FIRST TECH CHALLENGE

Engineering Portfolio

POWER PLAY presented by Raytheon Technologies

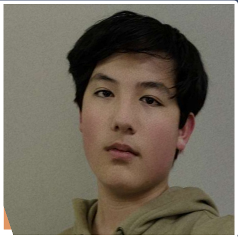
LOOSE SCREWS

22398

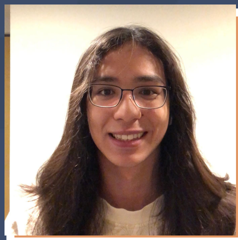
Highland Park, Illinois

About Us

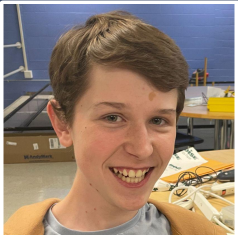
22398



Jeffery
Coder



Cooper
Coder



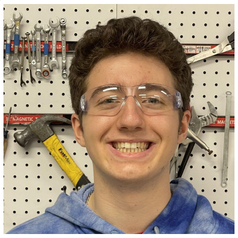
Kavan
Coder

Lucas
Outreach

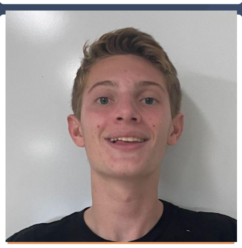
Abby
Outreach

Sacha
Builder

Mitchell
Builder



Asher
Builder



Dylan
Builder

Joshua
Builder

We are Loose Screws, a robotics team from Highland Park High School. The 2022-2023 season is our first year as a team and so far we have learned a lot about robotics. This year we've gone from acquainted with each other to a very tight-knit team.

Schedule:

Mon	Tue	Wed	Thur	Fri	Sat	Sun
3:10 5:00	N/A	3:10 5:00	3:10 5:00	N/A	N/A	N/A

LOOSE SCREWS

Collaborators

Mentors

Mr.Tobin

He is a special education teacher at our high school and is also a co sponsor to our robotics club. In addition we've been lucky enough that he has stayed late on some nights before tournaments so that we can get more work done on the robot.

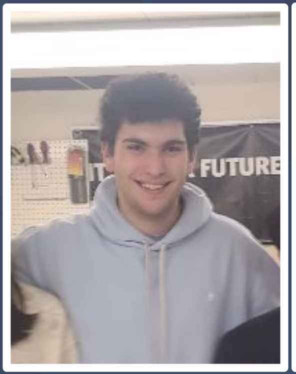
Mr. Mak

He is the engineering teacher at our highschool giving him experience in the robotics field. In addition he is head sponsor of the robotics team at our high school. He is very helpful in the organization of our team.

Ms.Hernandez

She is a social worker at our high school who is also a co-sponsor of our school's robotics club. Her experiences have been great for helping us stay organized and together.

Acquired Help



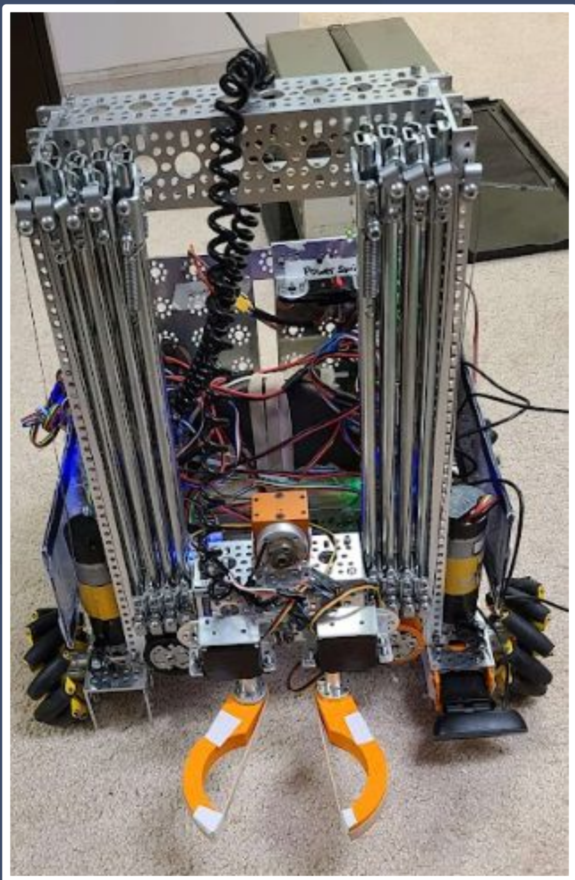
Jacob Hoyt
He is a senior at our school and a member of Rust In Piece. He has helped us to prepare for judging.

Gabi Natenshon
He is a junior at our school and a member of Vertigo. He has helped us a lot with our coding and more.

Teamwork

Values/Mission:
Our team values positive collaboration to produce innovative results. In order to follow through on our values we do a lot of events as a team. Some examples of us doing things together are going to movies, meals, phone calls, and clubs together. Throughout these events we have become close friends as opposed to just teammates.

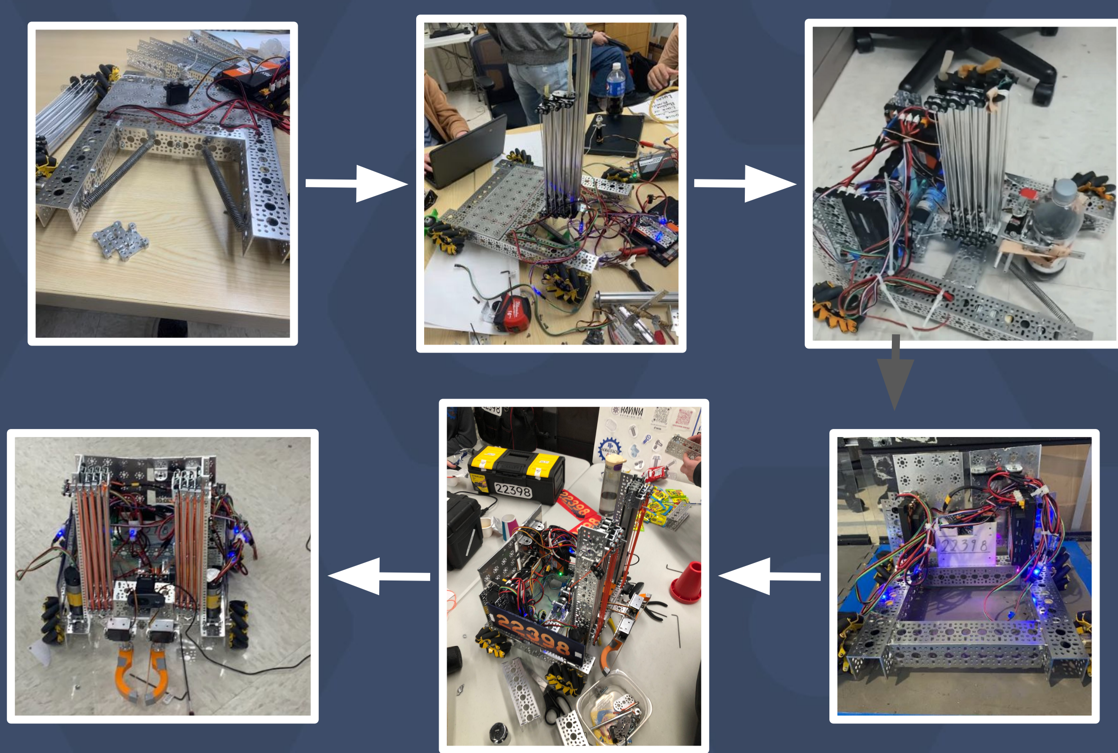
The Robot



This robot uses a claw powered by 2 servos to pick up cones. Then, using an arm that operates through two linear slides each paired with another motor. These are mounted on the chassis which consists of 4 mecanum wheels and 4 additional motors. The robot is also fitted with a camera that can detect the color from our signal sleeve.

Evolution Diagram

Initially, our robot consisted of a single arm using elastics to retract. After our first tournament we replaced the elastic arm with 2 linear slides. We also designed and 3D printed a new claw and made the frame of the chassis thinner. Next, we added a camera to the robot. After the third tournament we replaced the string with stronger, thinner string



Season Timeline

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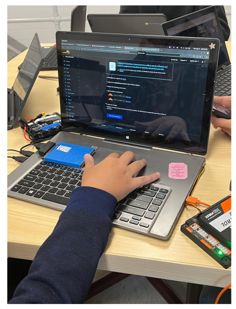
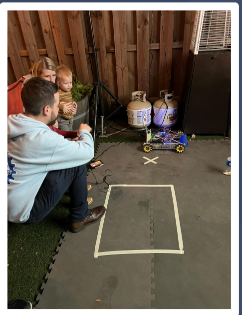
September
Introduction to FTC and Robotics and the creation of our team.

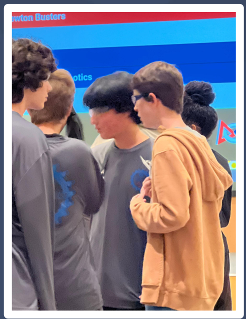


October
Discussed designs, completed decision matrices, and constructed our first version of the robot.

We also did our first outreach event at Ravinia Brewery.



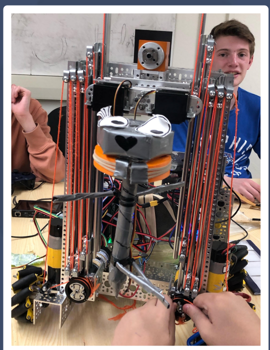
November
Made improvements to the arm mechanism and autonomous. We also prepared and participated in some matches.



December
Added a camera to the robot and worked on autonomous.
Added a second arm both using linear slides.

As a school team we don't get to work over winter break so most of december we didn't get to work on the physical robot.

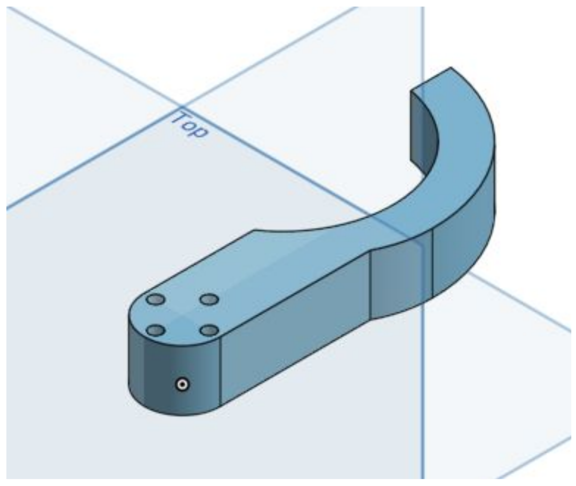
January
Made final adjustments to the arm and coding. We also worked on the portfolio and judging material.



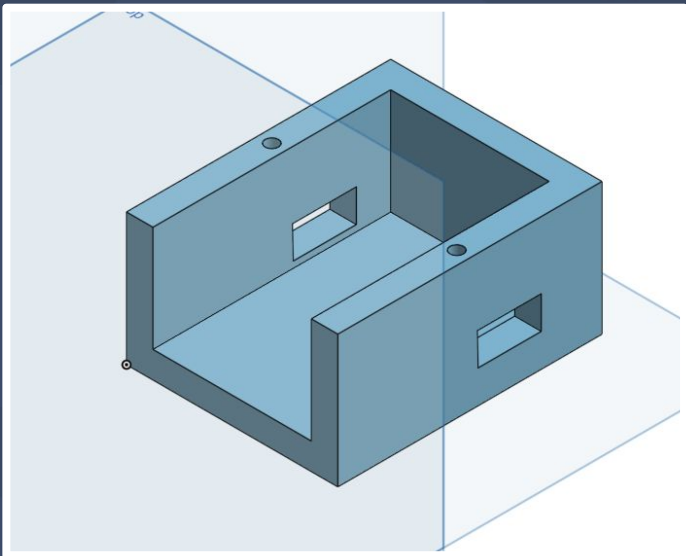
This month we've also been introduced to the portfolio and have learned how to improve on our designs.

3D Models

Over the course the season we have used 3D models to solve problems we've encountered.



The claws move in tandem via two servos attached to the linear slides. Rubber bands are wrapped around to increase static friction acting on the cone while being raised. It is designed to wrap around the midsection of the cone.



This model is used to secure the camera used during autonomous. The camera slots in and is secured by zip-ties. The part fits into the gobuilda drive train frame and aligns to see the signal sleeve.

Previously the camera was secured with a small metal bracket which caused the camera to slip. This solution has made the autonomous code much more consistent.

Problems & Solutions

We've encountered many engineering problems over the season, but we have also found many solutions.

Some of the major problems we encountered were the servo cords disconnecting as the arm raises, the slides stopping before reaching the bottom, and the string tangling as the slides descend.

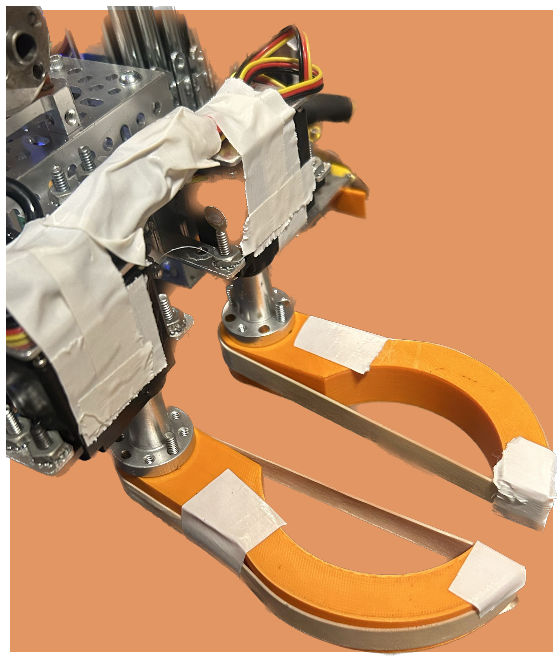
To fix the servo problems we added a coiled cord like a telephone cord that would not disconnect and would extend as the slides raise. We solved this by soldering a new cord onto the servo connectors. The slides stopping issue was a result of a small issue in the assembly. The strings tangling were caused by excess string which we shortened.

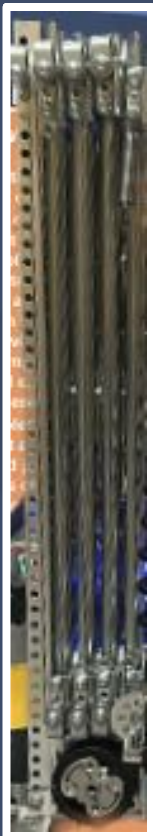
In these situations, we used team-work and communication to find the solution smoothly and effectively.

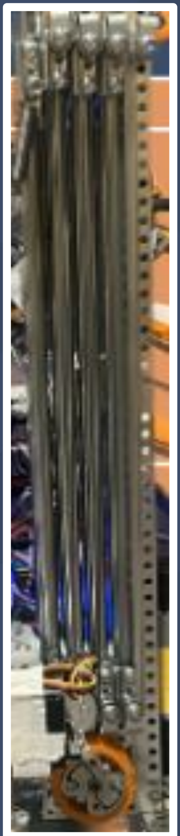
Robot Mechanisms

The Claw

The claw is the mechanism that allows our robot to take hold of the cones, it is the most important mechanism on our robot, because without it we have a robot that can stack no cones. It is composed of two servos attached to a metal bar, with 3d printed crescent shapes screwed into each servo, as well as a rubber band wrapped around each crescent piece. Using two servos is something we hadn’t seen before, we figured it would be simpler than using gear mechanisms, which could easily get tangled with our string. We encountered some difficulty with the 3-D print, the holes were too small for our screws, but it wasn’t anything a drill couldn’t fix. We also encountered problems with wire management, the wire was consistently disconnecting we fixed it by soldering a telephone wire to the servo, ensuring less disconnecting.



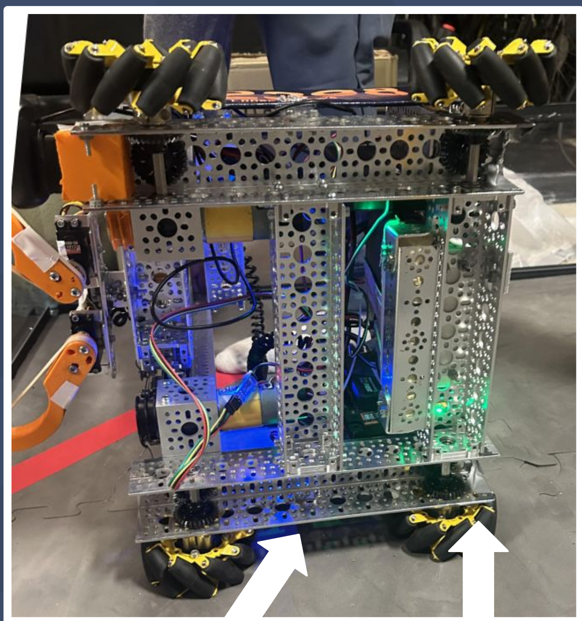




The Slides

The slides are a very important mechanism, it allows The cone to reach the Junction to be scored. The slides used are two gobuilda viper brand linear slides. They are each attached to a gobuilda motor, and mounted to each motor is a spool. This ensures stability for dropping cones on the junctions. First we encountered difficulty with the string we bought being too thick. Being a school team, making purchases is especially difficult being a school team. We ended up getting a thinner string. But our biggest problem was the string getting tangled, we solved this through clever implementation of pulleys that feed the string into the spools. Ensuring a tight string fit with little risk of tangling

Drivetrain

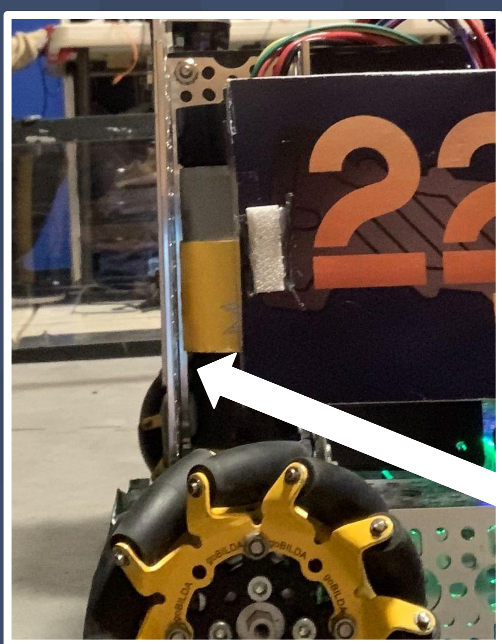


Our drivetrain is made of gobuilda parts. We have chosen mecanum wheels because they provide a large range of mobility. Our robot excels at scoring at various towers and traveling around the field, so this mobility is important.

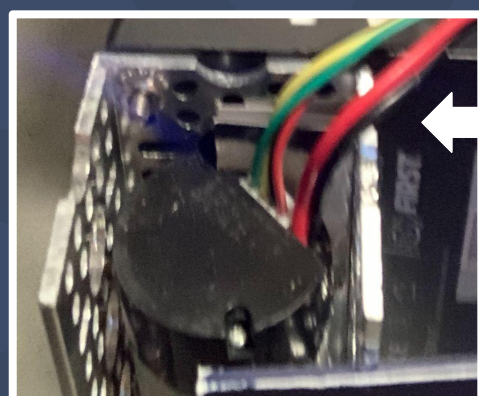
For the wheel axles, we chose to mount the motors vertically. This is because the slide and hub attachment are to gobuilda pieces that interact well with the motor. The extra space under the robot previously occupied by the motors gave us the ability to trim down the frame of the robot and make it less wide.

Empty space

Wheel axle, motor on other side



Vertical motor mount



Control hub screwed onto to the same gobuilda piece as motor

Social Media

We are active on both TikTok and Instagram. On these platforms we post fun and creative videos to document the problems we face and our work ethic. In addition oin both of these platforms we have reached out and interacted with many other teams both from within our community and across the nation. This has allowed us to make new connections within FTC and to learn more about FTC as well. Making friendships with people who have been doing robotics for longer than us is great because they can give us advice.

Design Process

STEP 1: Brainstorming
Our first step was to have an "idea session". We all sat around a table to suggest various designs.

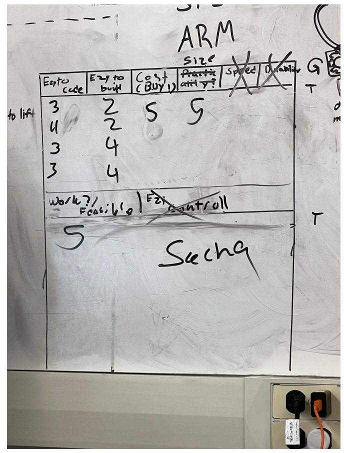
STEP 2: Decision
We then made decision a matrix so that we could all decide on an idea that everyone agreed on.

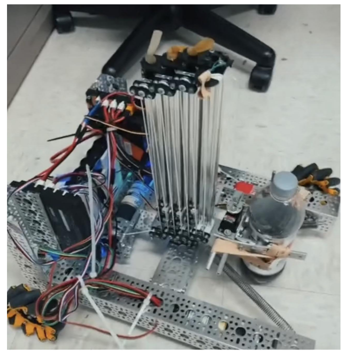
STEP 3: Plan
After this we started to think about what materials we needed and the specific things we needed to build and program.

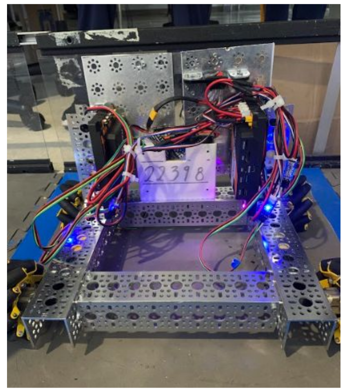
STEP 4: Roles
Then we assigned everyone to roles of some sort so that we could get a lot of stuff done and everyone knew what they were doing.

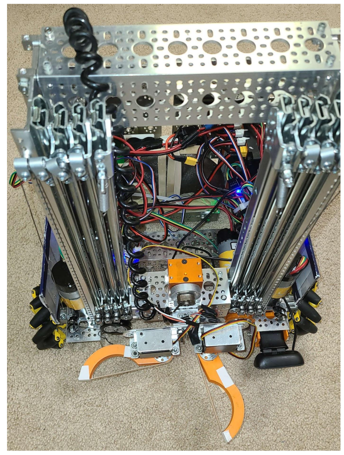
STEP 5: Learning
Throughout the building we had a lot of small problems from going too fast and we learned that we need to go slower and make sure that we understand what we are doing.

STEP 6:
After reaching the final product we realized we definitely didn't branch out far enough and that we needed to buy new materials that would function better.

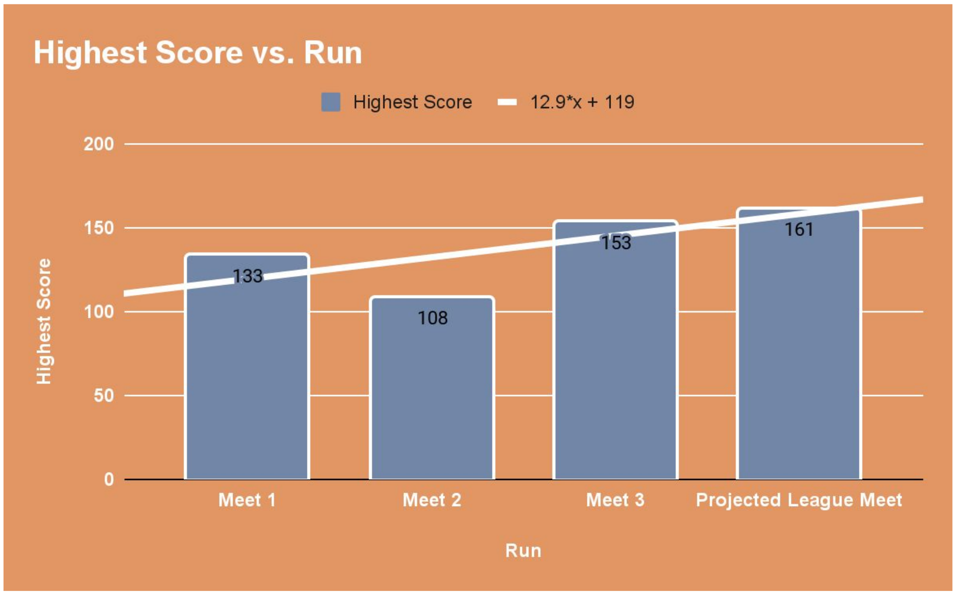








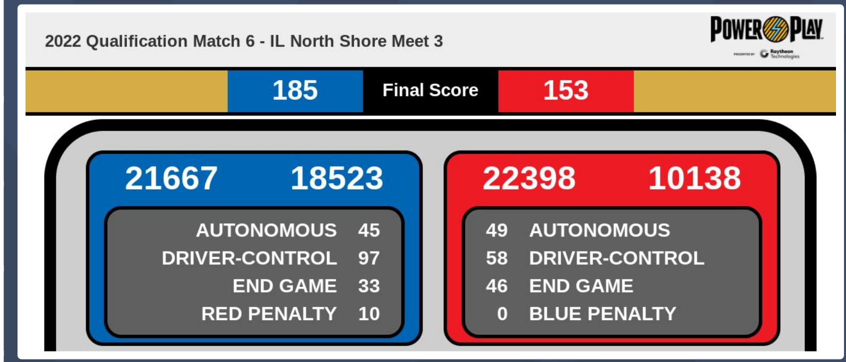
Game Statistics



Strengths:

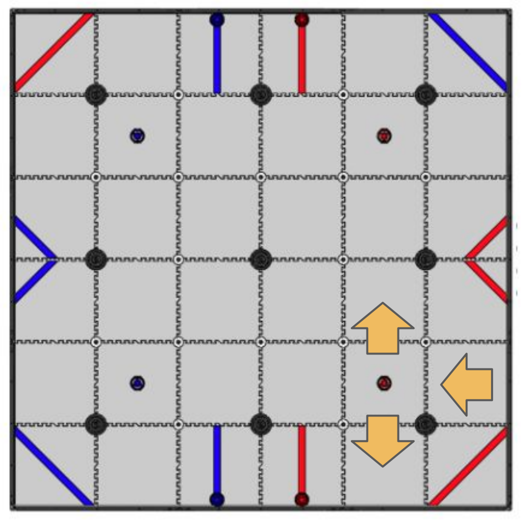
- We can reach all heights for the poles.
- Teamplay.
- If our arm doesn't work we can still push cones to other places.
- We are good at getting circuits.

Top 10 Scores	Auton	Tele-Op	Endgame
153	49	58	46
133	32	45	56
133	25	59	39
121	25	78	18
116	25	82	9
108	24	54	30
100	21	64	15
93	26	44	23
90	26	52	12
89	20	54	15



So far we haven't scored much on our own but we have been able to work well with our alliance partners to help them maximize their robot and score well. For now, this works, but when the arm of our robot is working better we want to be doing our own things during the match instead.

Autonomous



We chose to make our autonomous this way because these are new technologies for our team. We are using statically pre determined movements, to make the robot follow a programmed path. We measured the distances we wanted to move with a tape measure and we created a conversion ratio for inches to motor movement ticks.

OpenCV Pipeline

We used an OpenCV pipeline in order to process our camera's video and get an output optimal for autonomous. In our code, we are calling a custom function that will allow us to get the general color of a specific region. With this output, we operate the robot with the corresponding movements.

Proportional Integral Derivative

Proportional Integral Derivative is a control loop feedback process that we have implemented in order to finely control and maintain the position of our robot's vertical linear mechanisms. We've created our values and are experimenting with the Ziegler-Nichols no overshoot tuning method.

Programming Outreach

At an event hosted by our sponsor Ravinia Brewery we taught kids who are in their schools First Lego League teams how to code. We introduced them to the concept so that they could understand what they might be looking at when they continue their robotics career to high school.

Programming-Tele-Op

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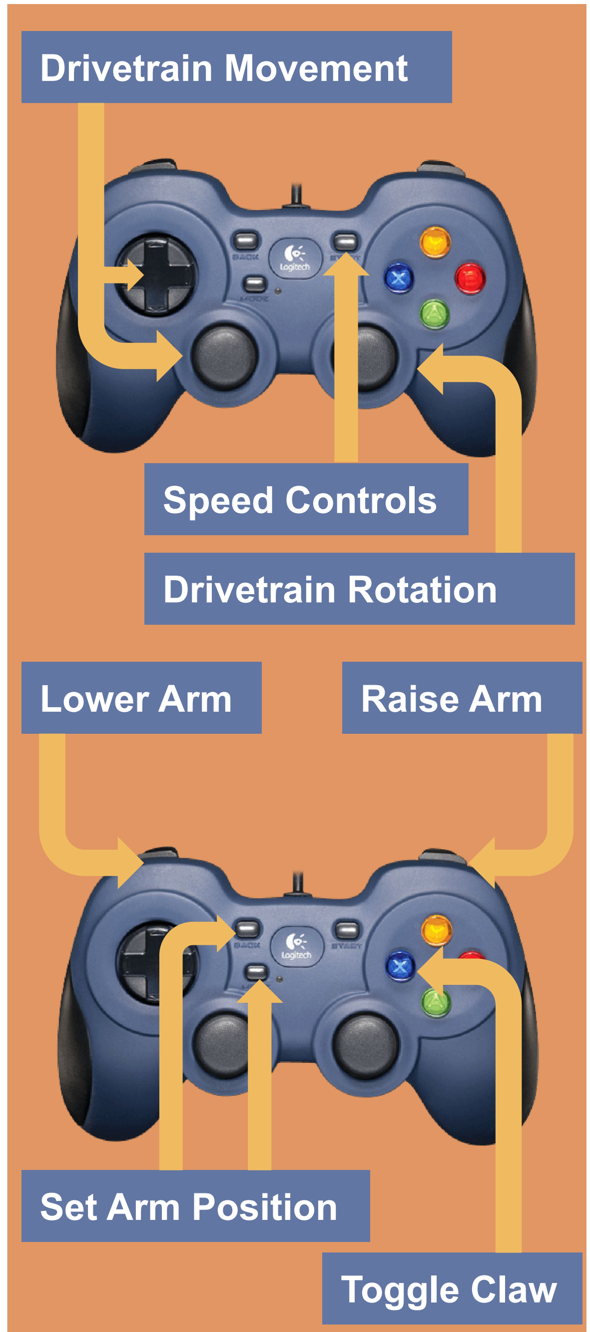
Strategy:

In Tele-Op our game strategy consisted of letting our more experienced partners focus on stacking. Throughout the season our strategy changed match by match due to experimenting but we mostly stayed on not being in our partner's way and going for circuits. In the endgame we would also use our custom piece to our advantage.

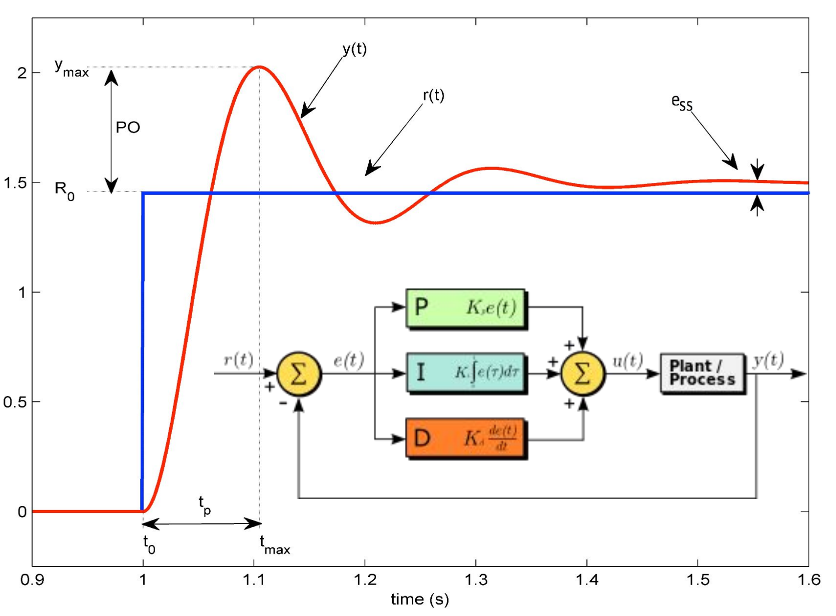
```
}
if (gamepad1.back) {
    clockwise = (float) -1.0;
} else if (gamepad1.guide) {
    clockwise = (float) 1.0;
}
clockwise /= 2;
fl = y + x + clockwise;
fr = y - x - clockwise;
bl = y - x + clockwise;
br = y + x - clockwise;

if (gamepad1.right_bumper) {
```



Proportional Integral Derivative Mechanism

We used Proportional Integral Derivative to easily control the position of our linear slides to preset positions for cones. This allows us to focus on moving the robot instead of moving the arm up and down and having to precisely maneuvering the arm.

$$u = K_p e(t) + K_i \int_0^t e(t)dt + K_d \frac{d}{dt}e(t)$$



Outreach

Project: Teaching Coding at Ravinia Brewery

Overview:
On October 26th of 2022 at the restaurant Ravinia Brewery, our robotics team taught students at the local elementary and middle schools who were involved in their school First Lego League robotics teams about our robotics team and how First Tech Challenge works. We set up a simple obstacle course and let the students drive the robot through it in order to inspire them to continue to do robotics through high school and allow them to understand what it will look like if they continue to stick with robotics.

Goal:
The main goal of this project was to inspire kids so that they would look forward to participating in First Tech Challenge when they are older.

Team Plan

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Independence:
Currently we are affiliated with our high school, so our materials belong to the school. Next year we are going independent and will become a community team. We will be receiving supplies that one of our members already owns and we are planning to raise more money through sponsorships in order to be able to fund ourselves.

Outreach:
We want to continue to use our contacts with local school students involved or interested in robotics in order to teach them about robotics and and how they can get involved in the future like we have in our past event.

Sponsorships:
In order to accumulate money next year we are going to be reaching out to a lot of companies for sponsorships. We understand that we are a rookie team so it will be difficult for us to get big sponsorships, so for now we are going to reach out to local/small businesses and people that we know. This will also be a great opportunity to get in touch with our community and will lead us to more outreach opportunities and events.

Improvement Efforts

- Other Teams
    - Rust In Piece - We have talked with this team a lot and in turn learned a lot from them. In the future as well we are hoping to work with them more.
    - Vertigo - They have also helped us with our coding and building our robot.
- Classes
    - Many of our team members take Computer Science and/or Engineering classes at our high school

Goals

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Team members will take classes at school to learn more (Ex. Comp Sci, Engineering).

We will learn from other experienced teams how to function better as a team and more.

To get a lot of sponsors as a community team to raise money.

Reach out to parents or other adults we know that may be experienced in robotics in some way.

Recruit and manage new team members so we can continue to grow and influence others.

Place higher next year and hopefully have a much more stable robot.