THE HIGHLANDERS

FRC Team #4499

2020 SEASON ENGINEERING DESIGN DOCUMENT

ABOUT US

Our team doubled since 2018 when we had 6 team members. Many of us our new to FRC, FIRST and Robotics.   We range from 7th grade to 12th grade.

STRATEGY

We decided to focus our robot to be a low trench robot that can cycle fast and can solo level climb in the end game

CHRONOSTAR

Website : www.highlandersfrc.com

Location : Fort Collins, CO

1 ROBUST

Build a robot that is designed to compete the game, but be made to withstand the game.

2 RELIABLE

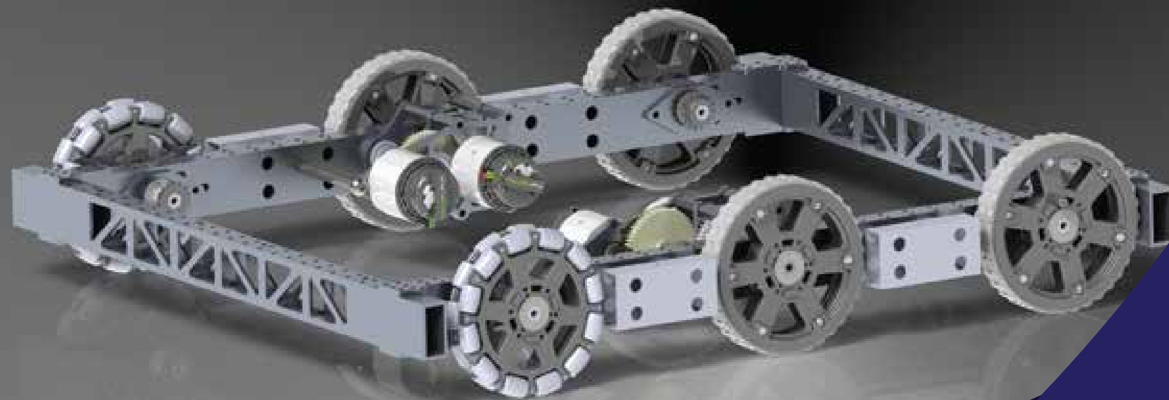
Build a robot that will compete and score goals round after round and througout the tournament season.

3 CYCLE ROBOT

Create a robot that can cycle the cargo and hatch fast, efficiant and reliable.

4 CUSTOM DESIGN

Create a design for our team to push our creative designs while learning from our mentors and alumni along the way.



THE CHASSIS

ABOUT

We designed our 2020 robot using the West Coast Chassis design. Making custom-designed chain tensioners we are able to dynamically adjust how are robot drives in a match. We used a 4 falcon drive train to give us rapid acceleration and the ability to have the power needed in a defense situation. In addition we decided to use 2 omnis on the front of our robot to give us superior agility while moving.

GEAR BOX

We chose to go design our own custom gear box for our 4 falcon motors.

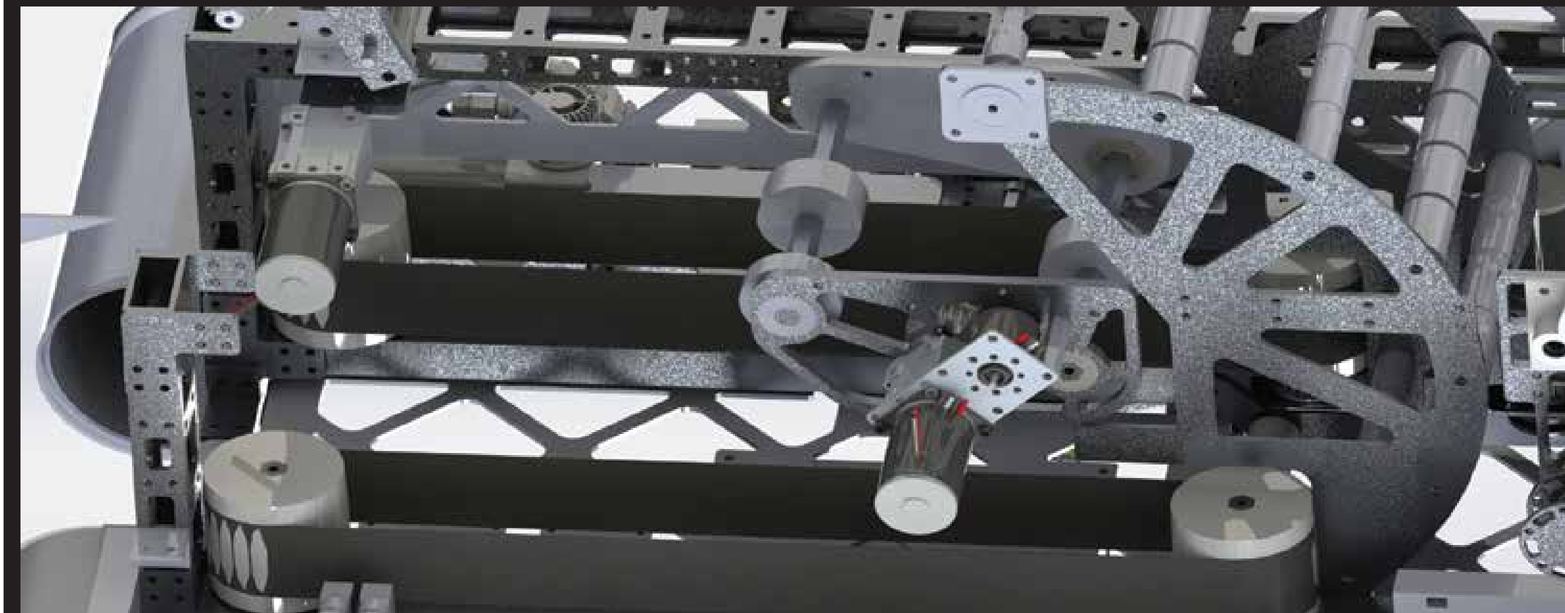
CHAIN TENSIONER

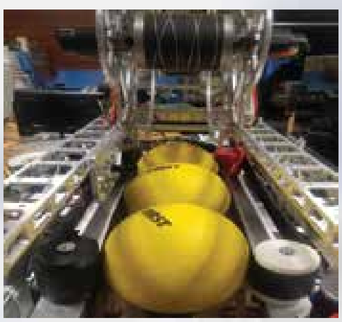
We decided to design the drive train chain with our custom tensioner so we don't struggle from last years problems.

CUSTOM WCC

We went with a West Coast Chassis design, but implemented it our own way.

THE FEEDER MECHANISM





CONVEYOR BELTS

We designed this 3 in one mechanism and counter balanced it with 2 60 lbs gas springs for linearized arm control.

INDEXER

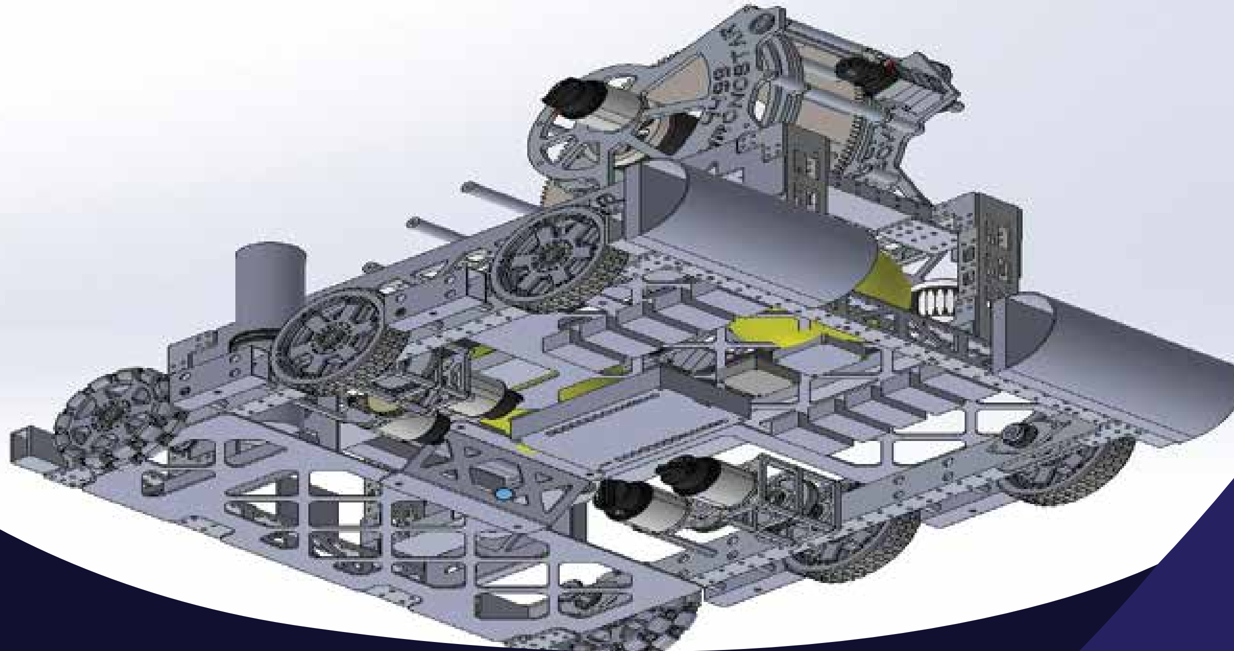
To be a trench robot we decided to combine multiple mechanisms, such as our intake and climber into singular comonents.

CURVED DEISGN

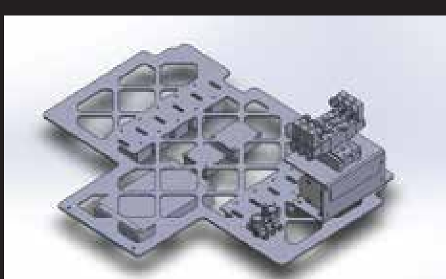
In order to singularize balls and increase our intake range we used 3D printed vectored wheels.

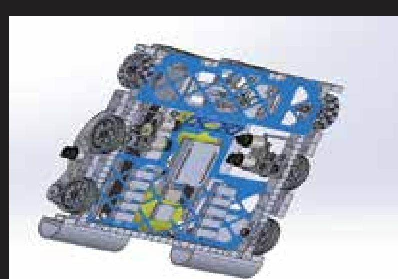
FEEDER MECHANISM

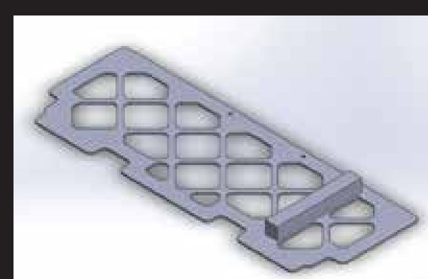
The feeder is the most iterated upon mechanism on our robot. It consists of three sections. First there is the intake, which incorporates a beam brake sensor to detect balls caught in the pass off between the feeder and the belt in order to automatically sort them and feed them back into the robot. Secondly there is the magazine, which uses timed runs to space balls and matches the velocity of a central wheel and outside belt system in order to ensure that balls translate without rolling through the system, stopping lockups and jams in the system. Lastly there is the indexer, which incorporates another beam brake sensor to ensure that we actually do have a ball and only allows balls to be fed to the shooter only when we want to. This system allows us to consistently singularize, and then feed 5 balls to our shooter.



ELECTRONICS BOARD DESIGN







MAIN BOARD

We placed our air tanks, pneumatic manifold, solenoids and RSL on the top shelf of our electronics board.

BOTTOM VIEW

We placed our PDP, canifier, VRM, PCM on the bottom of our electronics board.

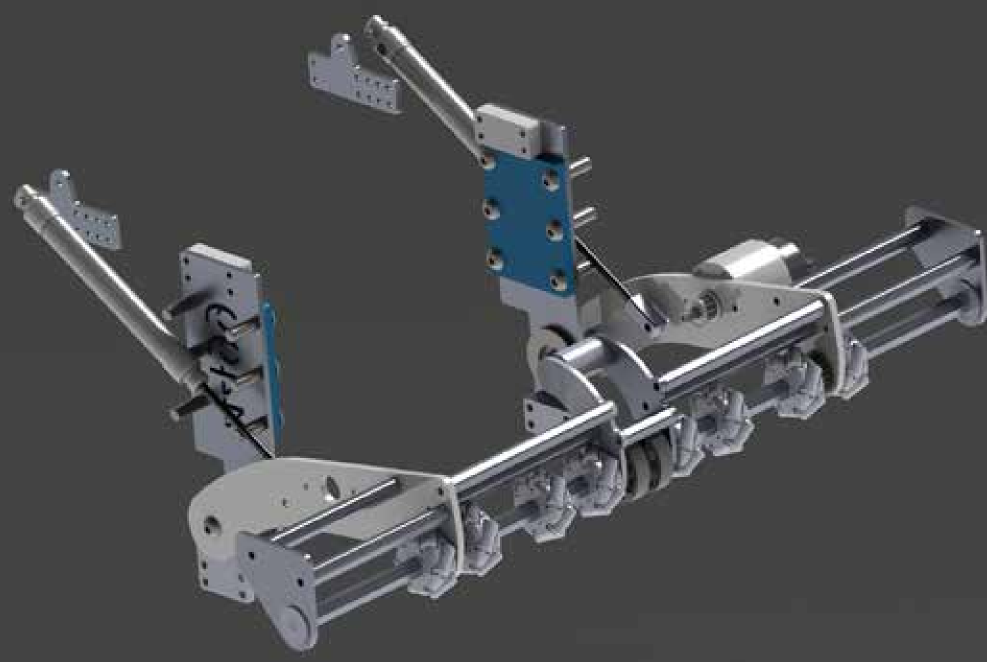
PLASMA JET

All of our electronics boards were cut out on our team-designed CNC plasma jet.

ABOUT OUR ELECTRONICS

We focused on having our electronics boards completly designed and layed out in SolidWorks. We even made a custom back board with our robot name: GRAVASTAR.

THE INTAKE MECHANISM

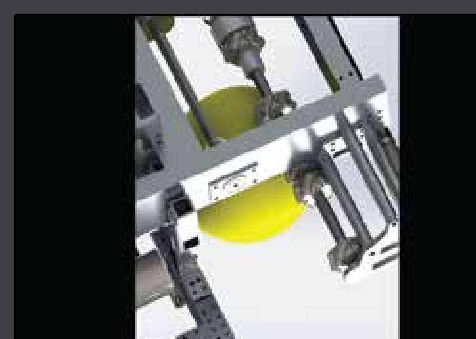


COUNTER BALANCED

We designed this 3 in one mechanism and counter balanced it with 2 60 lbs gas springs for linearized arm control.

PNUEMATIC

This mechanism uses a piston to actuate the up and down movement to make contact with the ball.



VECTORED INTAKE

In order to singularize balls and increase our intake range we used 3D printed vectored wheels.

INTAKE IMPROVEMENTS

After our first implementation of this arm we calculated the optimal force to counter balance the arm. We also added a preventitive measure to prevent balls from getting stuck under our robot. We decided to use a lightweight composite material, and machined carbon fiber rod.

CUSTOM

3 IN 1 MECHANISM

SHOOTER MECHANISM

FLYWHEEL

CAMERA MOUNT

HOW?

Our shooter started out as a basic prototype, 2 Neo's directly driving a black fairlane that we had from 2017. Using that shooter, our team was able to develop algorithms to track the target using vision, and automatically adjust our shooter velocity to hit our desired target from a multitude of ranges. This shooter however, had a few issues. Without an adjustable hood angle, we had a cap on the ranges that we could shoot from, and the shooter was too underpowered to fire from multiple distances. To fix this our competition shooter is able to adjust both hood exit angle and ball velocity, and with two geared up falcons we're able to hit the target from nearly anywhere on the field. It is able to spin up to its desired velocity in less than a second, and maintain high precision while shooting 5 balls in under two seconds. Too stop our wheels from delaminating, we have voltage and velocity caps on the shooter motors, as well as tied on safety wire across the shooter.

EFFECTIVENESS?

Our shooter can shoot all 5 balls in under 2 seconds.

COMPUTER VISION/PROGRAMMING

VISION TRACKING USING REFLECTIVE TAPE

CAMERAS

It was clear that this year we would need to have driver vision, but we had a limit of 4Mbit, so that would require us to manage our FPS/resolution and compression. To accomplish this we are using the JeVois camera and custom code.

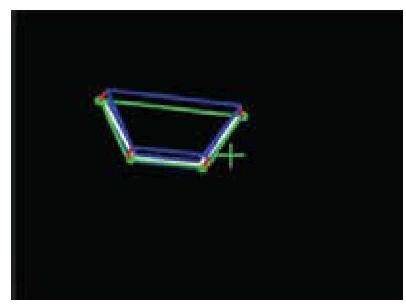
VISION TRACKING

We prioritized the ability to recognize the reflective tape using the JeVois camera and integrated CV code. We wrote custom Python code to detect the targets and calculate distance and angle to send to the RoboRio for an auto-score solution.

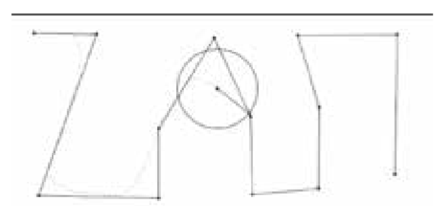
VSCODE/PURE PURSUIT

In order to create a driver assist "auto-score" button, we used a pure pursuit algorithm that creates a "look ahead" point at a configurable distance from the robot. This creates the speed and direction spline the robot needs to move to the target.

AUTO SCORING

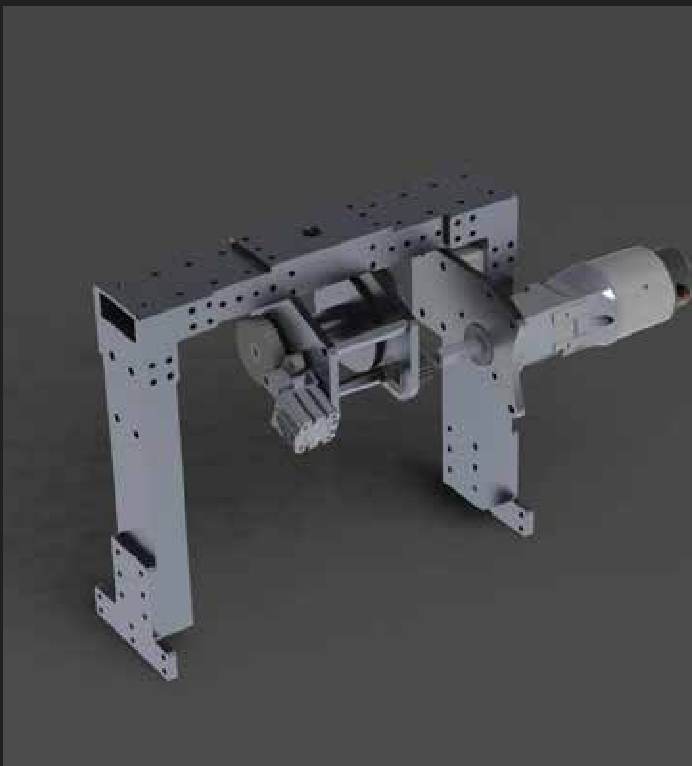


PURE PURSUIT



3D PRINTED MOUNTS

CLIMBER MECHANISM



CLIMBER - ARM

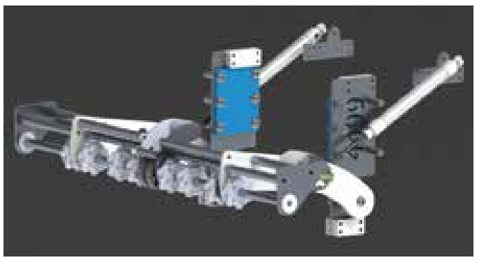
CAMERA WINCH

HOW?

After our 2021 season our climber was completly re-designed. Our original climber worked in combination with our intake arm, and this provided a slower less accurate execution. We designed and machined this climber that consists 2 mechanisms. The arm and the winch. The arm uses a detatchable hook that one placed on the generator, with a small amount of force it detaches. This allows the winch to spool up the rope and pull the robot up very quickly. Even though we did not get a chance to test this in a compeition, we are able to see great results in our shop. The winch is powered by a flacon motor and the hook is deployed using a pnuematic piston.

EFFECTIVENESS?

We feel that this mechanism will work for a climb in under 10 seconds.

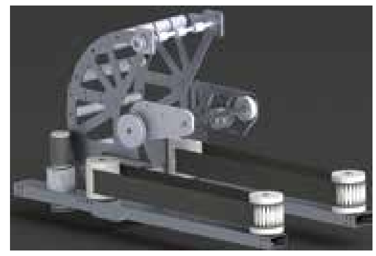


INTAKE

Our intake is powered by a Falcon 500 and uses pneumatic pistons
to raise and lower the intake. We use mecanum wheels to drive the balls to the center of the robot.

CLIMBER

Our climber functions by first raising itself with a piston, and then using a motor to go higher. It then places the hook and uses a separate motor to winch.



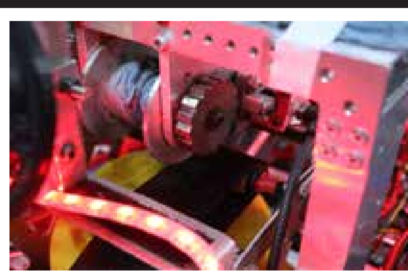
MAGAZINE

We implemented the combined use of 2 belts on the sides of the magazine to transfer the balls most of the length of the robot. They then get picked up by a ring of rollers driven by a wheel in the center.

CHRONOSTAR

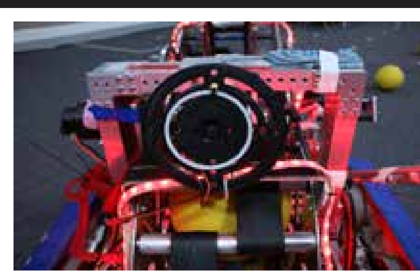
SHOOTER

The shooter is designed with the use of 2 falcon 500s. A steel flywheel with a high rotational inertia is implemented to make it not lose momentum when firing.



WINCH MECHANISM

We designed and machined our own custom one way ratcheting mechanism to hold our robot up after it climbs. This is actuated by a small pneumatic piston.



VISION

We have developed a custom vision processing solution using Jevios camera with open CV using Python. The target is tracked with the camera and distance and angle are sent to the robot to auto align. The vision code can also detect a ball.

ABOUT OUR ROBOT DESIGN DESCISION

We make our robot in house, machining, designing and assembling everything by team members. Each year we analyze the game challenge and decide on robot tasks with current years resources. Having fun is always on the top of the list!