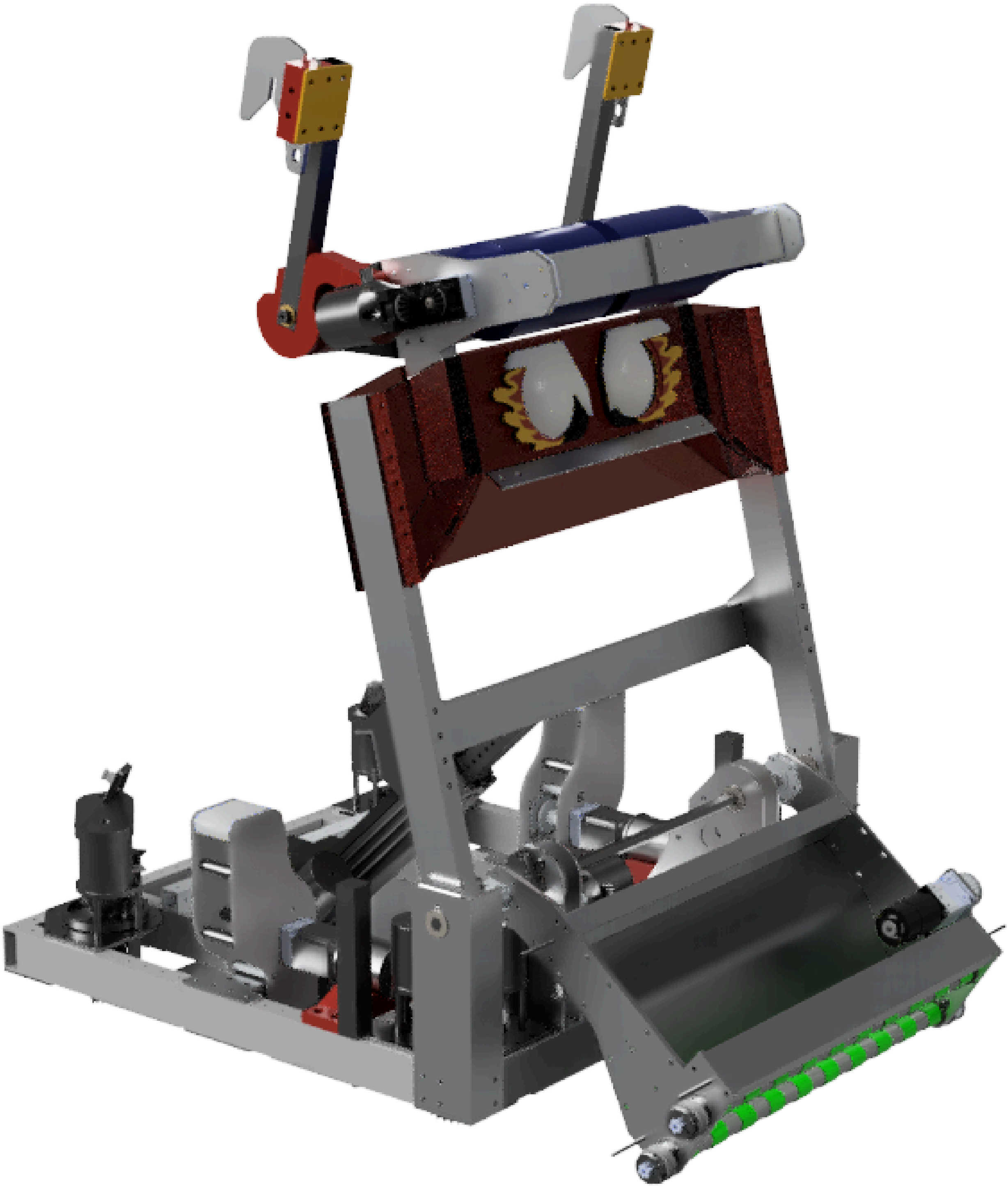
SLINK Info Packet



Overview

The Competition

Our team, Team FRC 6201 The Highlanders, designed and built a robot to compete in the 2023 FIRST Robotics Competition, CRESCENDO. From the game manual:

> In CRESCENDO presented by Haas, two competing alliances are invited to score notes, amplify their speaker, harmonize onstage, and take the spotlight before time runs out. Alliances earn additional rewards for meeting specific scoring thresholds and for cooperating with their opponents.
>
> Each match begins with a 15-second autonomous period, during which time alliance robots operate only on pre-programmed instructions to score points by:
>
> - leaving their starting zone
> - scoring notes into the speaker or amp
>
> In the final 2 minutes and 15 seconds of the match, drivers take control of the robots and score points by:
>
> - continuing to retrieve and score notes into the speaker or amp
> - parking or climbing onstage
> - scoring a note in the trap
> - harmonizing with other robots
>
> The alliance with the highest score at the end of the match wins!

Our Goals

Our goals for this competition is that our robot will accomplish as many of these tasks as possible in order to obtain the highest score during a match. It will also be designed for safety, reliability, and operational ease.

Overview

The Strategy

After the game was released, we examined the game and figured out all the different ways that robots could score. We noted that teams must score Notes (orange foam toruses) in either the Speaker: a thin opening high on the edge of the field; the Amp: a larger opening with the ability to increase points scored in the Speaker; or the Trap: which robots must climb up on a chain to reach. We also looked at the different ways that teams can earn Ranking Points through game play which are by scoring 18 Notes, or earning 10 points from endgame sources.

Our team's strategic analysis of the game, including match simulation through Google Sheets, was the backbone to all of the work we undertook this season. It resulted in our conclusion to focus on scoring Notes in the Speaker. We felt that the ability to score large amounts of points without relying on other robots was very beneficial in Qualification matches. We also felt that being able to climb was vital as the Ensemble Ranking Point was important to work towards.

Scoring in the Trap was not something our team decided to focus on, as we decided that our team would produce a more effective robot if we chose to focus on a smaller set of the game tasks.

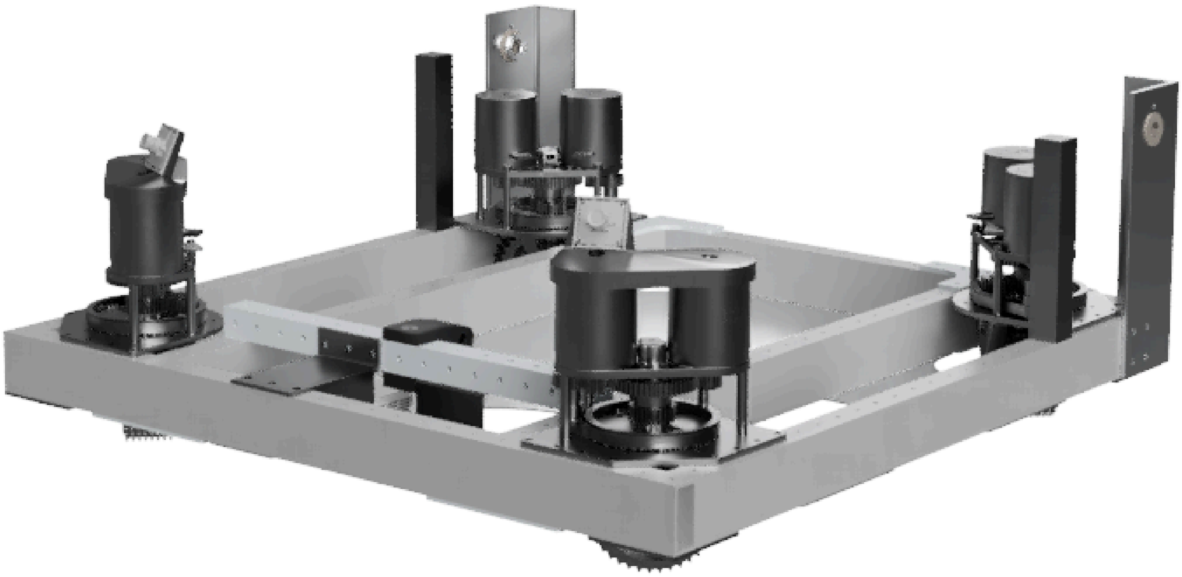
Time	far speaker	Team 1 Points	Team 1	multi trap amp	Team 2 Points	Team 2	climb and speaker	Team 3 Points	Team 3	Alliance Total
0	leave	2	2	go to amp		0	shoot speaker close	5	5	7
5	go to speaker		2	score amp	2	2	leave	2	7	11
10	score speaker	5	7	leave	2	4	drive to center line		7	18
15	go to source		7	move to ground pickup		4	drive to source		7	18
20	pickup source		7	ground pickup		4	source		7	18
25	go to speaker		7	move to amp		4	drive to subwoofer		7	18
30	score speaker	2	9	score amp	1	5	shoot speaker close	2	9	23
35	go to source		9	move to ground pickup		5	drive to source		9	23
40	pickup source		9	ground pickup		5	source		9	23
45	go to speaker		9	move to stage		5	drive to subwoofer		9	23
50	score speaker	5	14	onstage		5	shoot speaker close	5	14	33
55	go to source		14	onstage		5	drive to source		14	33
60	pickup source		14	trap	5	10	source		14	38
65	go to speaker		14	unclimb		10	drive to subwoofer		14	38
70	score speaker	2	16	move to ground pickup		10	shoot speaker close	2	16	42
75	go to source		16	ground pickup		10	drive to source		16	42
80	pickup source		16	move to stage		10	source		16	42
85	go to speaker		16	onstage		10	drive to subwoofer		16	42
90	score speaker	2	18	onstage		10	shoot speaker close	2	18	46
95	go to source		18	trap	5	15	drive to source		18	51
100	pickup source		18	unclimb		15	source		18	51
105	go to speaker		18	move to ground pickup		15	drive to subwoofer		18	51
110	score speaker	2	20	ground pickup		15	shoot speaker close	2	20	55
115	go to source		20	move to stage		15	drive to source		20	55
120	pickup source		20	onstage		15	source		20	55
125	go to speaker		20	onstage		15	drive to subwoofer		20	55
130	score speaker	2	22	trap	5	20	shoot speaker close	2	22	64
135	park	1	23	harmony	5	25	drive to stage		22	70
140			23			25	onstage		22	70
145			23			25	onstage	3	25	73

Subsystem Specifications

Our robot is made out of different subsystems. Each subsystem was designed to in order to try to get as many points as possible while being realistic for the team to build in terms of skill, time and budget. The table below lists each subsystem and describes what functionality it provides.

#	Subsystem	Description	Functionality
1	Swerve Drive	Allows the robot to move and turn in any direction.	Drive
2	Shooter	Fires game pieces into the speaker.	Score
3	Intake	Collects game pieces from the floor and feeds them into the shooter.	Collect
4	Climber	Pulls the robot up onto the chain.	Climb

Swerve Drive



We continued our exploration into swerve drive from the 2023 season, leveraging our experience to refine the drive base. Our use of swerve drive is a huge asset for our robots. It enables the robot to move quickly and precisely in any direction while rotating. This improves the capabilities of our robot while also reducing the complexities of controlling it.

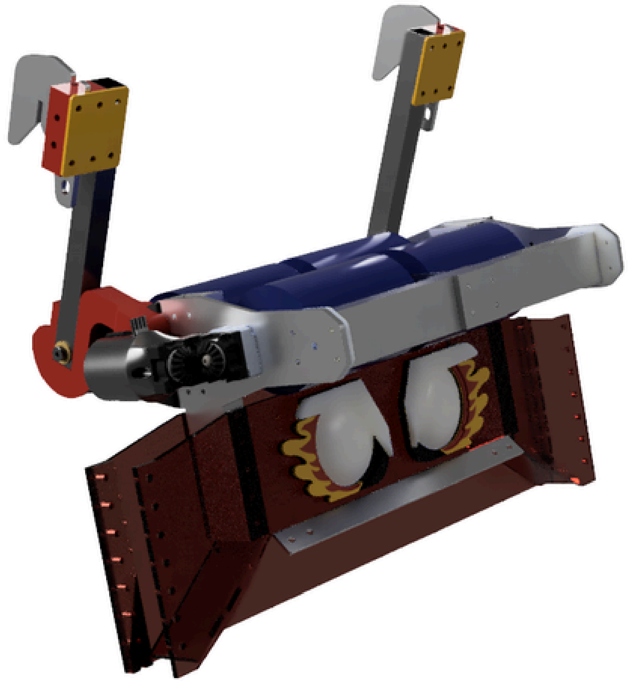
Our robot uses Swerve Drive Specialties Mark 4 modules with NEO v1.1 motors. We enjoyed the reliability of this system, as well as the ease of assembly and maintenance. To control the modules we used SparkMAX controllers, with a NavX MXP gyro on our RoboRIO for heading reference.

We innovated with our swerve by using custom absolute encoders. These encoders were designed by our team to fill our specific needs in a swerve drive train. At the core of these devices is a AS5047 chip, which communicates with a SparkMAX through pulse width modulation (PWM). We found these devices to be very capable and enjoyed how seamlessly they connected—physically and in code—to our modules.

Shooter

Shooter

At the beginning of the season we decided that we wanted to be able to shoot the notes as far and as fast as we could. However, we also needed to make sure that the note's flight was accurate and precise. This required stability without sacrificing speed. Most other teams have attempted this through flywheels planar with the note like the design on the Kitbot. This causes the notes to spin adding stability. However, it sacrifices distance. We knew that while it would be a challenge, we could do better. We turned towards perpendicular rollers, a solution that favors speed and distance. Our solution to adding spin and stability was to vary the friction along the roller by putting duct tape around one side of our rollers, creating spin. This provided stability while still still allowing for speed. Our end result could shoot accurately at 30 feet!



Actuation

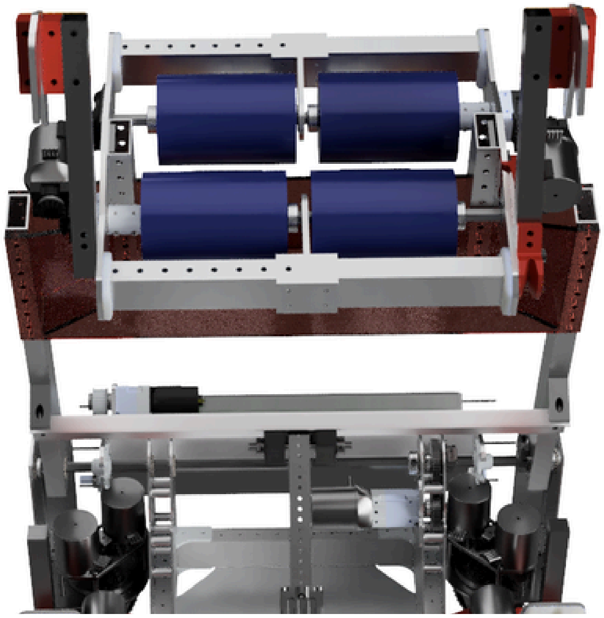
In order to control the angle of our shooter, we employ a customized REV Robotics linear actuator mounted to the middle of the arm and to the frame. The actuator is a unique way of driving the arm, chosen because it enables us to control the arm from a point further from the joint.

The actuator also provides a unique level of stability compared to other arm drive options like gears, chains or belts. It's also more controllable due to its precise and rigid driving. We utilize custom 3D printed parts to support and mount our actuator to the arm and robot frame, and a 180 degree flip gearbox to package the drive system more effectively.

Shooter: Code

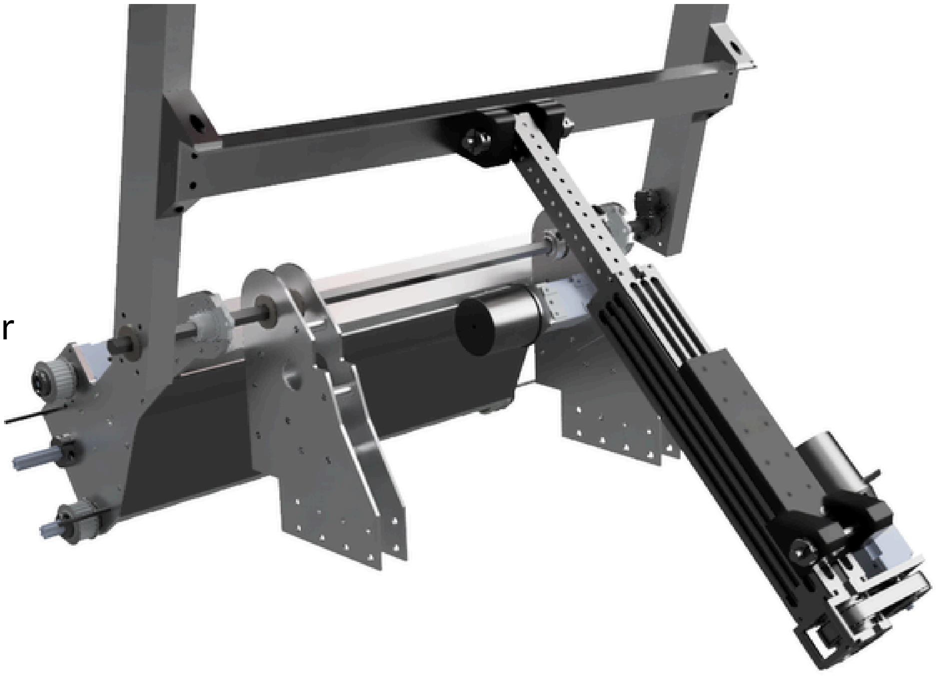
Shooter Code

Our shooter relies on tuned PID controllers to set and control the velocity of each of our flywheels. These PID controllers' commands are based on our distance from the Speaker. We receive this distance from our field localization subsystem, which combines AprilTag data from PhotonVision, and odometry data from our swerve base, to estimate our position on the field. We use a linear interpolation system to "train" our shooter on the correct speed to use based on how far away we are. This system requires us to provide it examples of correct shots from a variety of distances, from which it can interpolate between them to pick the correct speed for the Notes. We also use an Adafruit Beam Break sensor to detect when a Note has left the shooter, which concludes our automated shooting routine.



Actuation Code

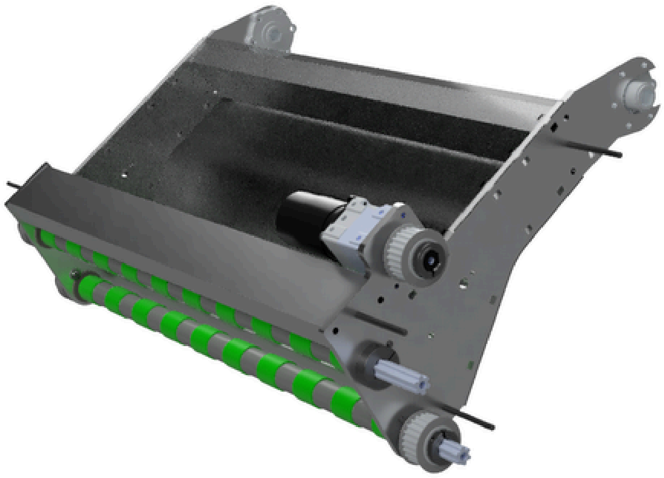
Our actuator is responsible for moving our shooter to a desired angle. We achieve this through a PID controller, which uses the length of the actuator as its control variable. The actuator subsystem receives target angle data from the same linear interpolation system mentioned above. When It's not shooting, the actuation code returns the arm to ready position.



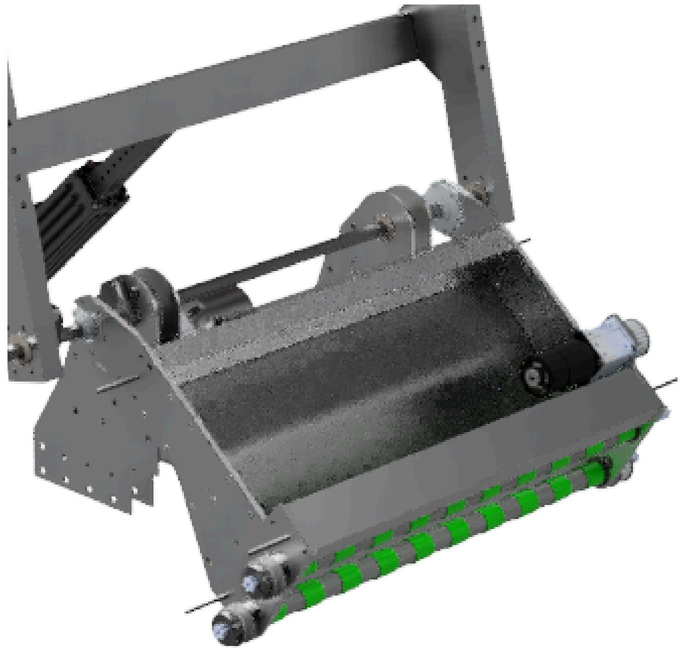
Intake

Intake

Our intake utilizes a set of twin rollers made of Sushi wheels to pick up Notes from the floor, by reaching over the bumpers. It then holds the note snugly inside, as the whole system flips from the floor into the robot. After actuating, it lines up within our co-axial shooter—regardless of the shooter's present angle—and when we are ready to shoot, back-drives to spin the Note out of holding and feed it into the shooter's flywheels.



Our goals during design and prototyping were for a sturdy subsystem that was also light. This led to a mostly PETG plastic composition, reinforced by box tube. The intake floor is made out of a rugged fabric which keeps the part light and flexible. The fabric could adapt to intake the note in more situations and could bend over the intake without issue.



Intake Code

Our intake is controlled by a PID controller, which allows it to either match its position with the shooter, or deploy all the way out to the floor to pick up a Note. We use an Adafruit Beam Break sensor to detect if we have successfully picked up a note, which is relayed to the driver through our LEDs. Our intake utilizes custom created kinematics to work out the angle to match with the shooter.

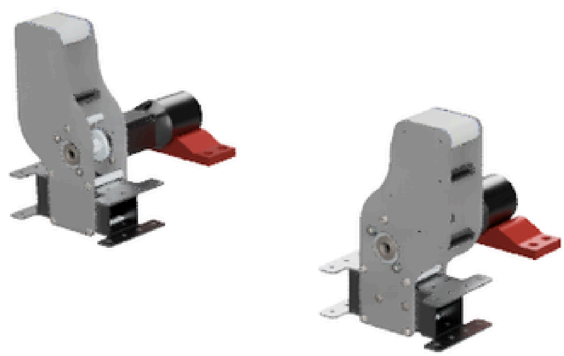
Climber

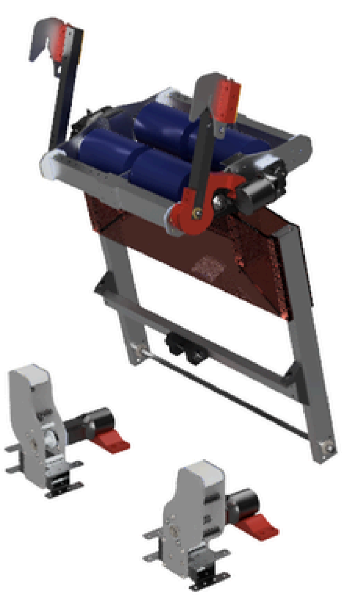
Climber

Climber is designed in two main assemblies: The winch and the “switchblade” hooks. The winch utilizes a high gear ratio and ratchet to pull the weight of the robot with ease. In order to pull from above the center of mass, the rope then travels up through the “winch raisers” which raises the point the robot would pivot on, an important touch to prevent the robot from flipping over. The rope then travels up the robot through breakaway guides to the hooks.

The “Switchblade” hooks are named for their quick pivot motion that brings them from their stowed position (under the shooter) to their deployed position (extended upwards above the shooter). This is necessary for ensuring the hooks are kept inside the bumpers and away from potential damage until the climb. As we pull the rope with the winch, the climbing poles are pulled up and around before the hooks can detach from the poles. Once the robot is positioned with the hooks just above the chain, the winch pulls harder and detaches the hooks, which fall onto the chain and lift the robot.

Our hooks are made of plasma cut steel with a notch to catch the chain so we don’t slip laterally while climbing at an angle. The steel also means we can use magnets for attachment without having to add extra weight.





Climber Code

Our climbing modules are able to be controlled separately, to allow precision in our climb, especially useful when climbing as the second robot on a chain. We control these in combination with the shooter actuator to achieve the best climb. We also use a PID controller for the initial pull, so that the hooks are deployed with the right amount of rope pulled.

Thank You To Our Sponsors!

A huge thanks to our sponsors for helping our team continue our journey! Their generous donations are what made this robot possible.

Team Contact Information

If you have any questions about any of our subsystems whether it be a question about the planning, the CAD, the assembly or code then please feel free to contact us using our contacts below.

We would love to answer any questions!

Social Media Contacts

Website: team6201.com
Email: frc6201@gmail.com
Facebook: FRC Team 6201
Twitter: @frc6201
Instagram: @frc6201

Main Contact

Laura Peters
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Team Meeting Information

Location: 81 Highland Ave, Somerville, MA 02143
Dates and times:

- Monday - Wednesday: 5:00pm - 8:00pm
- Thursday - 2:45pm - 8:00pm
- Friday: 2:45pm - 5:00pm
- Saturday: 12:00pm - 6:00pm

Sponsorship Information

Checks can be made out and mailed to
Somerville High School Robotics

Mailing Address

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