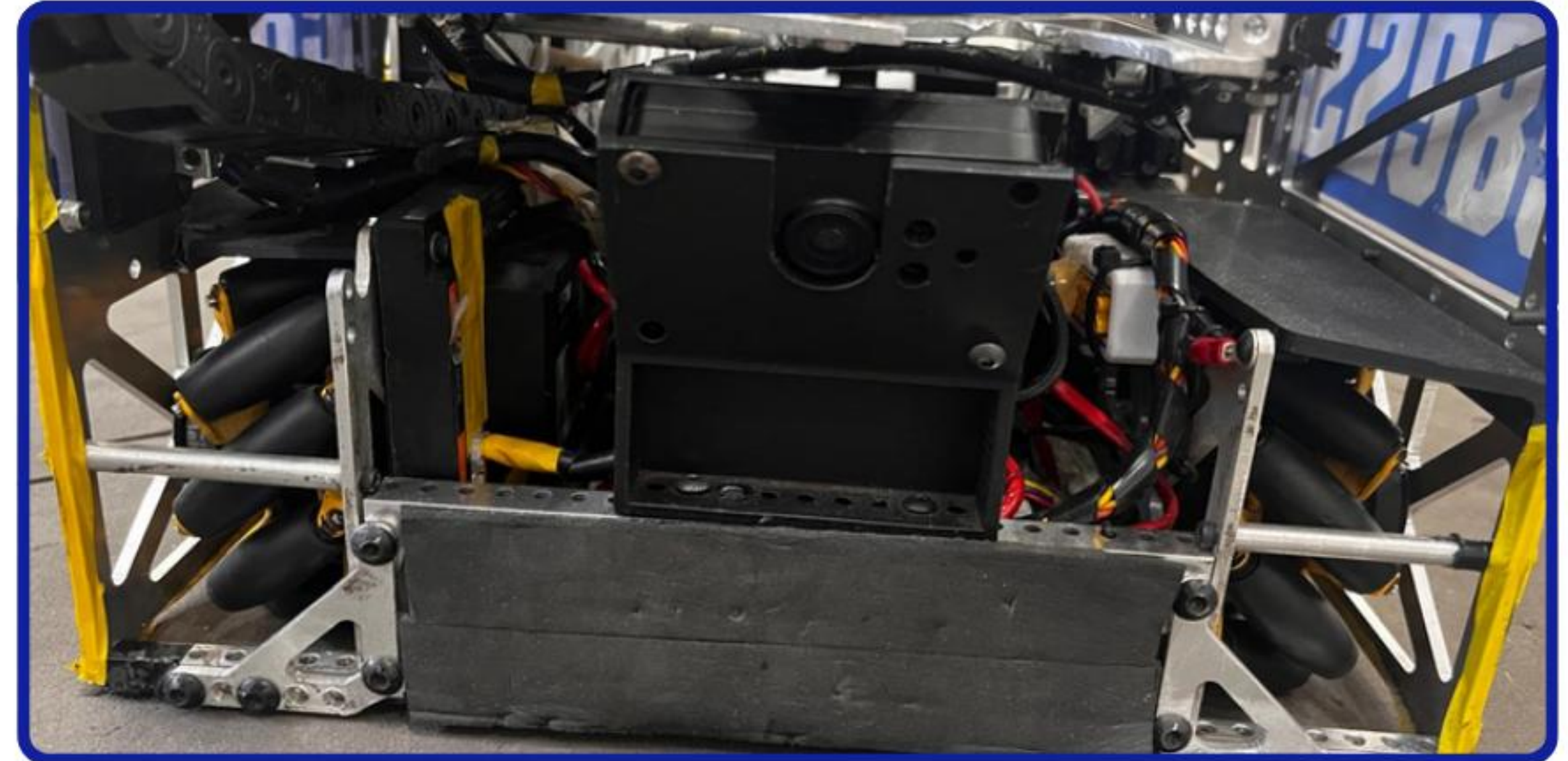
SOLUTION

- SolidWorks simplifies the editing process by allowing you to make changes without the need to go back and revise each step individually. This ensures 100% accuracy and eliminates errors, providing a seamless and mistake-free modification experience.



How does it work?

- Target Detection – LimeLight processes images in real-time to identify game elements (e.g., AprilTags, team-provided markers).
- Pose Estimation – Using AprilTags, LimeLight can estimate the robot's position (x, y, rotation) on the field, aiding in accurate navigation.
- Automatic Alignment – It provides offset angles and distances to allow robots to align precisely with field elements (e.g., scoring zones).
- Data Integration – The camera sends processed data to the Control Hub, which can be used to adjust robot movement dynamically.
- LED Ring for Illumination – Ensures consistent vision tracking in various lighting conditions.

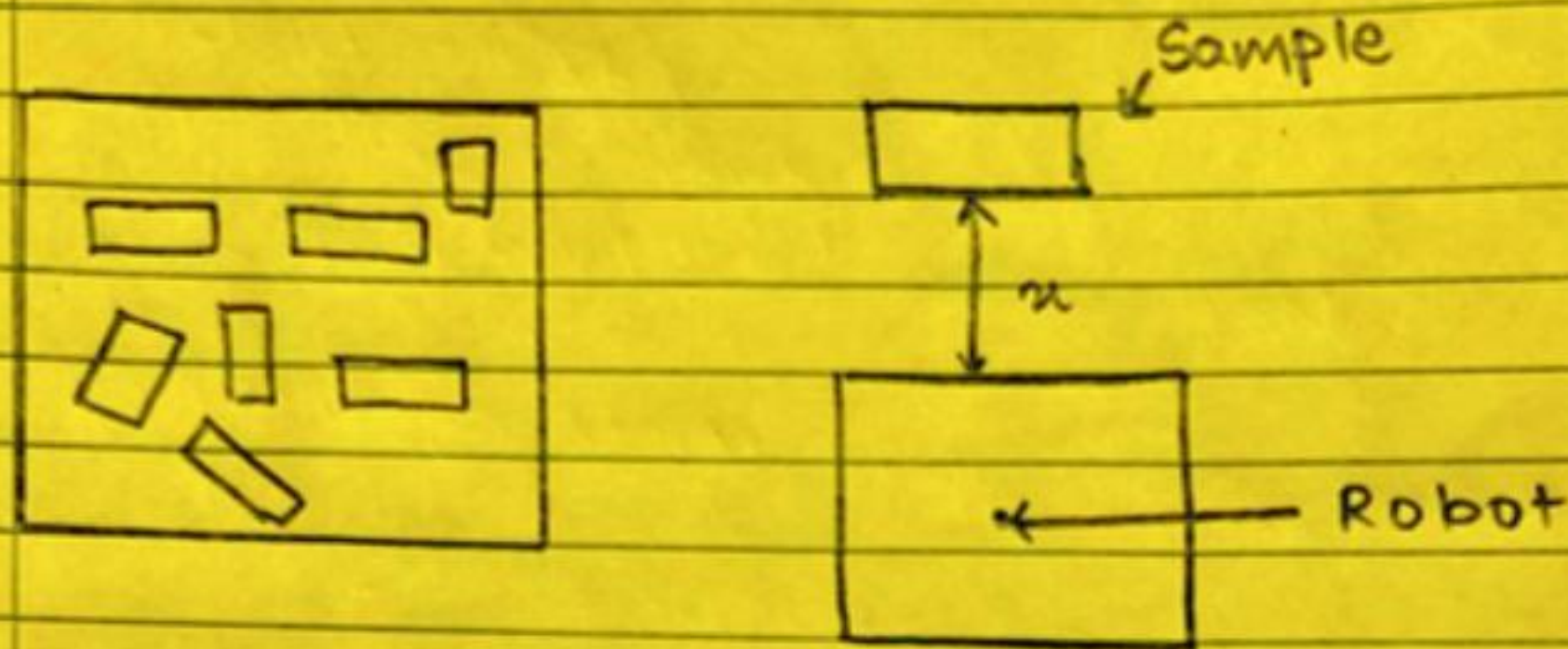


- LimeLight is a vision processing system commonly used by teams for robot localization, target detection, and autonomous navigation.
- It is a specialized camera with onboard processing that helps robots detect and track vision targets, such as AprilTags or game-specific markers, to improve autonomous and teleoperated performance.

LIMELIGHT CALCULATIONS



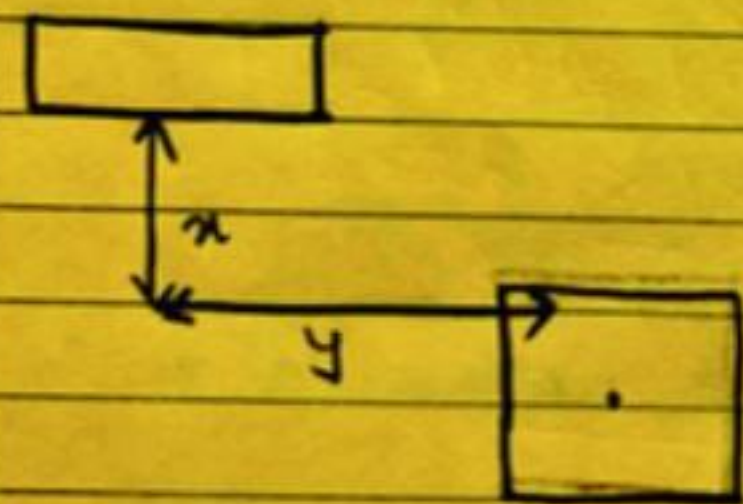
• CASE 1



Coordinate $(x, y) = (x, 0)$

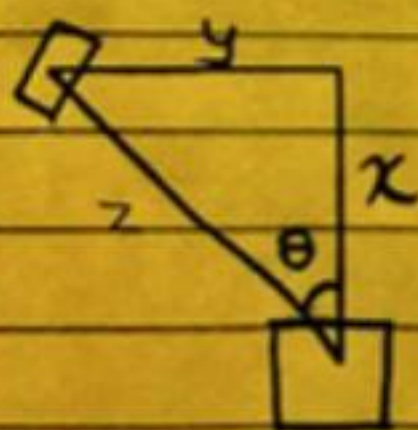
$y = 0$ for this case because the sample is right in front of the bot

• CASE 2



Coordinate (x, y)
 x and y will be having some values based on how far the sample is. The bot will strafe until the error i.e. y is 0

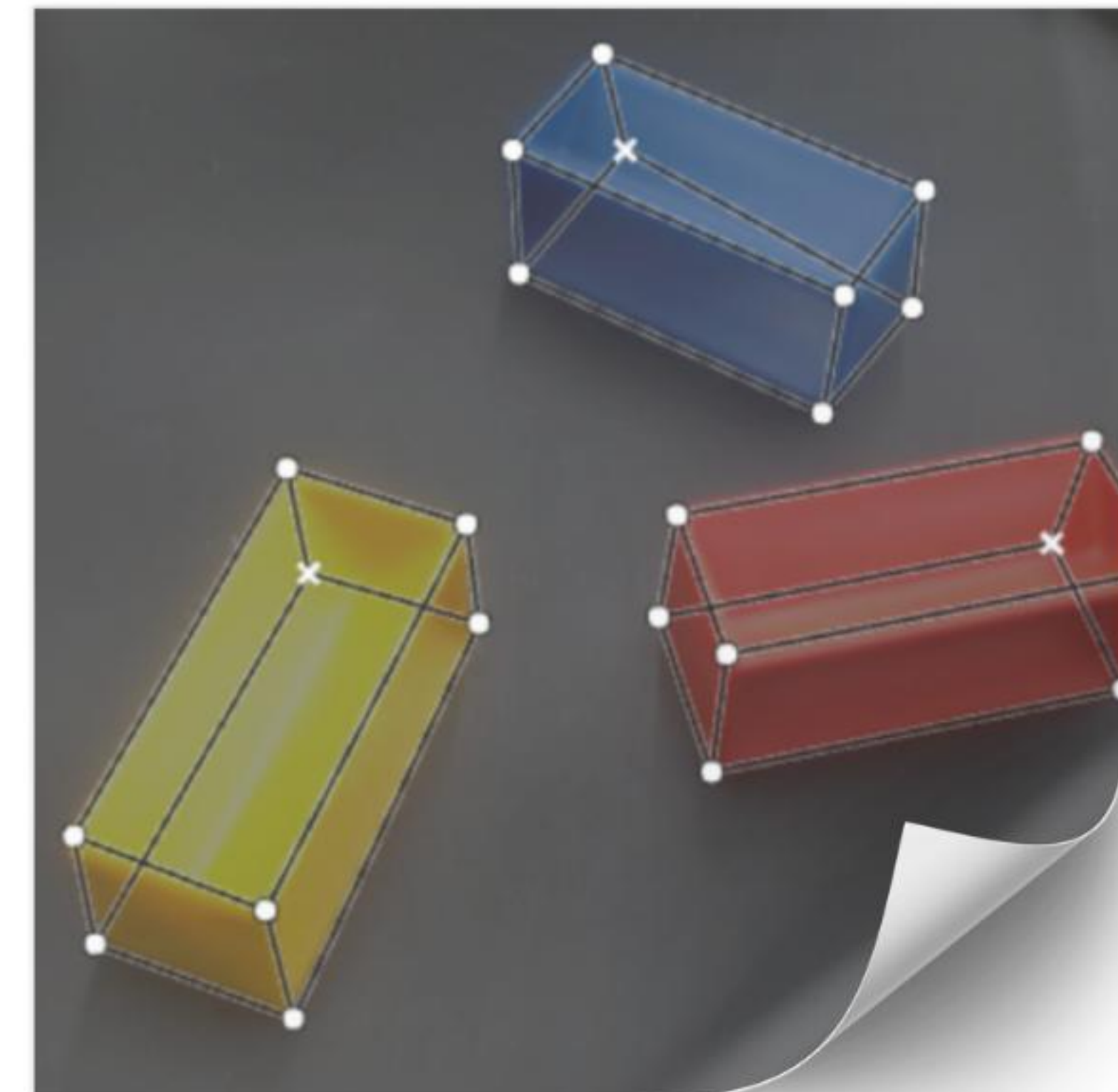
• CASE 3



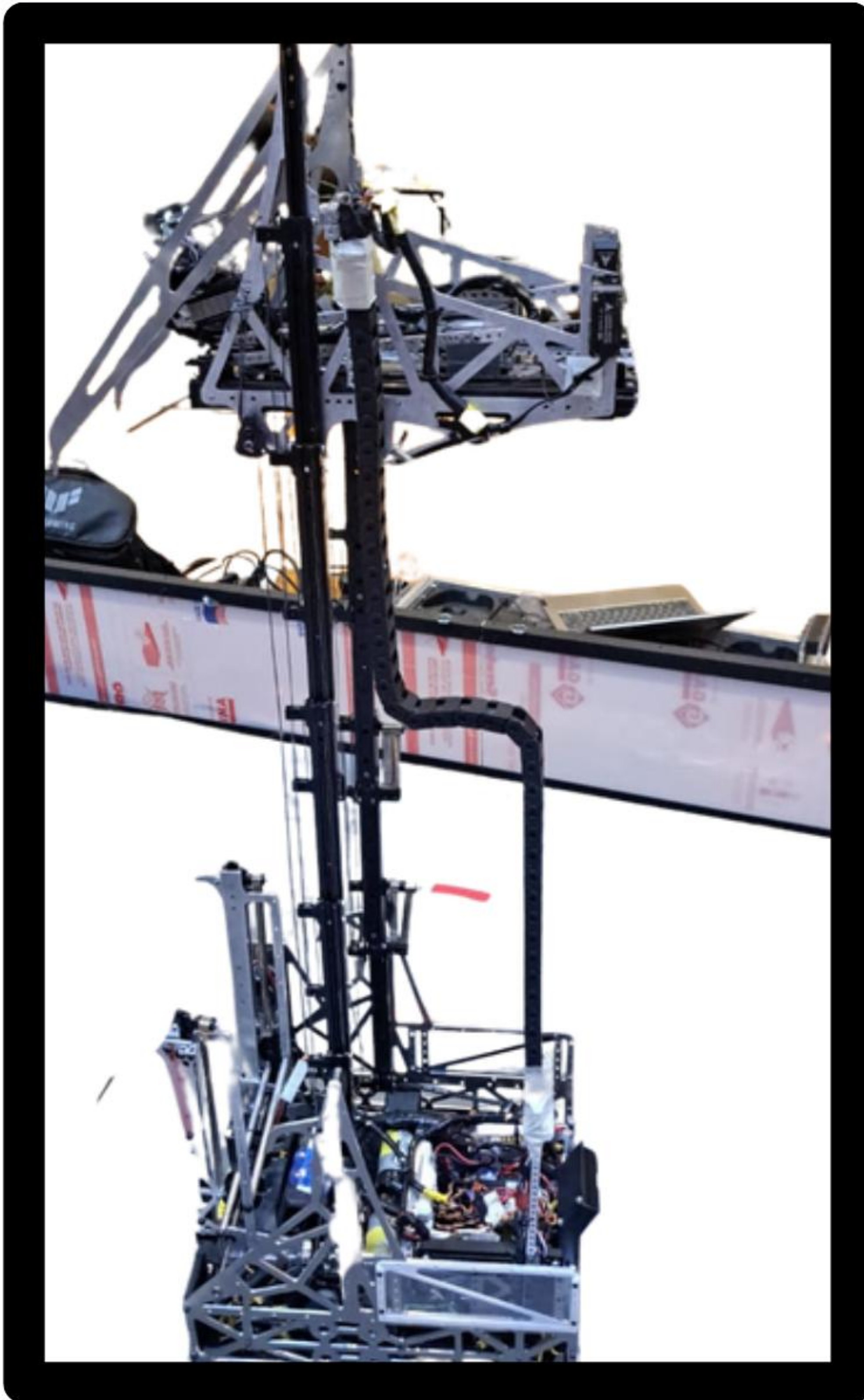
- Will calculate the z value by $\sqrt{x^2 + y^2}$
- value will be in inches
- We will feed this value to extension servo
- $\tan \theta \Rightarrow$ will use $\cos \theta = \frac{x}{z}$
 $\theta = \cos^{-1}\left(\frac{x}{z}\right)$



The limelight



VERTICAL EXTENSION



We have incorporated a total of five BWT sliders on each side, which enables us to achieve the precise height necessary for hanging on the higher chamber and scoring in the high basket.

We use our lifters for a dual purpose-hanging as well as lifting the rack pinion to score.

PID



```

this method inside loop
void LifterPid(){ 3 usages
controller.setPIDF(kp,ki,kd,kf);
double error=controller.calculate(robot.LeftElevator.getCurrentPosition(),
robot.LeftElevator.setPower(error);
robot.RightElevator.setPower(error);
robot.LeftElevator2.setPower(error);

```

We started with only P (proportional) to increase kP until the lifters are completely reaching the target and not overshooting. Then we added D (derivative) to increase kD until the lifters stopped smoothly. Lastly for I (integral) only if needed we use kI if the lifters never quite reach the target.

PID (Proportional-Integral-Derivative) control is a feedback control system used in our bot to improve the accuracy and stability of our lifter resulting in a reduce of current.

We use P (proportional) If our lifters do not reach the desired position, apply more power, if it is closed reduce the power to prevent over shooting.

If the lifters never quite reach the target , I(integral) adds extra power.

If the lifters are moving too fast toward the target, D(derivative) slows it down. It predicts future errors based on speed.

RACK WEIGHT CALCULATION



$$\text{Weight} = 3.5 \text{ Kg}$$

$$\text{Gear ratio} = 4:3 = 12$$

$$\text{Force due to Gravity} = 3.5 \times 10 = 35 \text{ N}$$

$$Z = 12 \times 0.105 =$$

$$\text{Radius} = 0.015 \text{ m}$$

$$\frac{Z}{d} = F$$

$$\frac{Z}{d} = \frac{1.26}{0.015} = 84$$

For 3 motors

$$= 84 \times 3 = 252$$

$$252 \text{ N} > 35 \text{ N}$$

$\therefore$ It can lift the rack

3.5 KG Rack

Gear Ratio - 4:3

252 N > 35 N

**Therefore it can
lift the rack!**

HANGER



We used REV Ultraplanetary Hex DC motors instead of servo motors for higher torque to lift the 13kg robot.

The lower hanger has central force spring on the ends so that upon releasing the hanger reaches the desired height. This reduces load on the motors as well. We also are using CNC hooks and BWT sliders for minimal friction for the lower hang.

We also have a passive hanger which contains more CNC hooks and rubber bands and is attached to the plates. This helps in retaining the position of the robot when the power is cut off at the end of the match.

The higher hanger also has CNC hooks and is attached to a vertical extension equipped with 3D printed protection to avoid samples falling down.

HANGER

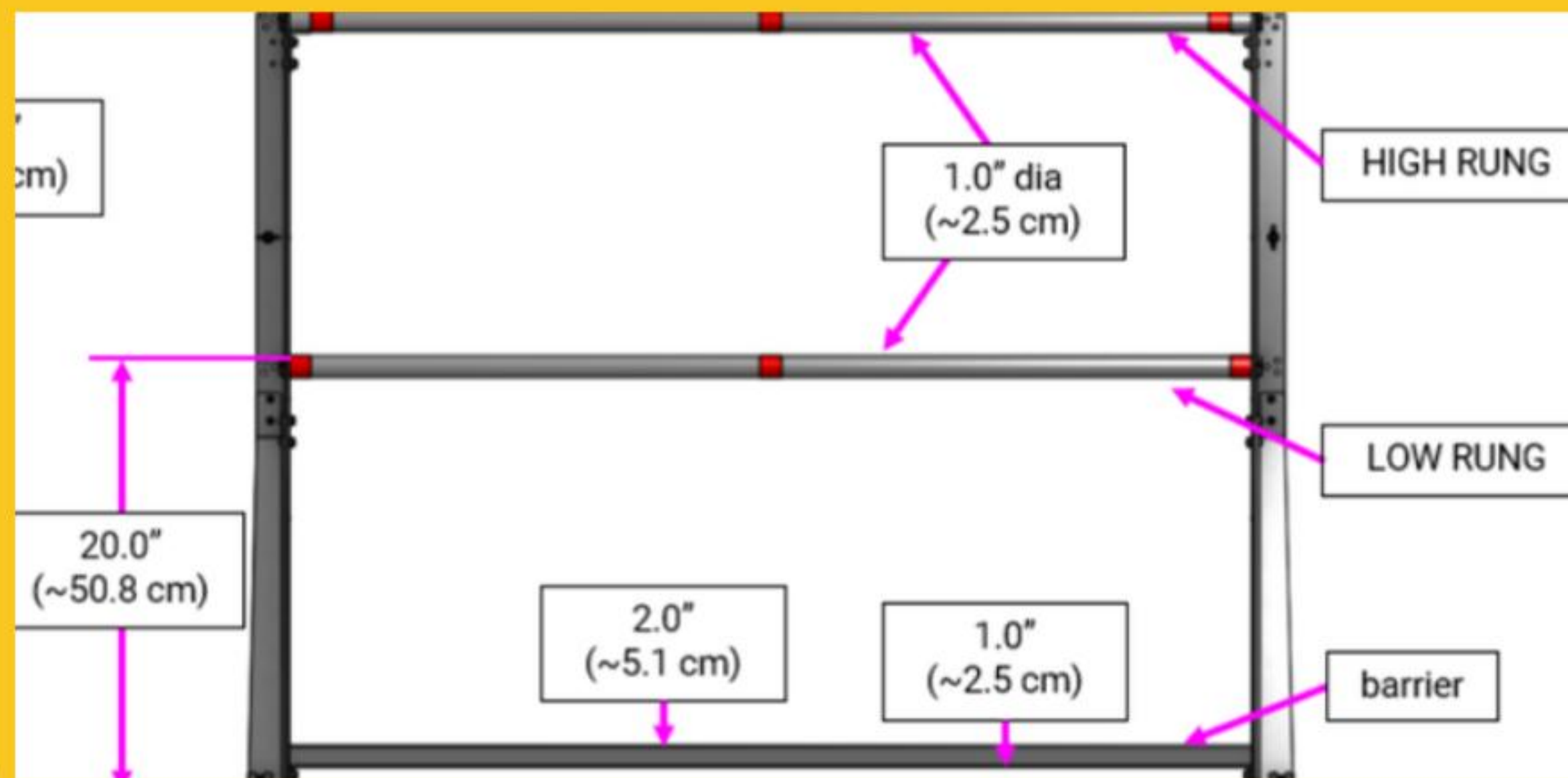
ITERATIONS

1. PROBLEM

- Our motor was unable to handle the robot's extreme weight and it had trouble raising leading to stress and breakage of the motors.

SOLUTION

We implemented a central force spring which reduced the load on the motors and helped preserve motors and decrease time taken for the hang.



2.

PROBLEM

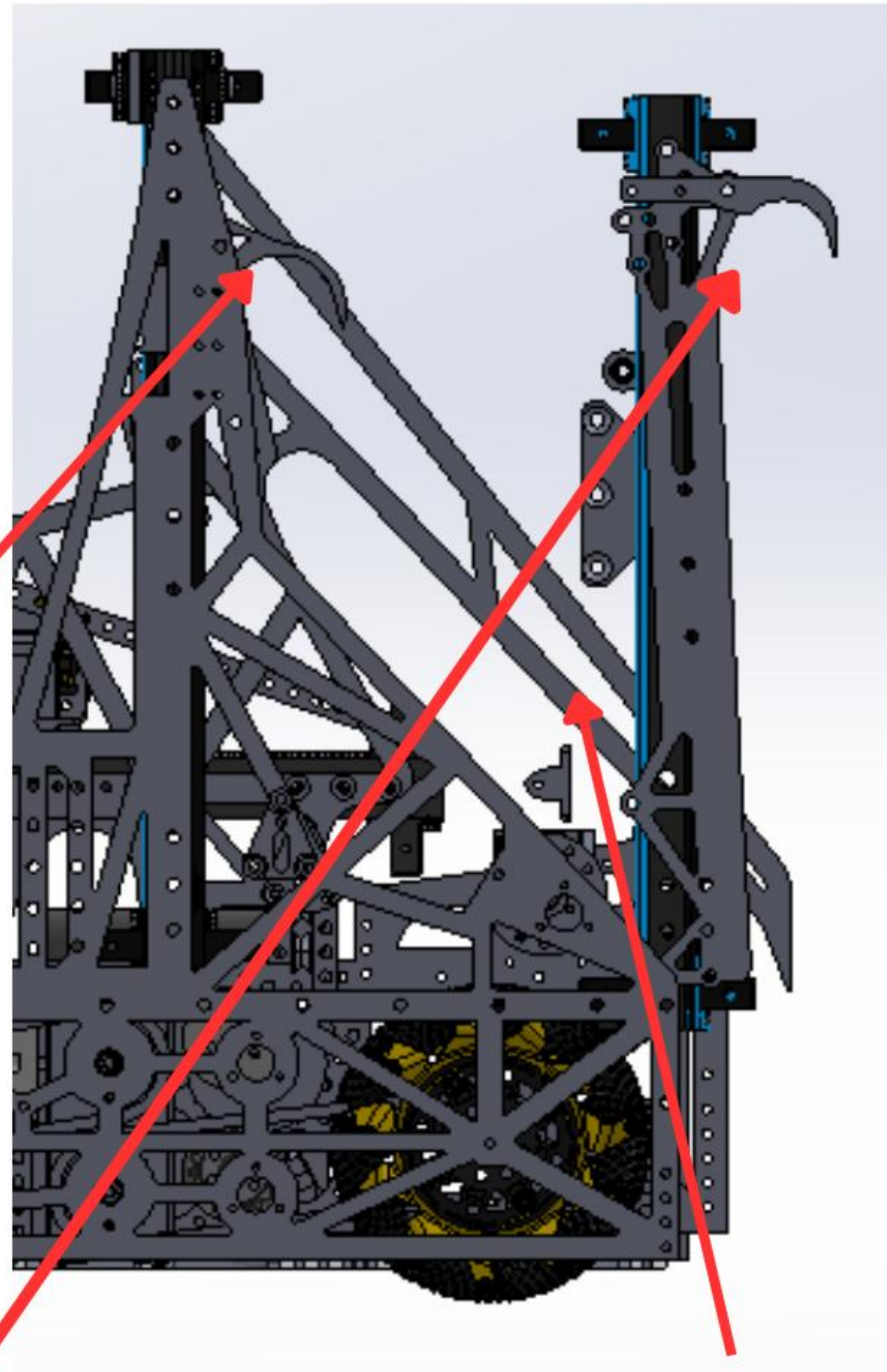
- Our robot was not hanging properly after cutting the power after end game. This would result in us not getting the points for the hang due to improper hang finishing.

SOLUTION

We implemented a passive hook system with attached rubber bands that helped the robot lock in place even after the game had ended and power was cut so that we could secure the points.



LABELLED HANGER



**Passive
Hook**

**Lower
Hanger**

Higher Hanger

CALCULATIONS



Gear ratio for Lower hanger motor 5:5:3

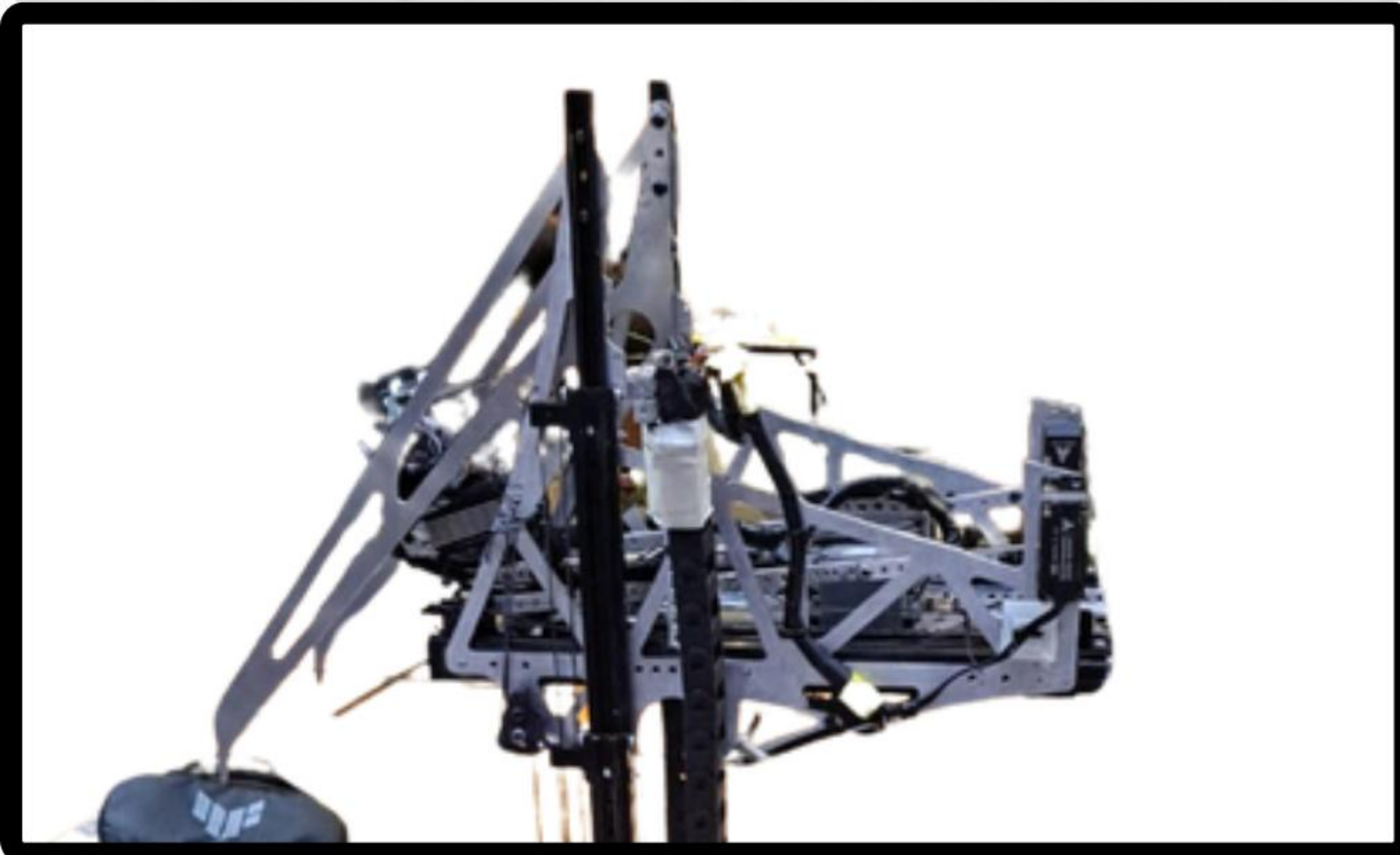
$$Z = 75 \times 0.105 = 7.875 \text{ Nm}$$

$$\frac{Z}{d} = F$$

$$\frac{7.875}{0.015} = F = 525 \text{ N}$$

$$525 \text{ N} > 118 \text{ N}$$

$\therefore$ It can lift robot



- Weight = 11.8 kg
Force due to gravity = 10 N
Force on ground = $11.8 \times 10 = 118 \text{ N}$

- Gear ratio for Linear slide motors = 3:4 = 12

$$Z = 12 \times 0.105 = 1.26 \text{ Nm}$$

$$\text{Radius} = 0.015 \text{ m}$$

$$\frac{Z}{d} = F$$

$$\frac{Z}{d} = \frac{1.26}{0.015} = 84 \text{ N}$$

- For 3 motors = $84 \times 3 = 252 \text{ N}$

$$252 \text{ N} > 118 \text{ N}$$

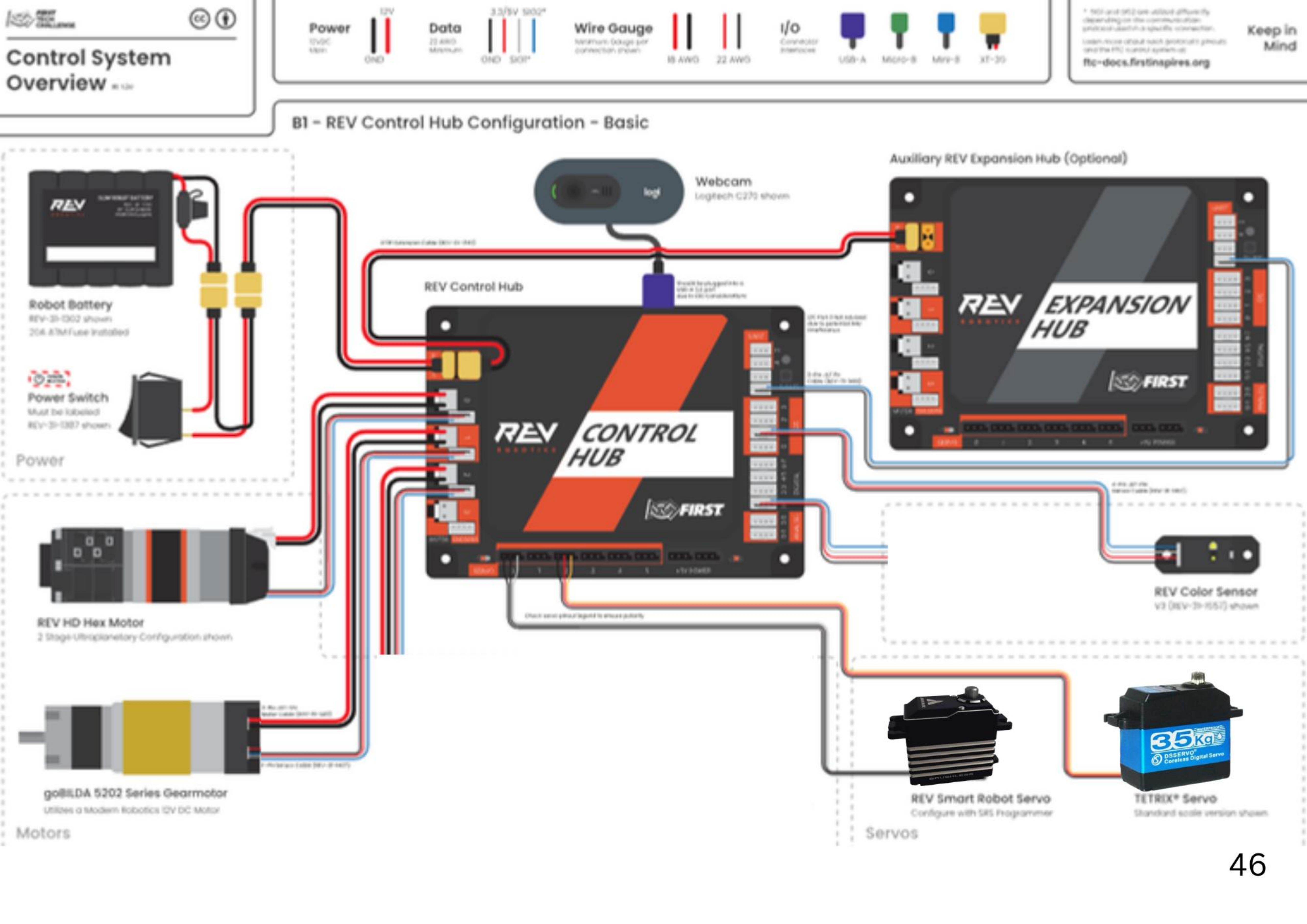
$\therefore$ It can lift bot

- Gear ratio for Lower hanger motor 5:5:3 =

$$Z = 75 \times 0.105 = 7.875 \text{ Nm}$$

$$\frac{Z}{d} = F$$

$$\frac{7.875}{0.015} = F = 525 \text{ N}$$



PROGRAMMING



What are sequences?

Sequences are like pre programmed pieces of code. they make complex actions easier and allow us to debug code with ease

How have we integrated sequences ?

In our bot we use many sequences, such as limelight. Limelight allows us to automatically pick up samples and specimens, which makes this process easier for the drivers

Sample picking:

to pick up samples with ease we use a sequence to detect whether there is a sample or not. if there is a sample, it picks it up, and if there is no sample it waits until there is one

Problem: The driver needs help consistently scoring cones in TeleOp due to unexpected external factors on the field, like other robots or game pieces.

Solution: We implemented a program called "Slow Mode," which slows down the robot's movement while in TeleOp. This allows for more precise movements, increasing our scoring accuracy at competitions.

AUTO IMPROVEMENT AND SENSORS



What are sensors?

Sensors are devices that are used to take input and give this data to the bot.

How are sensors useful?

Sensors have many different functions. They allow autonomous navigation and object detection

Sample picking:

We use a colour sensor in our gripper to detect the distance between the sample and the gripper

Limelight:

During auto we use limelight to pick up samples. Limelight detects the position of samples for the gripper to pick them up

NavX:

We use NavX for bot positioning.



SUBSYSTEMS

The intake and outtake -

Our outtake subsystem allows us to place samples and specimens with precision exactly where they need to be for scoring. It also doubles as intake which will enable us to take samples and specimens from the submersible with ease.

The elevator -

This subsystem is used to move the gripper up and down. It allows us to place specimens on the submersible and samples in the high basket. The elevator is also used for hanging.



POWER BUDGETING

- Power Budgeting cuts power to servos and other parts not in use. It calculates how much power each motor, sensor, and electronic component requires and making sure the battery can handle this load without running out or causing performance issues. It involves timing the actuation of the motors so that we the inner lining does not get fused.
- Good power budgeting helps prevent problems like when voltage drops and components stop working), ensures your robot can run all its systems simultaneously, and maximizes battery life during both autonomous and teleop phases.
- It's especially important when using high-power components like motors and when designing strategies that require sustained or peak power usage like out lifter sequence for the scoring in high basket and the auto period.



THE DRIVE TEAM



DRIVER



SHIVEN SHAH

OPERATOR



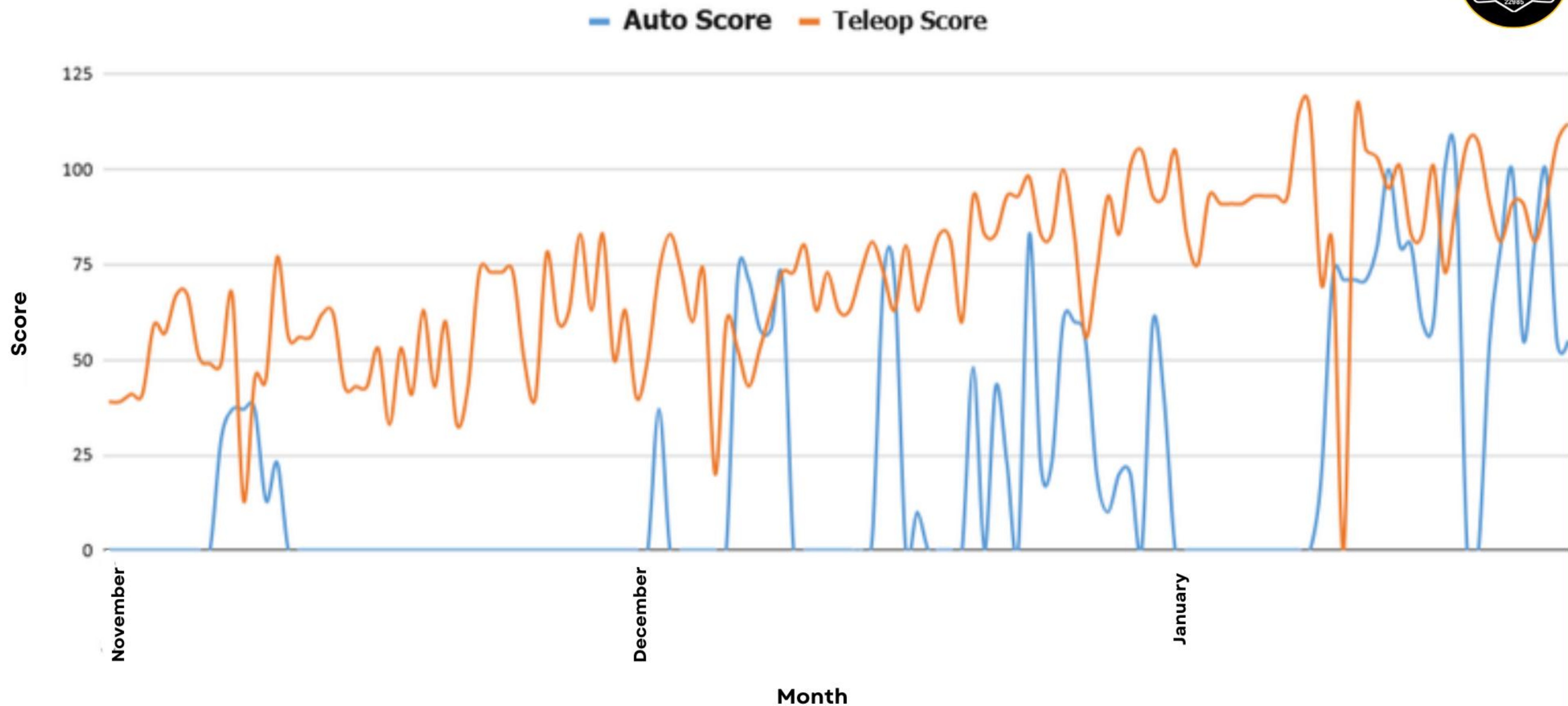
MAITHILI AGARWAL

HUMAN
PLAYER



VAANYA KUMBHAT

Practice Scores



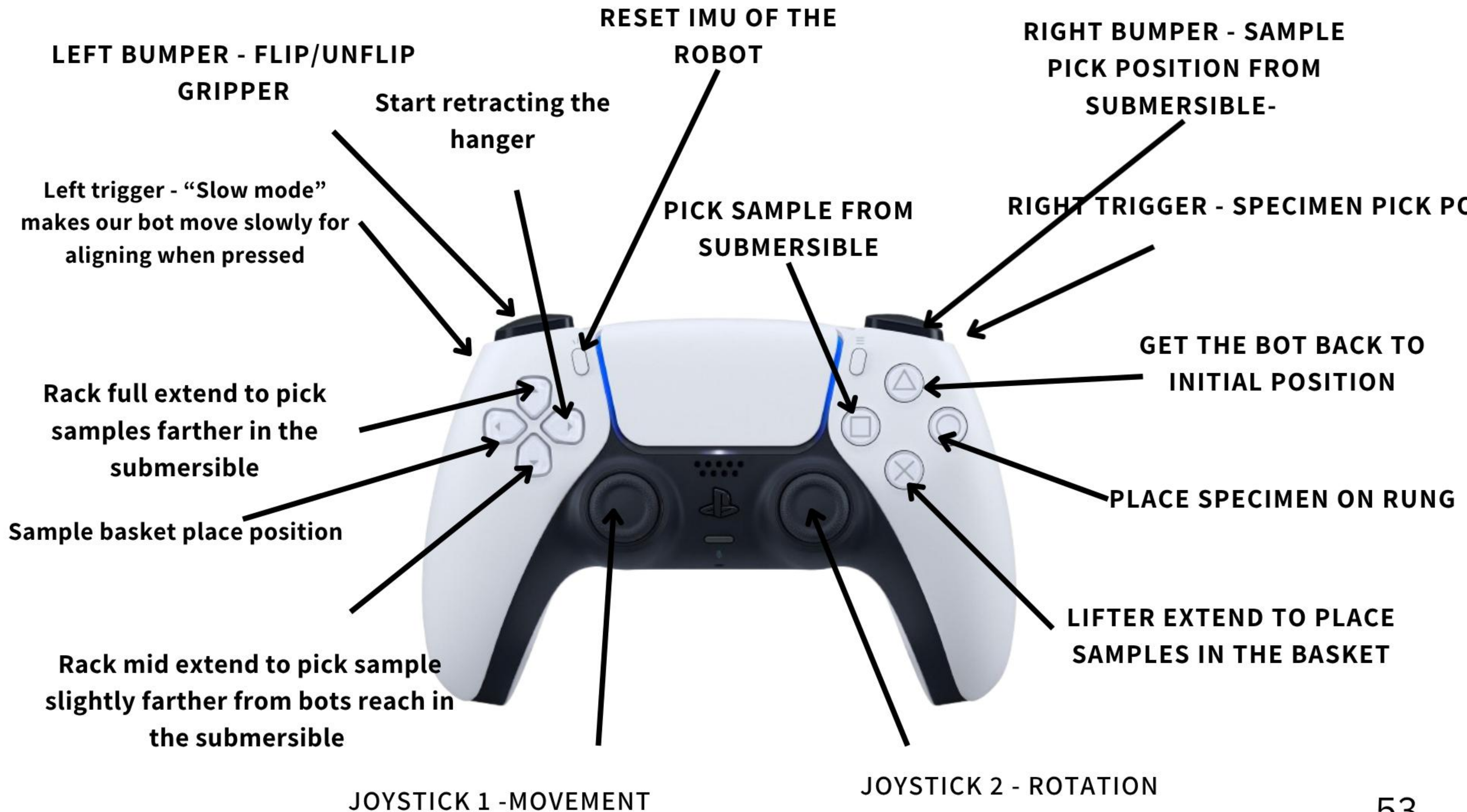
Drive Team Practice Scores

The graph above shows our drive team's progress with scores, which is gradually improving with practice.

Timeframe

The graph is from November, when we first finished our bot, to as recent as end of January

DRIVER CONTROLS



OPERATOR CONTROLS



MANUAL SPECIMEN PICK

EXTEND HANGERS

MAX EXTEND

**SET HEIGHT TO
LOW BASKET**

MID EXTEND

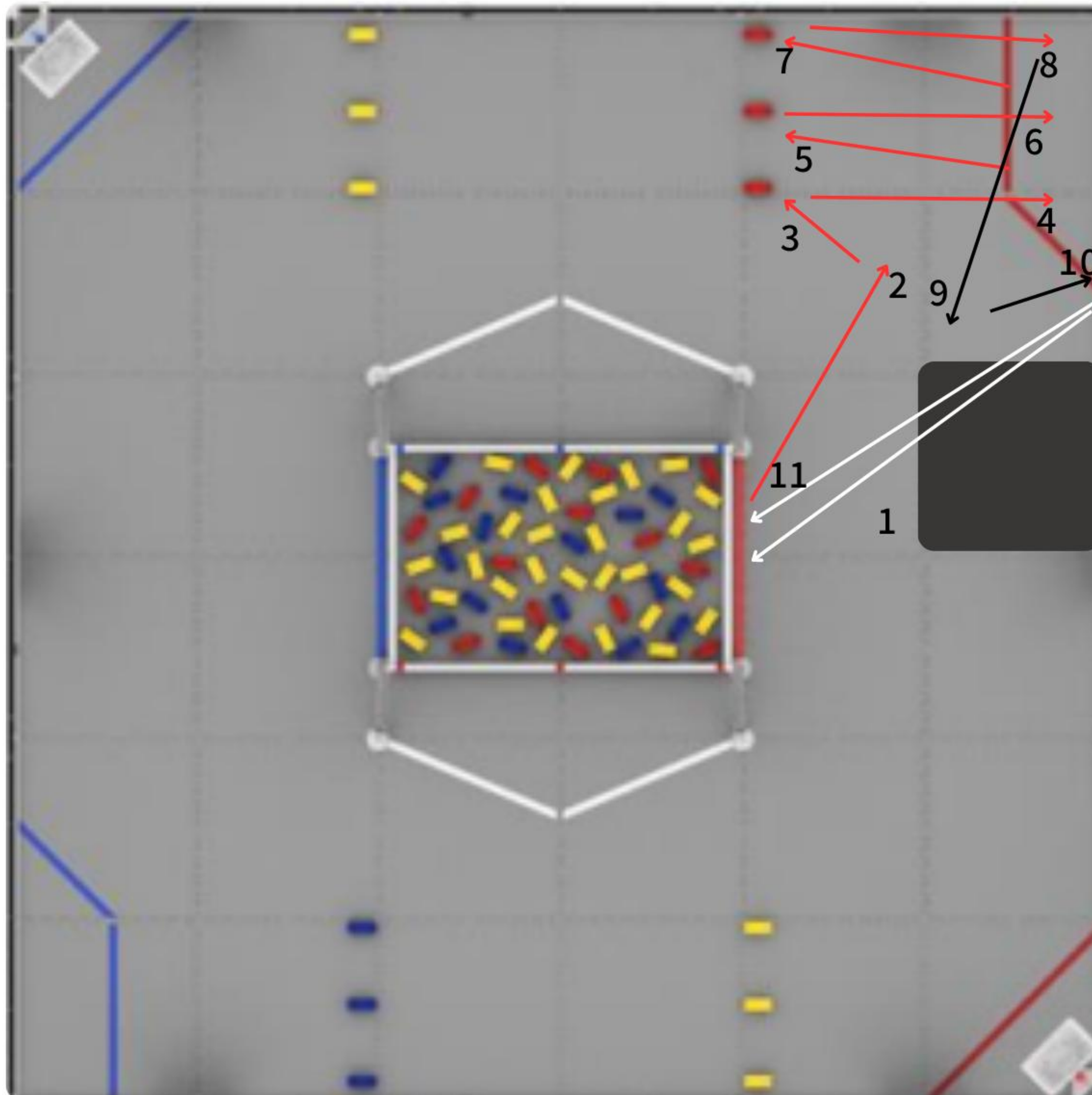
**DISABLE COLOUR
SENSOR**



**SET HEIGHT TO
HIGH BASKET**

This controller has a number of manual overrides incase any sensor of the bot doesn't function correctly or we face any other extraordinary situation. After the scrimmage we realised that we needed to have certain backup plans like disabling the color sensor while picking if it doesn't detect a sample due to bright lights

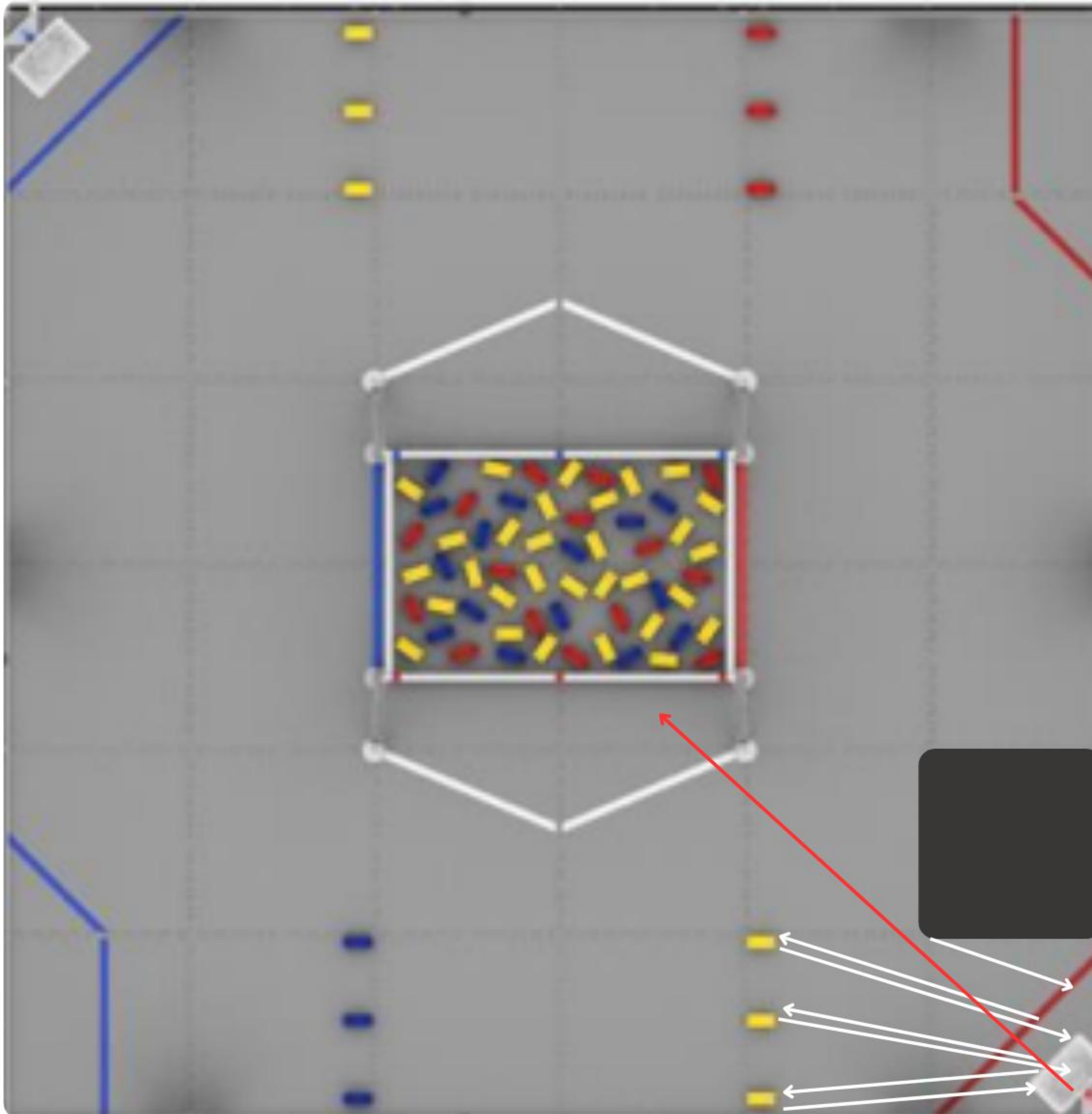
OUR AUTONOMOUS PATH



Specimen Auto (103 points)

1. Our bot places a pre-load on the high chamber and then goes to the spike and picks the 3 alliance specific samples.
2. One by one it drops the sample by turning the bot.
3. It then picks and places the 4 specimens(1 pre-load and 3 spike marks) on the high chamber.
4. It parks in the observation zone.

OUR AUTONOMOUS PATH



Sample Auto (83 points)

1. Our bot places a pre-load on the high basket and then goes to the spike and picks the 3 neutral specific samples.
2. One by one it drops the sample by in the higher basket.
3. It then picks a alliance specific/ neutral sample from the submersible with the help of the limelight and then drops it in the high basket.
4. It parks in the alliance ascent zone.



SCOUTING

1. ANALYSIS OF LAST YEARS TEAMS

We took the top 50 from last year's regional and analysed each team based on how they engineered their robot and what was their strategy. This helped us know how to think and plan our strategies and our bot.

2.

QUALITATIVE SCOUTING

In each of the scrimmages and practices, we scouted other teams to get to know how good of a partner they will be, what are their strengths and weaknesses and such qualitative data to plan how we are going to work as an alliance or as opponents.

3. SCOUTING FORM

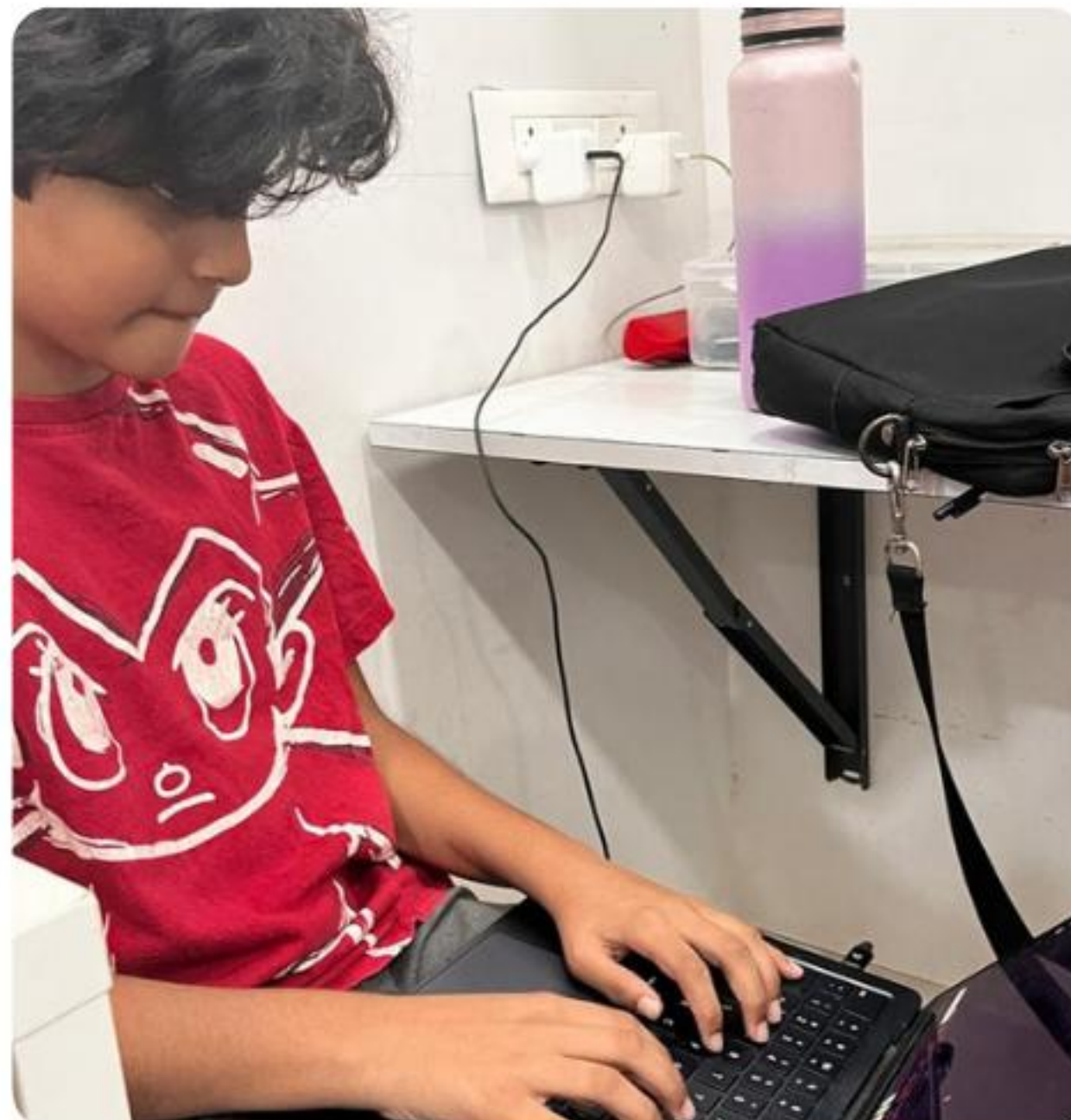
We made an enhanced Google form to scout each team during a match. All the data collected will go to an excel sheet which analyses the team based on their scores

4.

ALLIANCE PICK LIST SHEET

The alliance pick list sheet is also generated from the excel database. This sheet consists of teams and their data that were really good and then from that list we choose the best team we can pick.

OUTREACH



AMAR CHITRA KATHA



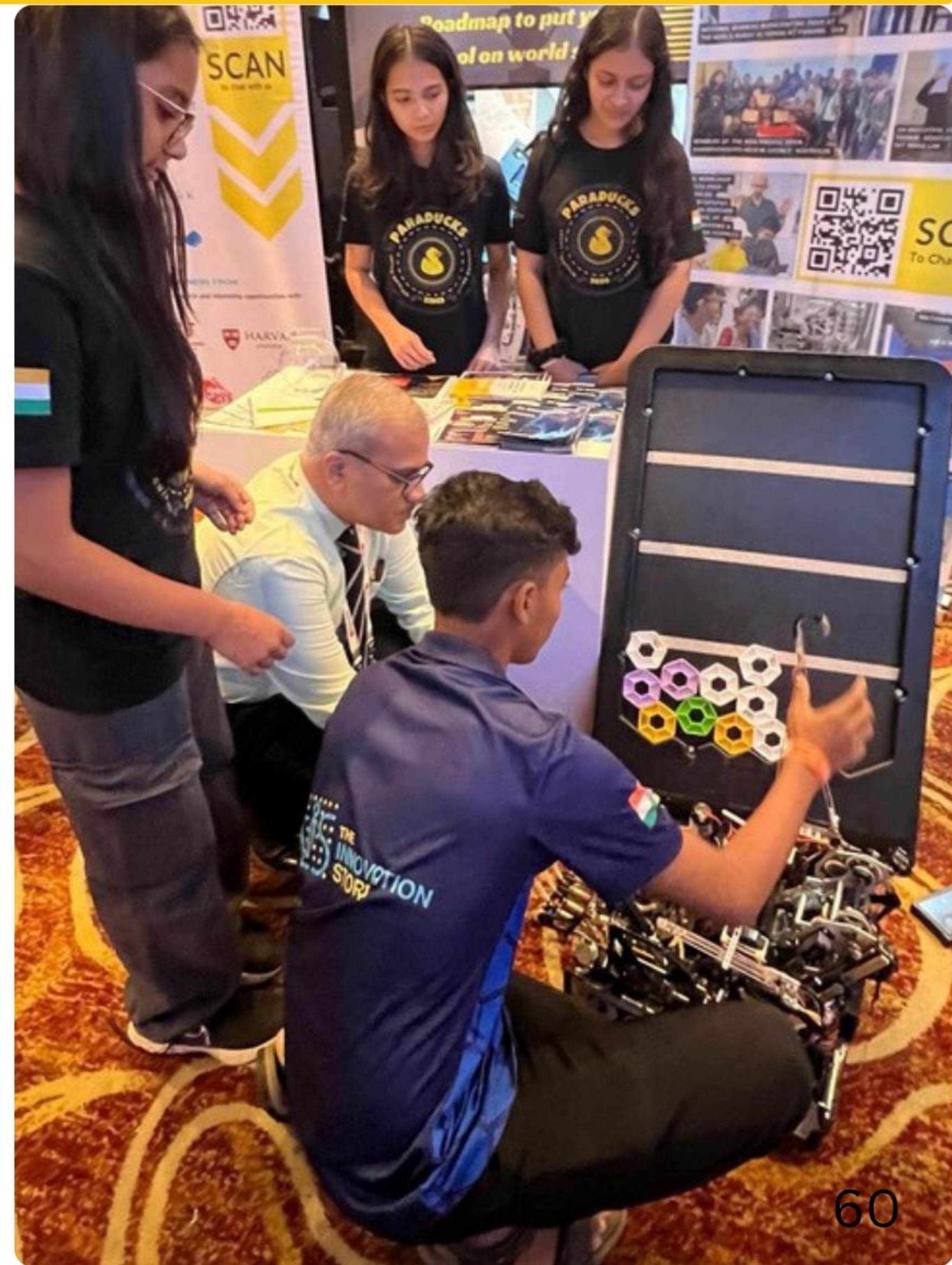
They were pleased that we were there, and we presented our mission and explained what First and FTC are. After a lengthy discussion, they provided us with valuable feedback, that we have incorporated into our various presentations which helped us improve our judge's presentation as they suggest we give a presentation with more enthusiasm .



EDU SUMMIT



At the Edu-Tech Summit, we presented to 15 school heads from India to promote awareness of STEM and FIRST programs. Our goal was to spread awareness throughout our country. Our robot demonstration emphasized and showed the importance of STEM education in schools and the positive effects of FIRST programs on students. We aim to start and mentor FIRST teams in multiple different schools nationwide.



TEACHING NGO TEAMS



We talked to 25-30 underprivileged Children about FTC and inspired them by explaining how it works, the theme of **FTC** this year, and inspiring them to join our mission. We hope to push them forward in their journey and hopefully motivate them to do more and better work throughout the season.



ROBOT DEMONSTRATIONS



Through robot demonstrations and workshops in schools, we reached over 2000 students, showcasing their potential and promoting FIRST programs. These events highlighted what students could achieve with robotics and encouraged them to join FIRST initiatives. By sparking their interest and demonstrating the possibilities within the realm of robotics, we aim to inspire and engage the next generation of innovators and problem-solvers.



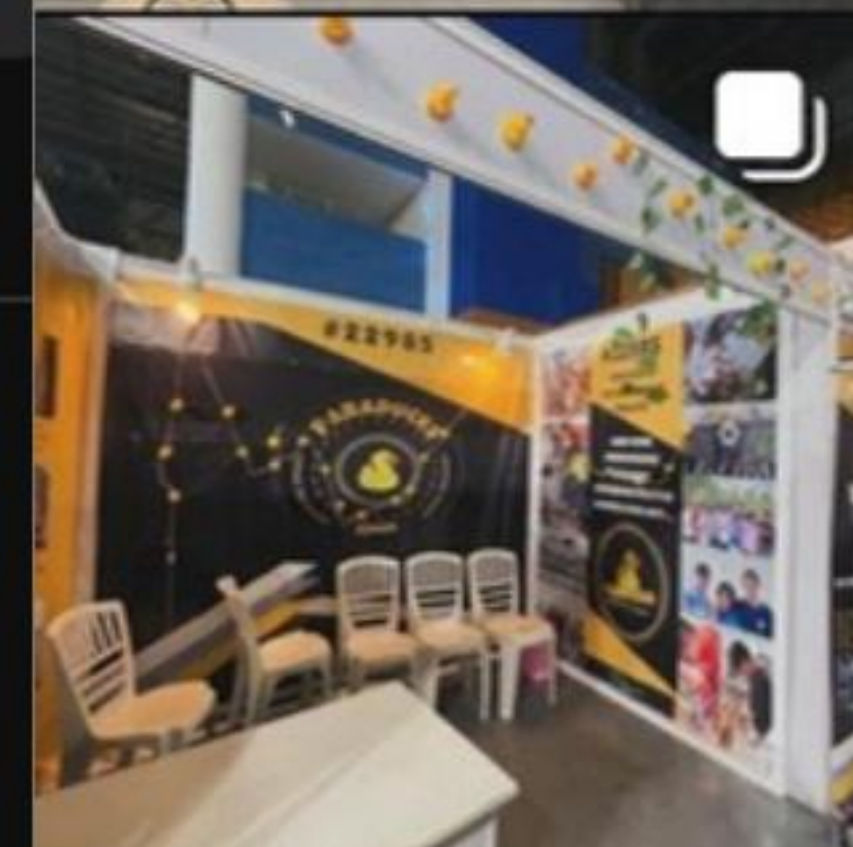
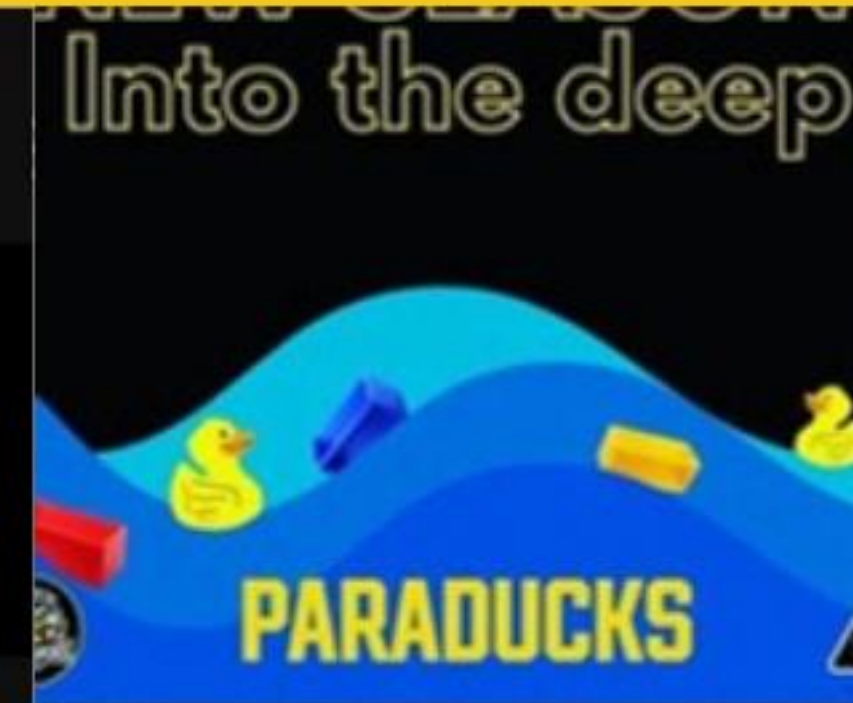
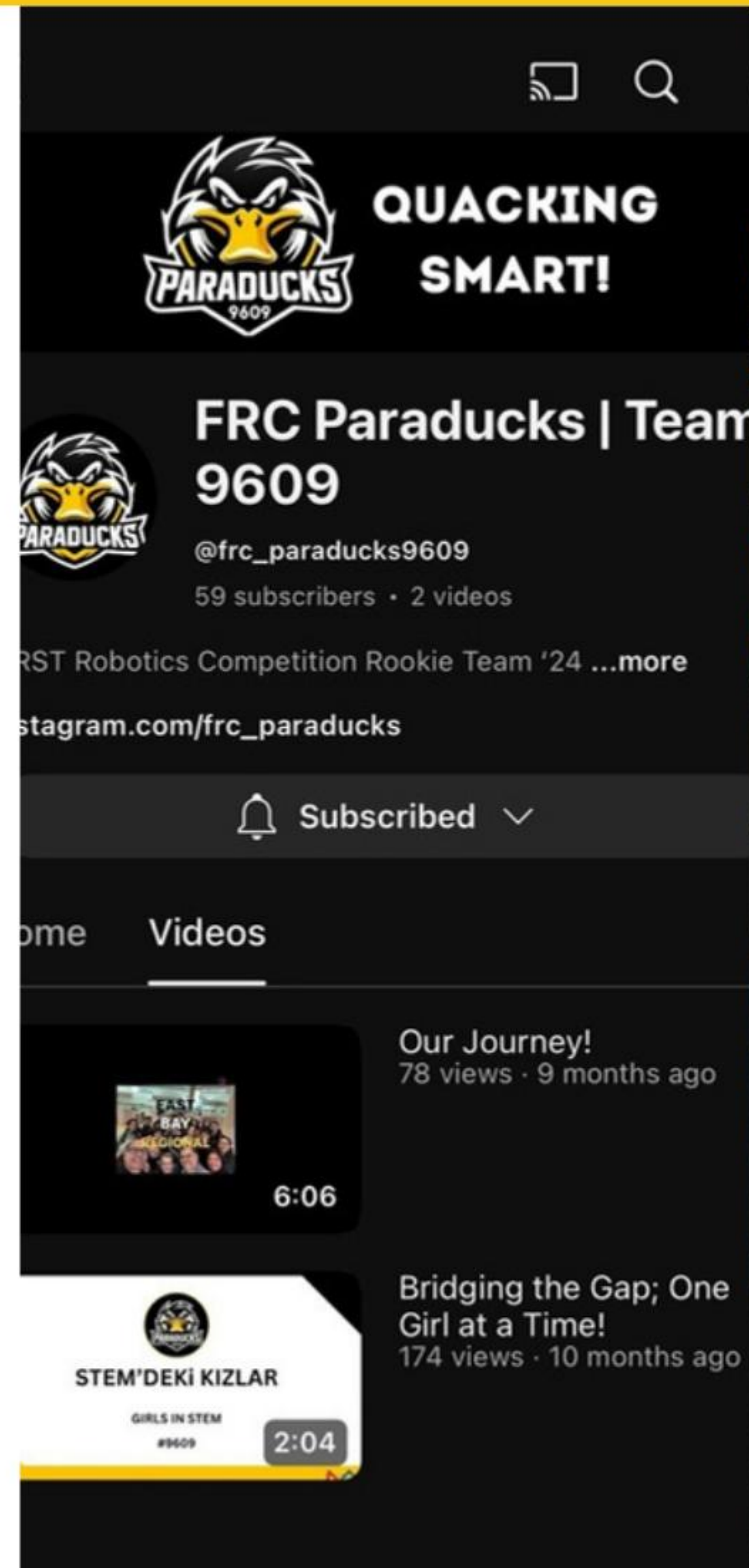
SOCIAL MEDIA



Over the years, we have built a social media presence to spread awareness about FTC and FIRST across India while also showcasing our achievements. We believe social media is a powerful tool to reach out to the community, inspire young students, and connect with other teams

550+ Followers

350+ Teams

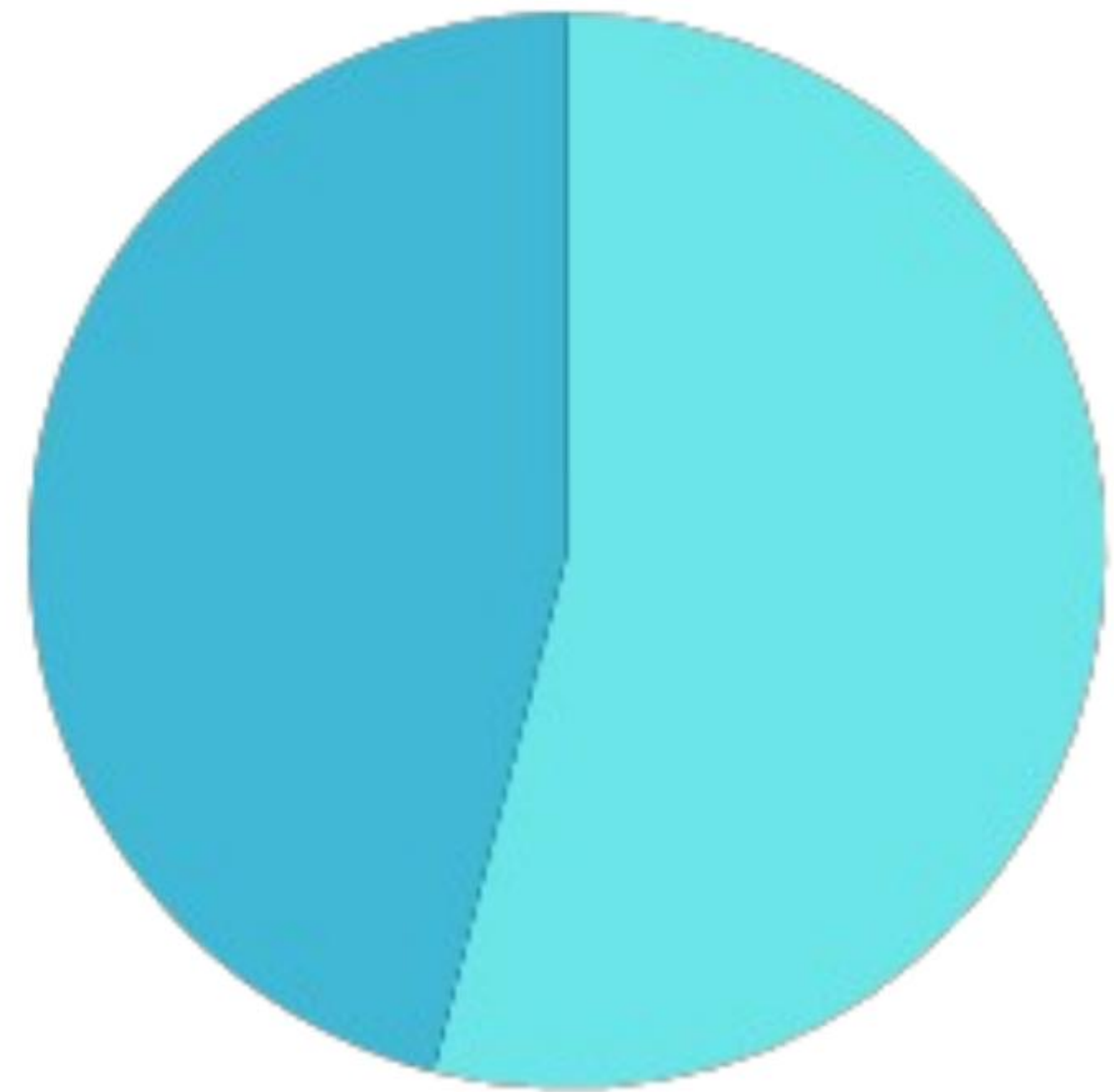


SOLVE FOR SOCIETY



Ran Solve for Society Innovation Challenge Theme Assistive Technology - Over 800 government school students participated in the Solve for Society Innovation Challenge on Assistive Technology, showcasing their STEM skills. The challenge provided a platform for students to demonstrate their creativity and problem-solving abilities, fostering innovation and empathy. It empowered students to use technology to make a tangible impact on society.

Boys
46%



Girls
54%

SPONSORSHIPS



We had emailed over 40 different companies about sponsorship we had told them about FTC how it works and what our goal and mission were. We asked them for a meeting in the eyes of a sponsorship hoping we can find the money to get different products and help with our outreach. We got responses from over 15 companies.

to customerservice ▾

Respected **Amar Chitra Katha** team,

I hope this email finds you well. My name is **Maithli Agarwal** and I am a 14-year-old girl from Mumbai. I am writing to you on behalf of Team Paraducks, a FIRST robotics team comprising 12 children from 9 different schools in Mumbai.

The **FIRST Tech Challenge (FTC)** is a prestigious international robotics competition organized by the non-profit organization **FIRST** (For Inspiration and Recognition of Science and Technology). Each year, teams of middle and high school students, guided by coaches and mentors, work together to design, build, and program robots. These robots are built to weigh up to 19 kg and compete in a new game each season, challenging us to solve complex engineering and programming problems.

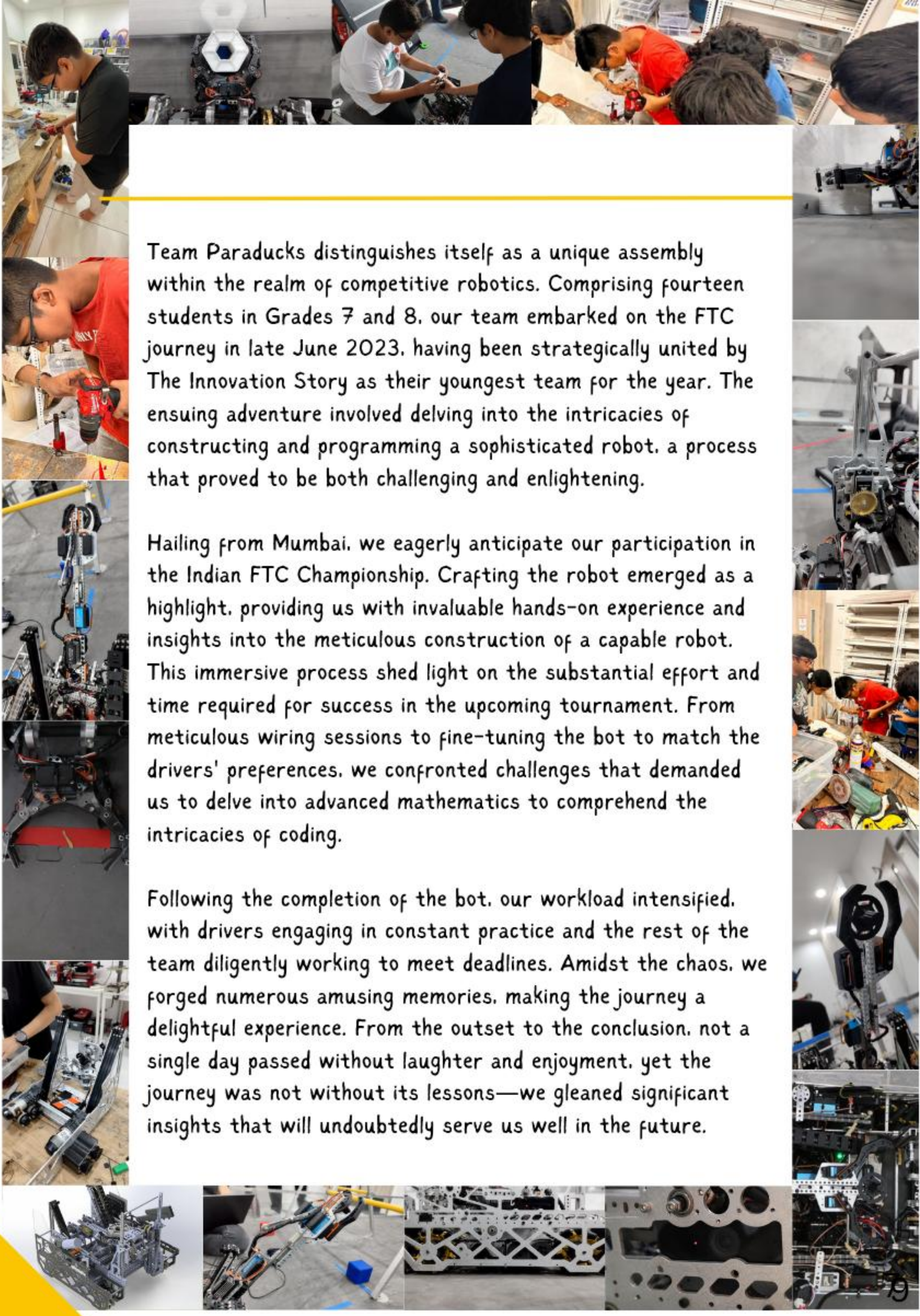
Team Paraducks has had an incredible season in 2023-24, during which we achieved great success. We came 2nd among 59 teams at the **India Championship** in Goa, securing a spot at the **Asia Pacific Championship**. There, we proudly represented India and competed against the best teams from around the world coming **first for the second time in a row**.

We believe that partnering with **Amar Chitra Katha** would not only benefit our team but also align with your commitment to supporting young talent and education. We would love to feature your company's logo on our robot and t-shirt which would be seen by students and adults across India. We would love to get in touch with you and explain the outreach and impact. We would like to request an opportunity to visit your office in person and deliver a 45-minute presentation.

Thank you for considering our request. We look forward to the possibility of partnering with **Amar Chitra Katha** and making a difference together.

Invest in the future of STEM, invest in Team Paraducks!

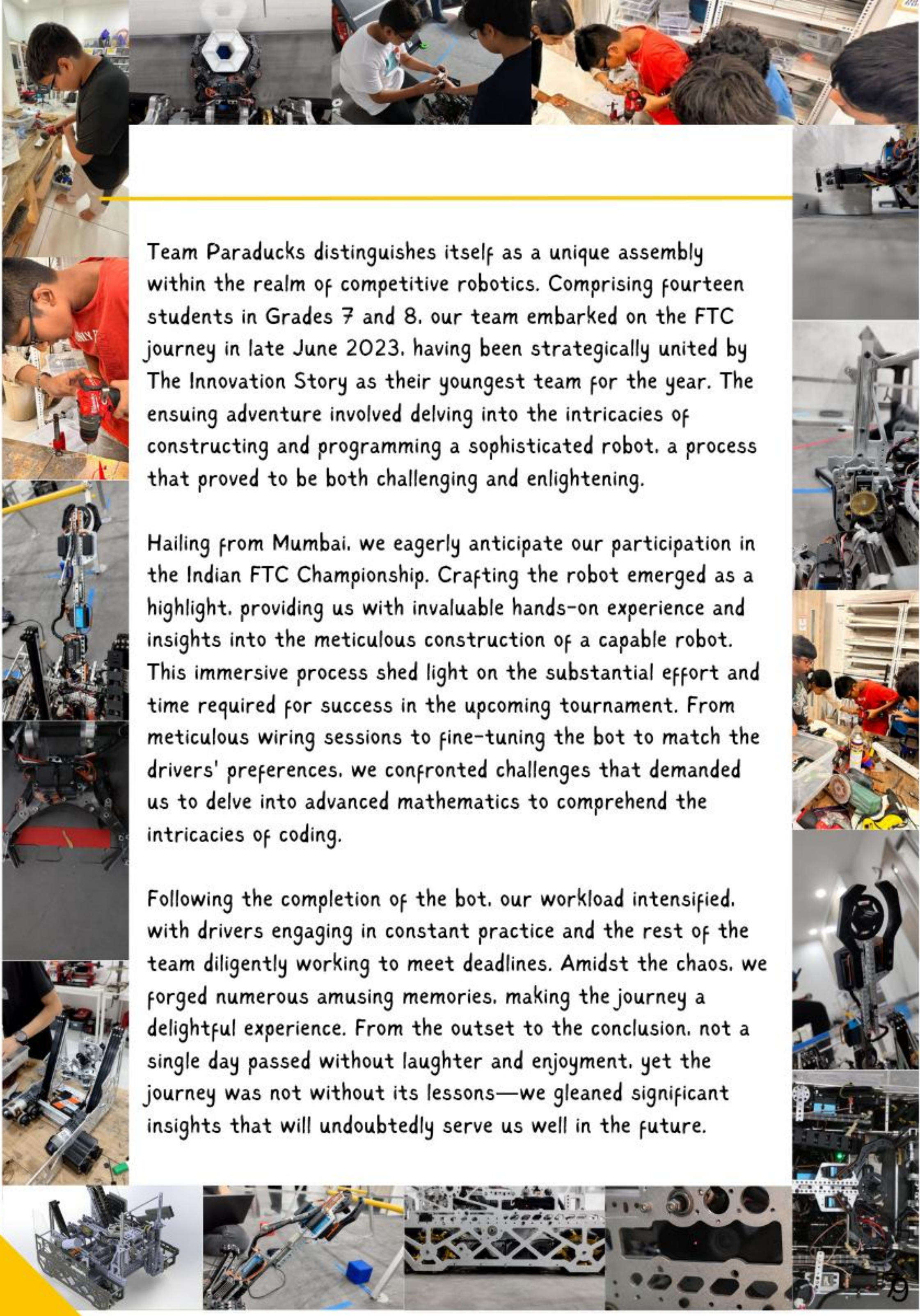
Warm regards



Team Paraducks distinguishes itself as a unique assembly within the realm of competitive robotics. Comprising fourteen students in Grades 7 and 8, our team embarked on the FTC journey in late June 2023, having been strategically united by The Innovation Story as their youngest team for the year. The ensuing adventure involved delving into the intricacies of constructing and programming a sophisticated robot, a process that proved to be both challenging and enlightening.

Hailing from Mumbai, we eagerly anticipate our participation in the Indian FTC Championship. Crafting the robot emerged as a highlight, providing us with invaluable hands-on experience and insights into the meticulous construction of a capable robot. This immersive process shed light on the substantial effort and time required for success in the upcoming tournament. From meticulous wiring sessions to fine-tuning the bot to match the drivers' preferences, we confronted challenges that demanded us to delve into advanced mathematics to comprehend the intricacies of coding.

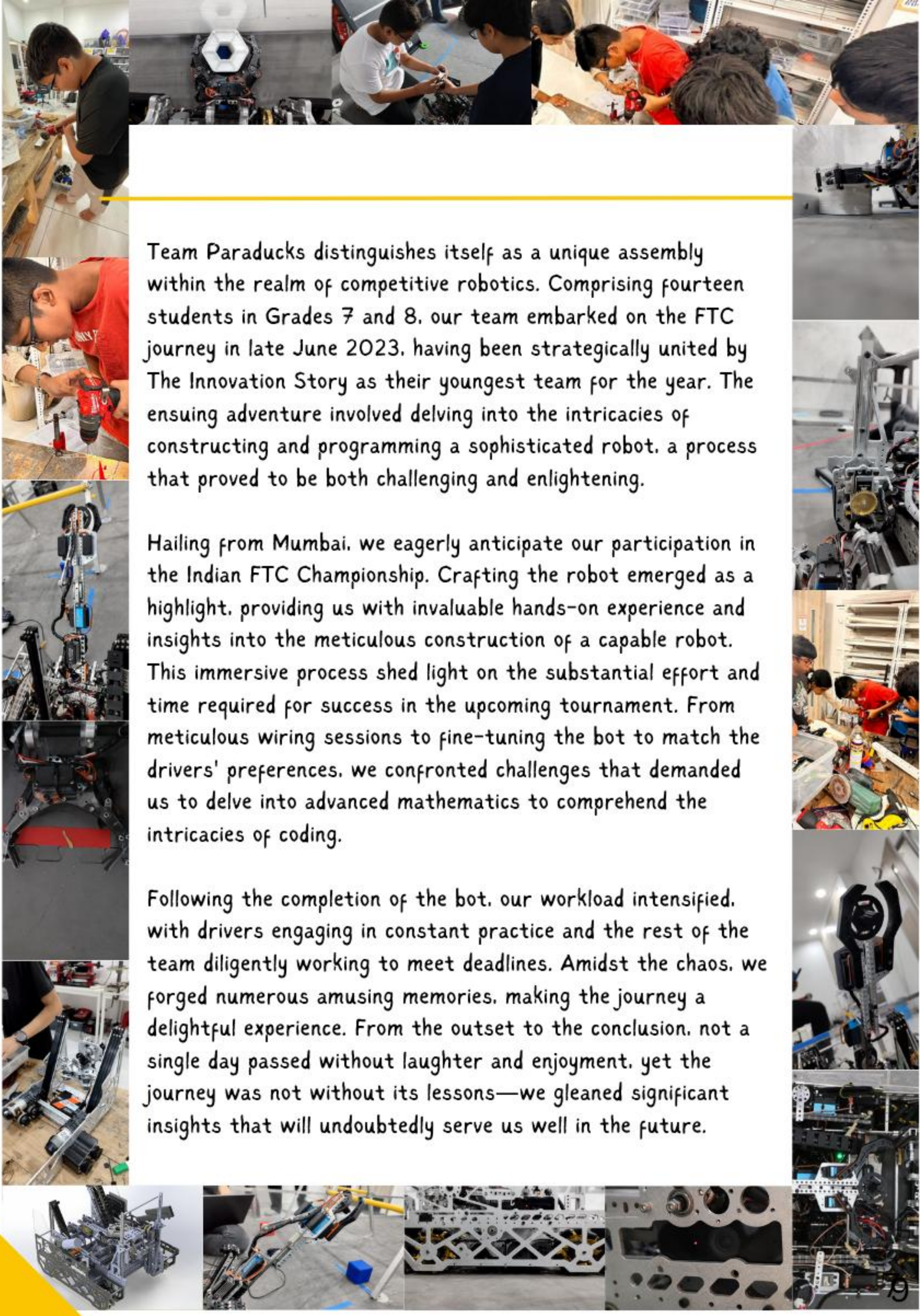
Following the completion of the bot, our workload intensified, with drivers engaging in constant practice and the rest of the team diligently working to meet deadlines. Amidst the chaos, we forged numerous amusing memories, making the journey a delightful experience. From the outset to the conclusion, not a single day passed without laughter and enjoyment, yet the journey was not without its lessons—we gleaned significant insights that will undoubtedly serve us well in the future.



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