RECONFIGURABLE FRC SWERVE CHASSIS with UNDER BELLY MOUNT BATTERY SYSTEM

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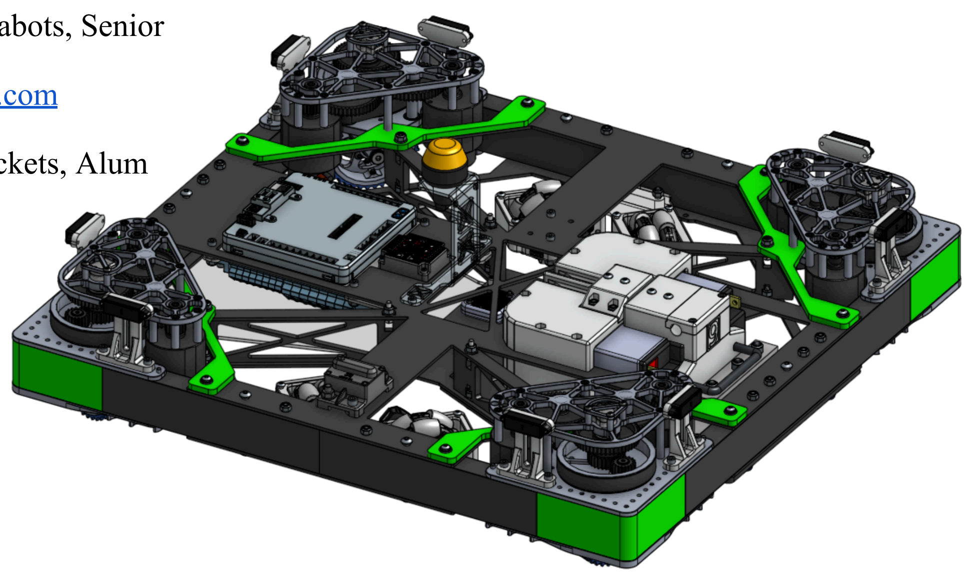

Summary

*Project overview, results and significance (write this last)

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Introduction

Problem Statement

FRC teams waste time developing chassis' at the beginning of every season, instead of developing competitive tooling.

Background

By making a reconfigurable chassis that is robust and durable it will allow teams that want swerve drive to spend less time on developing a chassis and more on developing competitive tooling for the season.

Objective

The objective of this project is to make a simple reconfigurable chassis for FRC that uses a variety of COTS swerve drives, is robust, durable, and simple to make for FRC teams.

CAD Model Development

Software

We used Onshape to make the CAD model for this Project. We used Onshape because it has reconfigurable properties and the CAD model can easily be shared with other teams.

Model Features

The model has many reconfigurable properties such as:

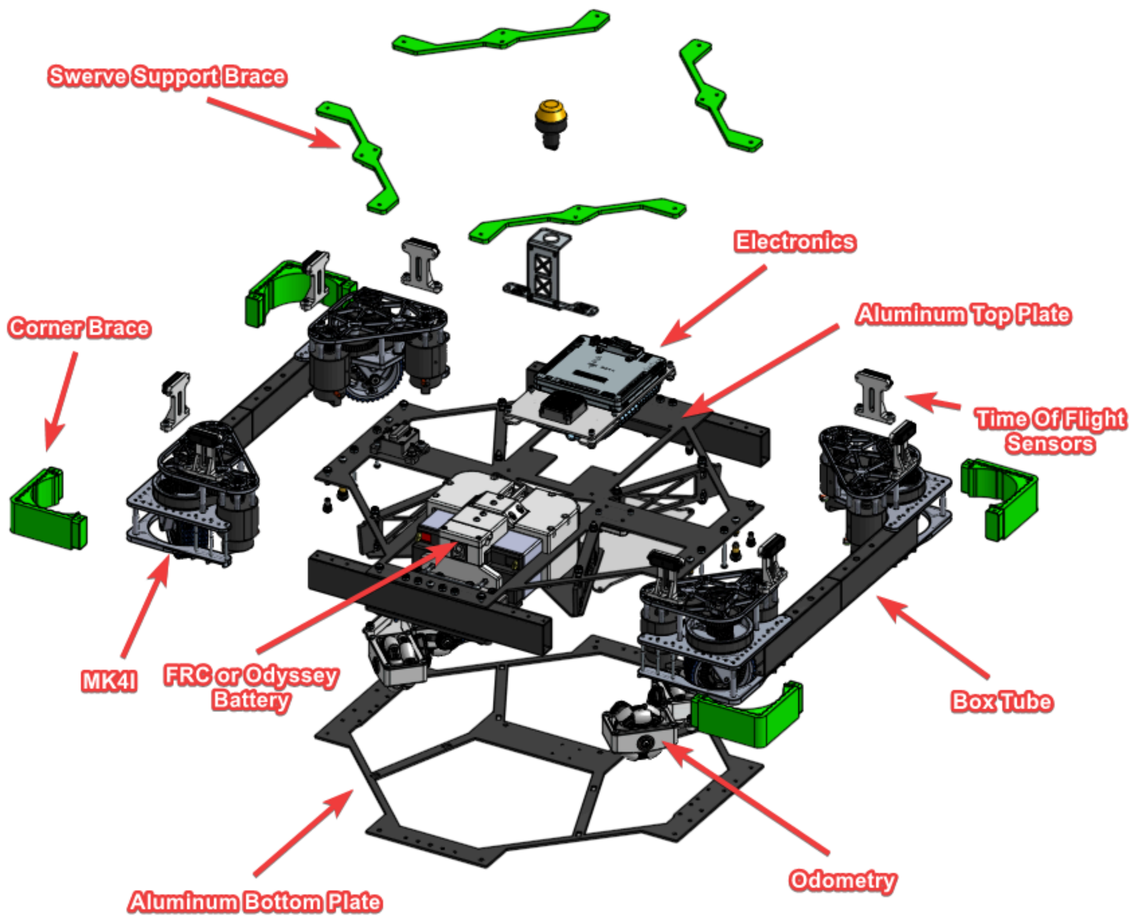
- Length 24in to 36in
- Width 24in to 36in
- Enable/Disable Electronics
- Enable/Disable Hardware
- Enable/Disable PCM
- PDP or PDH
- Falcon or NEOs for swerve drive motors
- FRC or Odyssey battery
- Extrusion Thickness
- Lighten Extrusion
- Tooling/Cover Plate
- Enable/Disable Bumpers
- Bumper Height
- Odometry Pods
- 2 or 4 Odometry Pods
- Enable/Disable Blinkin
- Enable/Disable Camera Tower
- Enable/Disable Orange Pi Holders
- Camera Type
- Battery Holder Type
- Quick Change Swerve Pods
- Can use the following swerve modules:
    1. SDS MK4i
    2. SDS MK4
    3. SDS MK3
    4. SDS MK2
    5. Thrifty Swerve V1.1-1

Limitations

- The model can not go below 24in for width and length
- The model can not go above 36in for width and length
- While the pods themselves are quick change you will need your own quick-disconnect wire connectors
- The height of the tooling plate is ~3in from the chassis, this may not be enough for some teams
- The ground clearance of the chassis is currently only adjustable to two points with the SDS MK4i, MK4, and MK3 swerve modules

Manufacturing

Components



Machining Processes

To make the chassis we used our CNC Router to cut all the aluminum parts. We used as few different screw standards as possible to keep the tools required to a minimum. As far as tools go the chassis ultimately only takes some allen keys, wrenches, and some time to assemble.

<u>Final Product</u>

This is the final product with the camera tower enabled. We used this chassis for design testing as well as testing camera, auto, and teleop code. This chassis also uses the ODYSSEY battery rather than the FRC battery. This test bot gave us plenty of valuable insight into the issues with the design and the fixed problems with the design. This is what we wound up with as a final product, we are extremely excited to bring you a KOP Swerve FRC chassis!

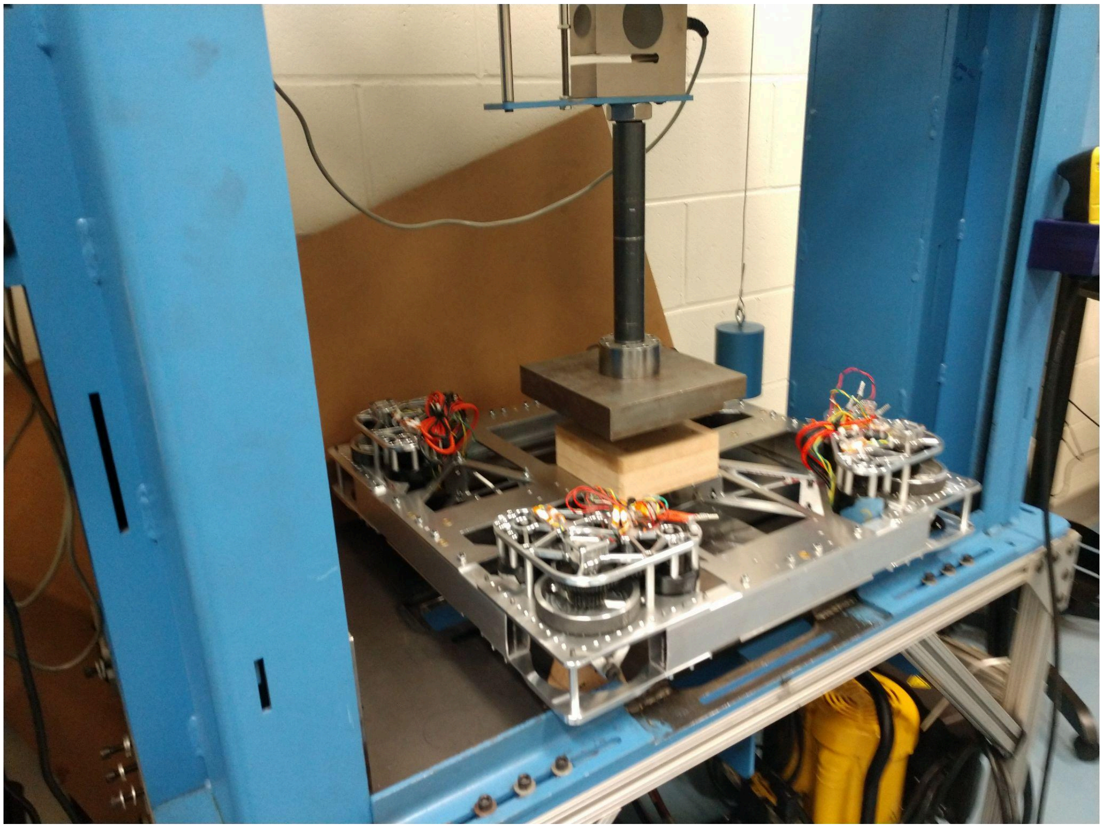
<u>Cost Analysis</u>

This is the [BOM with pricing] for the swerve chassis

Sheet metal, 3D prints, and hardware.

Brief description or discussion where necessary/

Testing



Parameters of Interest

Deflection in the center of the chassis along the long unsupported segments is minor at 200 lbs of load, noticeable at 800 lbs, and extremely noticeable at 1200 lbs of load. Permanent deformation at 800-1200 lbs on the inner structure pieces tabs. Permanent deformation over time at the center at 1200 lbs of load at 50 cycles, it remained slightly bent after the 50 cycles and did not return to normal.

FEA Setup

*Materials, fixtures, loads, etc.

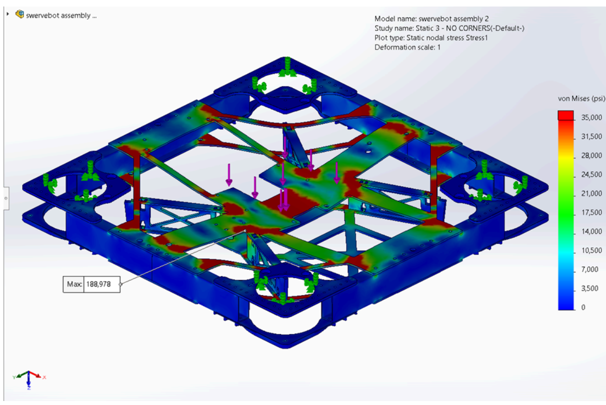
Static Testing Setup

For the static testing we used the static test machine at Caster Concepts. On the robot we used a 10in by 10in square that was set in the middle of the chassis. We used the displacement measurement on the static test machine to measure the deformation when the chassis is underload.

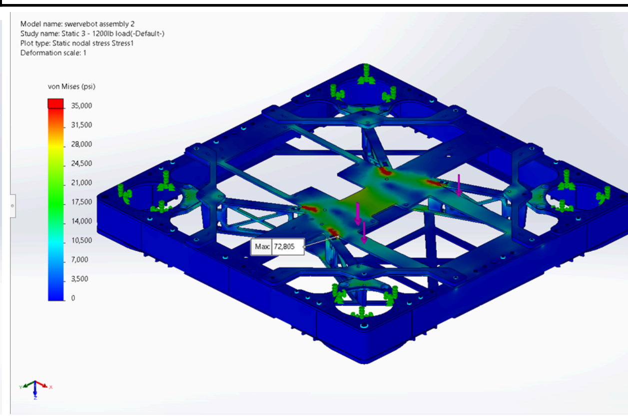
FEA Results

24"*24" Chassis FEA

Load In lbs:	Basic FEA deformation:	FEA with Corner and Swerve Support Brace:
400	0.397in	*
800	0.794in	*
1200	1.191in	*



1200 lbs Basic Chassis



1200 lbs with Corner and Swerve Support Brace

[1]Static Testing Results

24"*24" Chassis

Load In lbs:	Basic Chassis:	Chassis with Corner and Swerve Support Brace:
400	0.343in	0.144in
800	N/A	0.209in
1200	N/A	0.283in
2400	N/A	0.51in

[1] *To Be Determined

30"*30" Chassis

Load In lbs:	Chassis with Corner and Swerve Support Brace:
400	0.15in
800	0.341in
1200	0.545in

Link to 24"*24" Chassis 2400 lbs Static Test: Link
Link to 30"*30" Chassis Static Testing: Link

Comparison

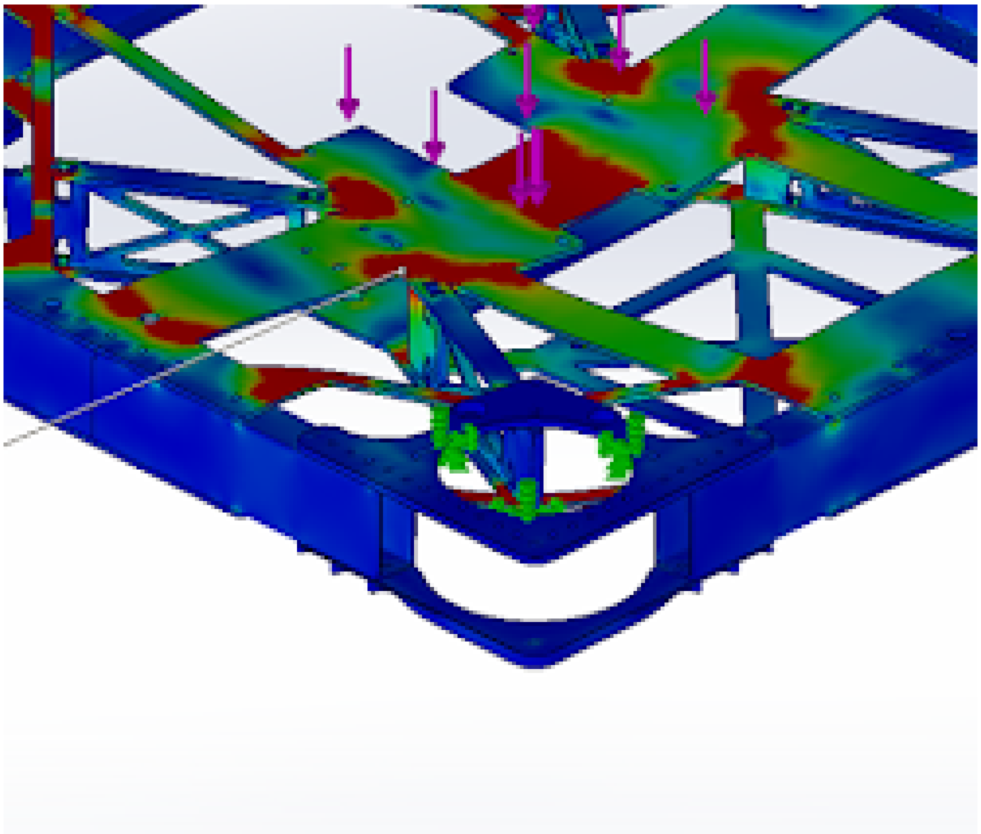
The two chassis had significant differences between the results based on the size difference, the 24X24 chassis had 0.185in of deformation at 200lbs of force after 10 cycles and the 30X30 had .299in of deformation after 10 cycles of 200lbs, that is roughly a 61% increase due to the size increase.

The two chassis also had large differences at 1200lbs, the 24X24 had .292in of deformation after 50 cycles at 1200lbs and the 30X30 chassis had .614in of deformation after 50 cycles at 1200lbs, that is roughly a 110% increase.

The size of the chassis definitely will affect strength, while the numbers seem scary, those numbers are not that large of a displacement and should not stop the chassis from working.

Analysis

FEA



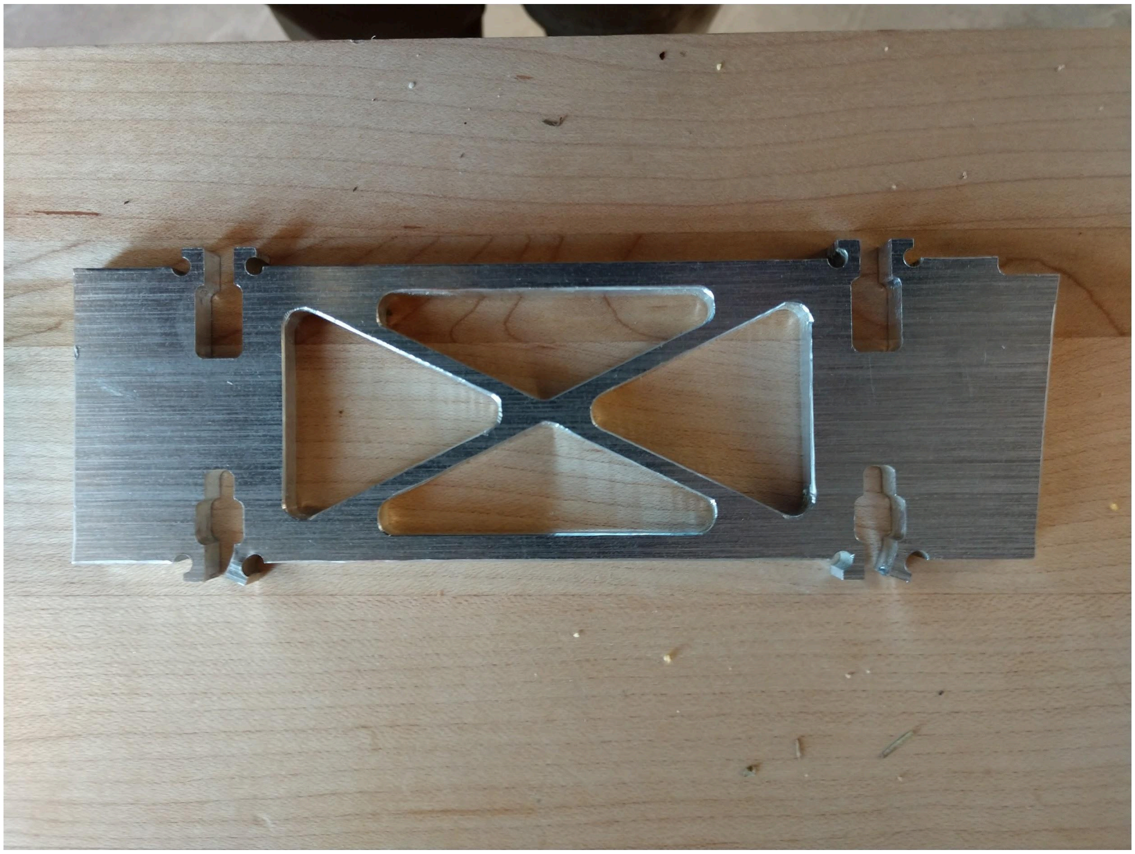
<u>Failure Mode Analysis</u>

There were two really obvious failure points and we found fixes for them, we discovered that the main failure point was going to be the swerve pod as the pod itself was only actually ted in at the box tube rather than the center of the chassis, this led us to add the 3d printed corner protectors to stop the corner plates from bending and the 1/4in corner support braces that tie the swerve pod more directly to the center of chassis than they were before.

<u>Design Changes</u>

After the first round of FEA we ran, we decided to add the corner braces and the swerve pod support pieces, those parts increased the rigidity of the chassis a lot as the pods were not directly tied into the center of the chassis before and they were showed to want to bend the corners before we added the braces, now the corners are less likely to be the failure point on the chassis.

Static Testing



<u>Failure Mode Analysis</u>

The chassis had a few points that bent more than others, the beams that go from the center to the sides of the chassis were bending at the higher pressures however it was not an amount of pressure that the center of the robot should have on it during the FRC season. The inner support braces began to bend in the center at bigger sizes and at higher pressures, those have been thickened enough to where they should not bend like they did.

<u>Design Changes</u>

We reduced some tolerances in the inner structure parts that were to lose and allowed for the chassis to buckle under the pressure, this was due to us using the wrong size screw but we realized that even with the right size screw the same thing could happen so we decreased the tolerance to fix the issue, we also decreased the thicknesses of some cutouts allowing for the meat of the chassis to be stronger.

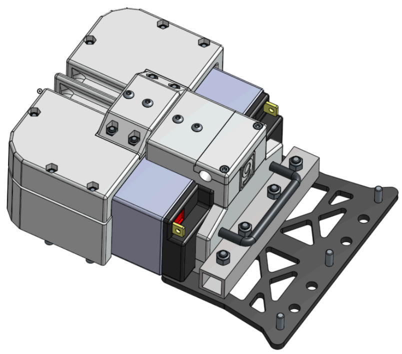
CONCLUSION

The initial attempt at this was done in SolidWorks and team 9312 Nerd Spark was the team to use the first version of the chassis. This chassis does not suffer from most of the flaws that the original did, the original began to bend in the center after a few competitions, we believe that the bending will not be quite so prominent, another issue was the bottom plate being made of 1/16 in aluminum and getting bent, we switched to 1/8th in aluminum to prevent that. In the time that this was under development there was one competition which resulted in 9312 destroying a PDH, that has also been solved by a electronics cover being installed to protect the PDH or PDP. We also switched away from the weaker formed sides to go with the stronger and more affordable box tube.

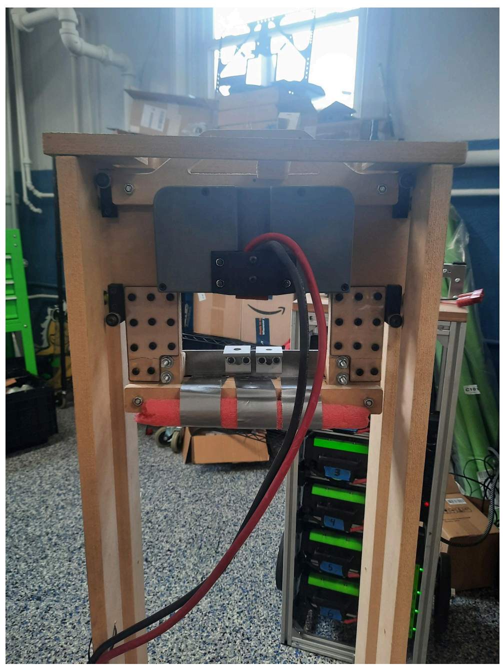
The goal of this project was to give teams who want to use a swerve robot the ability to purchase a KOP and focus on developing the seasons tooling and systems to have the maximum time before their first competition to ensure that they are working enough to use at competition. This chassis is designed to have a modifiable tooling plate for teams to mount the seasons systems due to the amount of space taken up by essential electronics typically leaving teams with not enough space for every system that they can use to make a better robot. Overall the Chassis is designed with the tight time frame to design test and make parts work in FRC, the chassis is meant to allow teams to come up with the most that they can and have more time to spend on that season specifically

Future Work

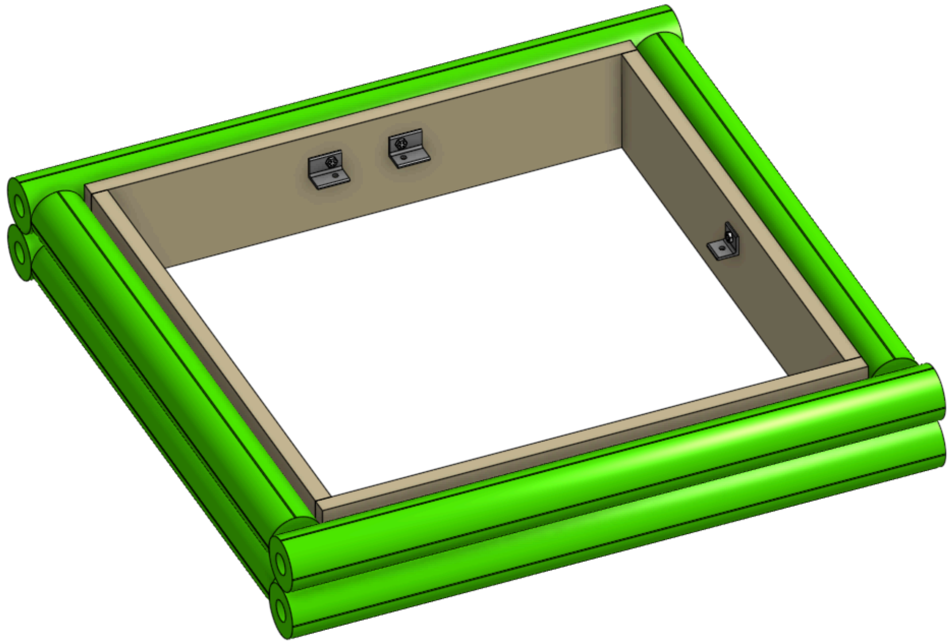
In the future finding a better way to store the battery in the robot, something that is secure and easy to change batteries.



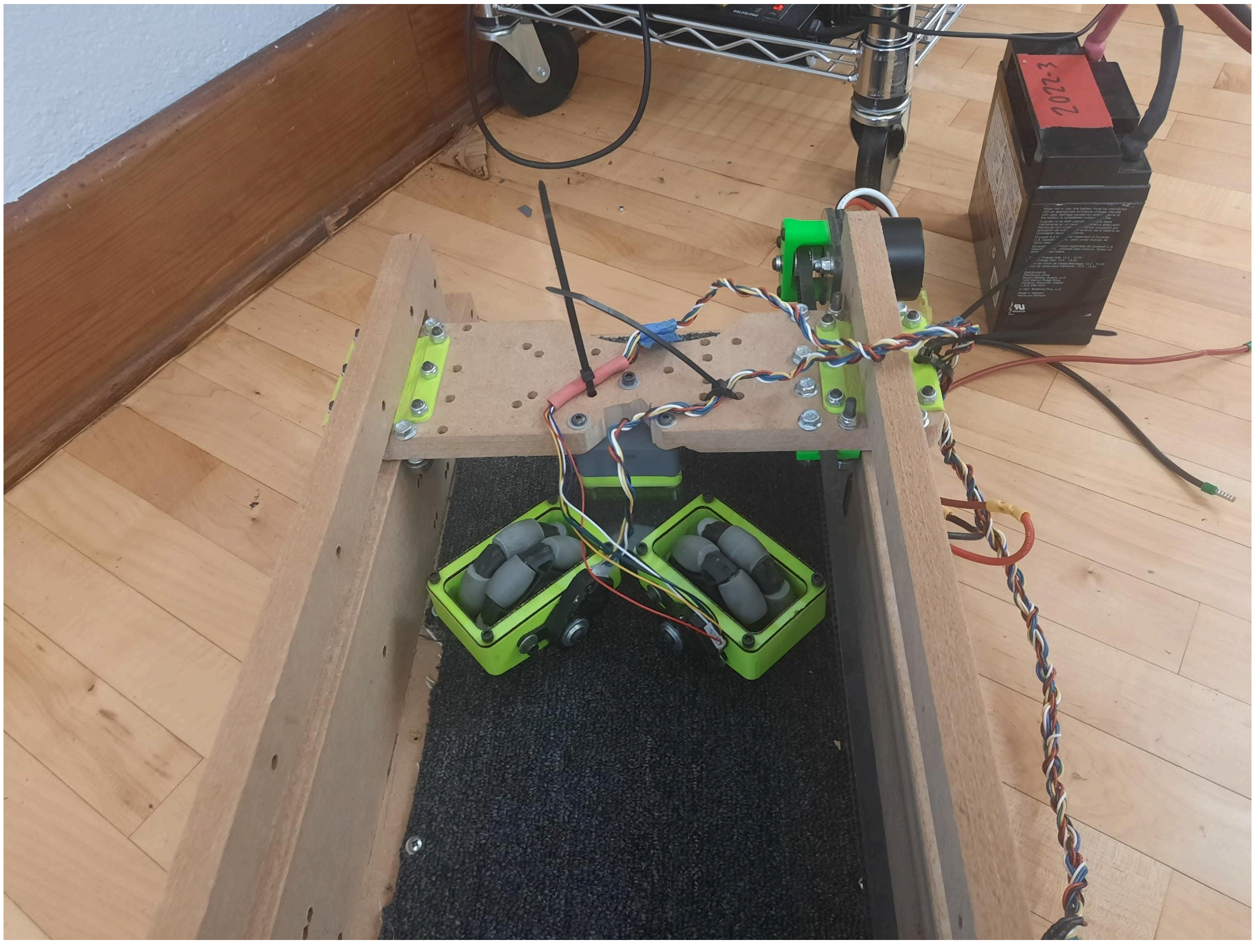
More and more accurate battery testing is one of our goals, the current battery tester is not entirely accurate to real life, however we would like to do some more accurate testing later on.



Better bumper attachment is one of the biggest, we would like to reduce the necessary accuracy when making bumper brackets as well as decreasing the time to change bumpers.



There is reason to also continue working on and testing our odometry pods to make them more accurate and durable with our odometry pod test rig as well.



Acknowledgments

Give kudos to any teams that may have inspired certain design choices.

Tell everyone how smart and handsome Tyler is.

-1986 Team Titanium 2017 Robot inspired the use of polycarb as a spring for the Odometry.

References

*Give reference to any documentation or publications you used for technical info.