Team Igutech

6964

Engineering Portfolio

Game Strategy

Autonomous

- We always challenge ourselves to get the maximum number of points realistically possible in autonomous
- The inaccuracy of powershots made us prioritize high goal autonomous shots
- We aim for the maximum number of rings in the high goal (relative to the starter stack), both wobble goals, and a robot park

Driver Controlled Period

- Since high goal shots are worth the most points, we try to maximize the amount of 3 ring cycles into the high goal during Tele-Op
- Our robot design revolves around minimizing cycle time to maximize the number of cycles
- During End Game, the first thing we do is intake rings and collect the wobble goals. We then shoot power shots using collected rings
- With the remaining time, we either go for more high goal cycles or hit any missed powershots

Design Process

Prototyping

- Create rudimentary prototypes that are fast and effective for the main mechanism that is highly adaptable (shooter, indexer, etc.)
- CAD a more permanent solution that adapts with other prototyped mechanisms

CAD

- Model full mechanisms and integrate them with other mechanisms

Testing and Rebuild

- Test built mechanisms as soon as possible and redesign where necessary.

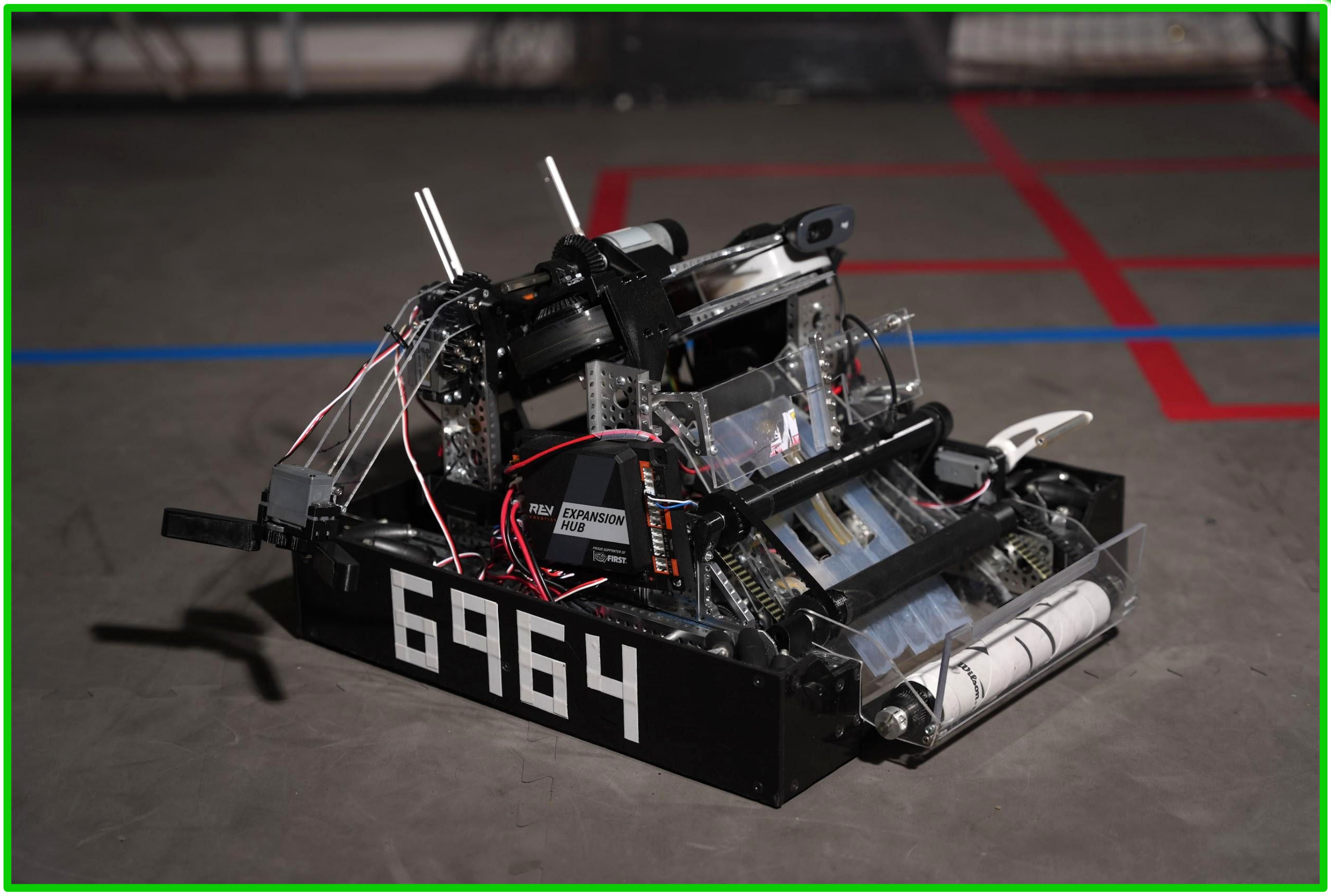
Auxiliary Mechanisms

- After the main mechanism enters the design freeze point, focus on getting end-game mechanisms ready. This includes the intake deployment and wobble goal mechanisms.

Software Development

- Using Git for version control
- Whenever we test new features, we use a branch which creates a copy of our current code. This allows us to modify and test while being able to revert to old code quickly
- When we are satisfied with the new feature, we can merge it back with the old code.

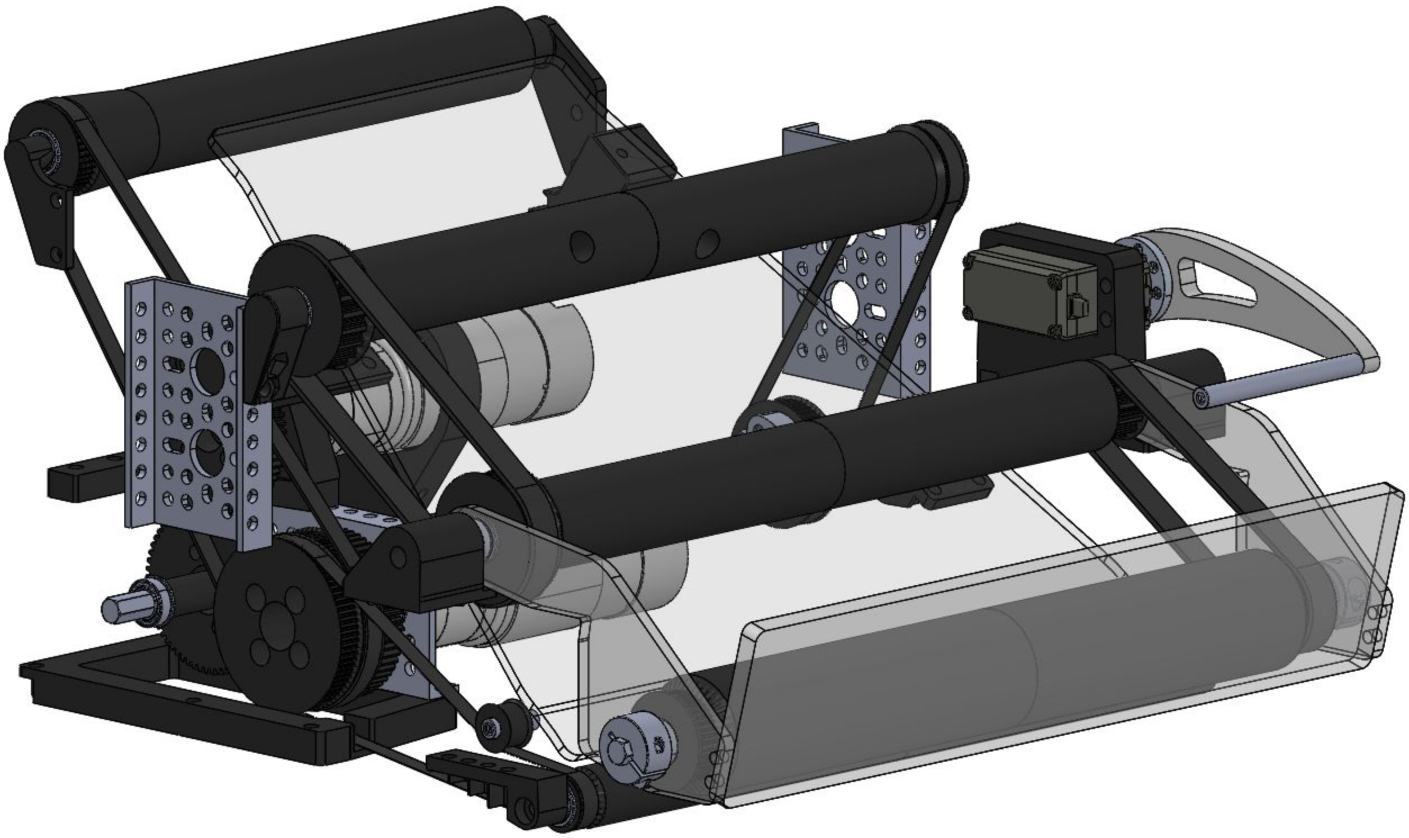
Robot Design - I



- Strong 3D-printed and aluminum channel construction
- Custom designed in Solidworks
- 3D printed dycem rollers on intake
- Two-motor intake for faster speeds
- 1000RPM intake rollers
- Linkage lifted bucket for indexer
- Compliant flywheel shooter for consistent shots
- High speed 16:1 Drivetrain (6.5ft/s)
- Geared wobble goal arm for high torque
- Highly accurate odometry localization
- Over 200 3D-printed parts

Robot Design - II

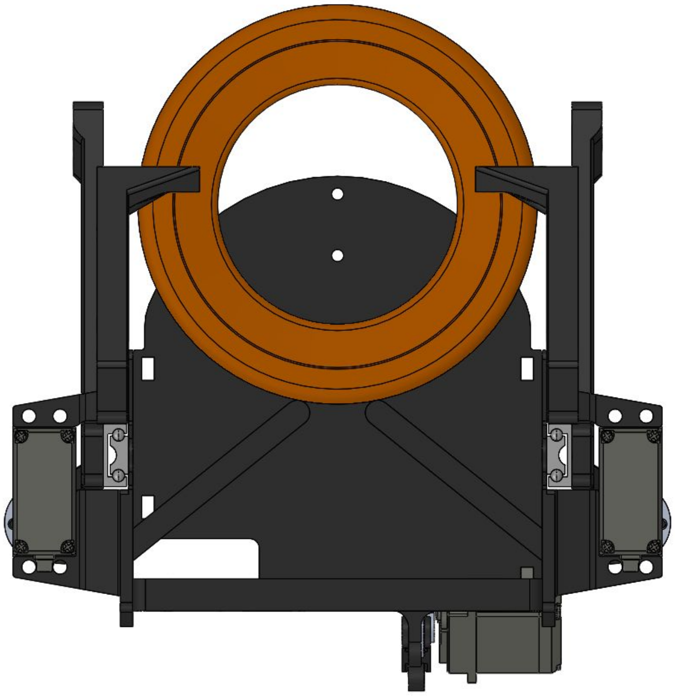
Intake



- Servo deployment in autonomous
- 3D printed dycem rollers on intake
- Two-motor intake for faster speeds (1000RPM)
- 52in/s tangential velocity
- 264mm (10.4in) wide
- Front polycarb plate is angled to tip over rolling rings
- Bottom roller lifts rings off the ground
- Small bottom roller diameter (18mm, 0.71in) increases effectiveness
- Top back roller loads rings into indexing bucket
- Surgical tubing assists the top back roller with loading

Robot Design - III

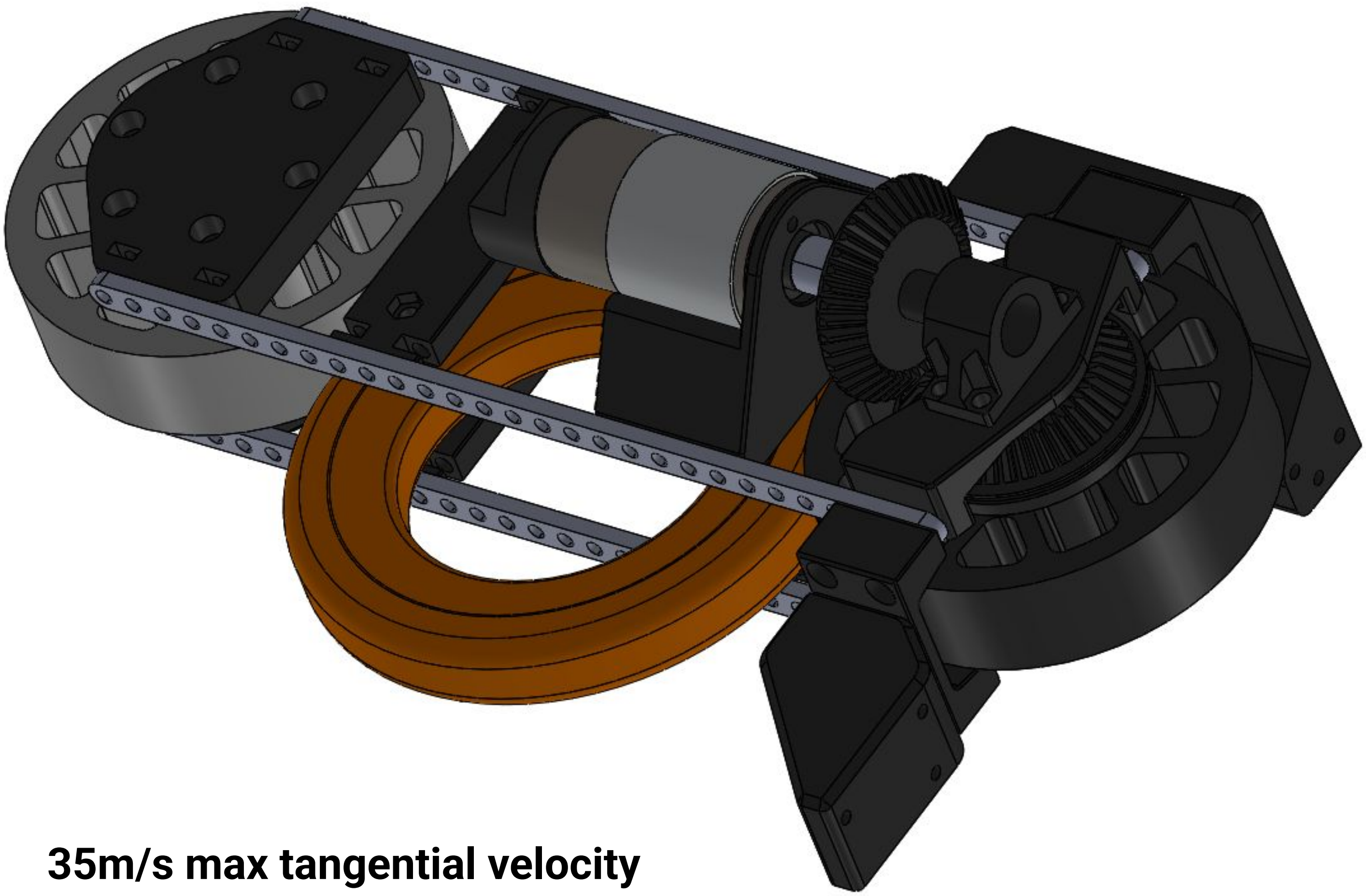
Indexer



- Linkage driven lift
- 0.25s to ring shooting position
- 0.3s for a three ring burst shot
- Lift angle matches with shooter angle for consistent shooter loading
- Two high speed servos push rings in for increased consistency
- 3D-printed plate construction increases subassembly rigidity

Robot Design - IV

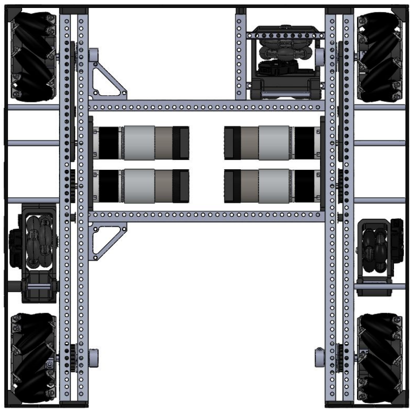
Shooter



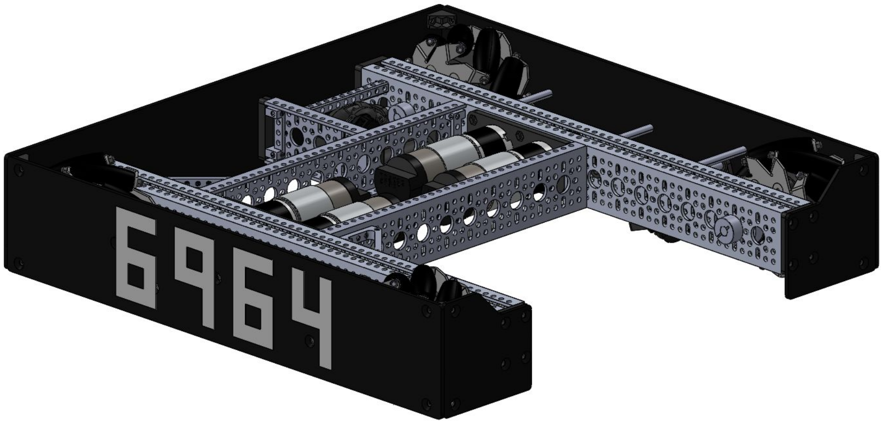
- 35m/s max tangential velocity
- 1:1 gear ratio
- Aluminum crossbars increase rigidity and consistency
- Grippy compliant static wheel increases spin consistency
- Motor driven wheel expands and increases sideways consistency
- >95% high goal shot accuracy

Robot Design - V

Drivetrain

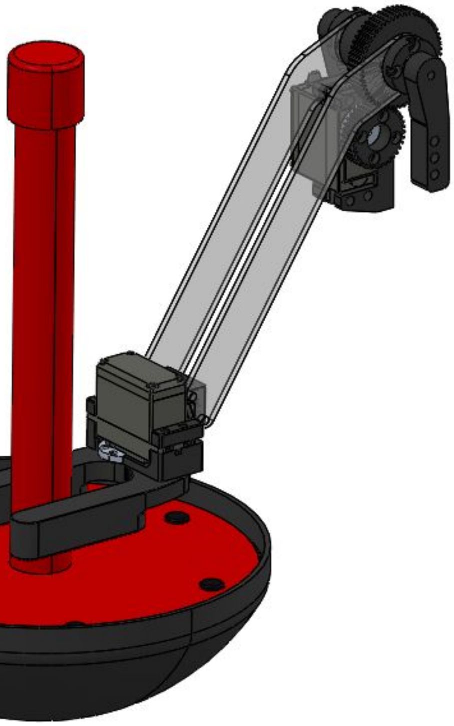


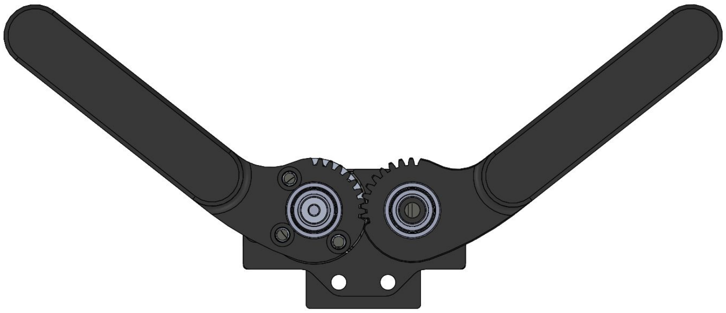
- Maneuverable mecanum drivetrain
- High speed 16:1 drivetrain
- Strong and light aluminum construction
- High strength HTD5 belts



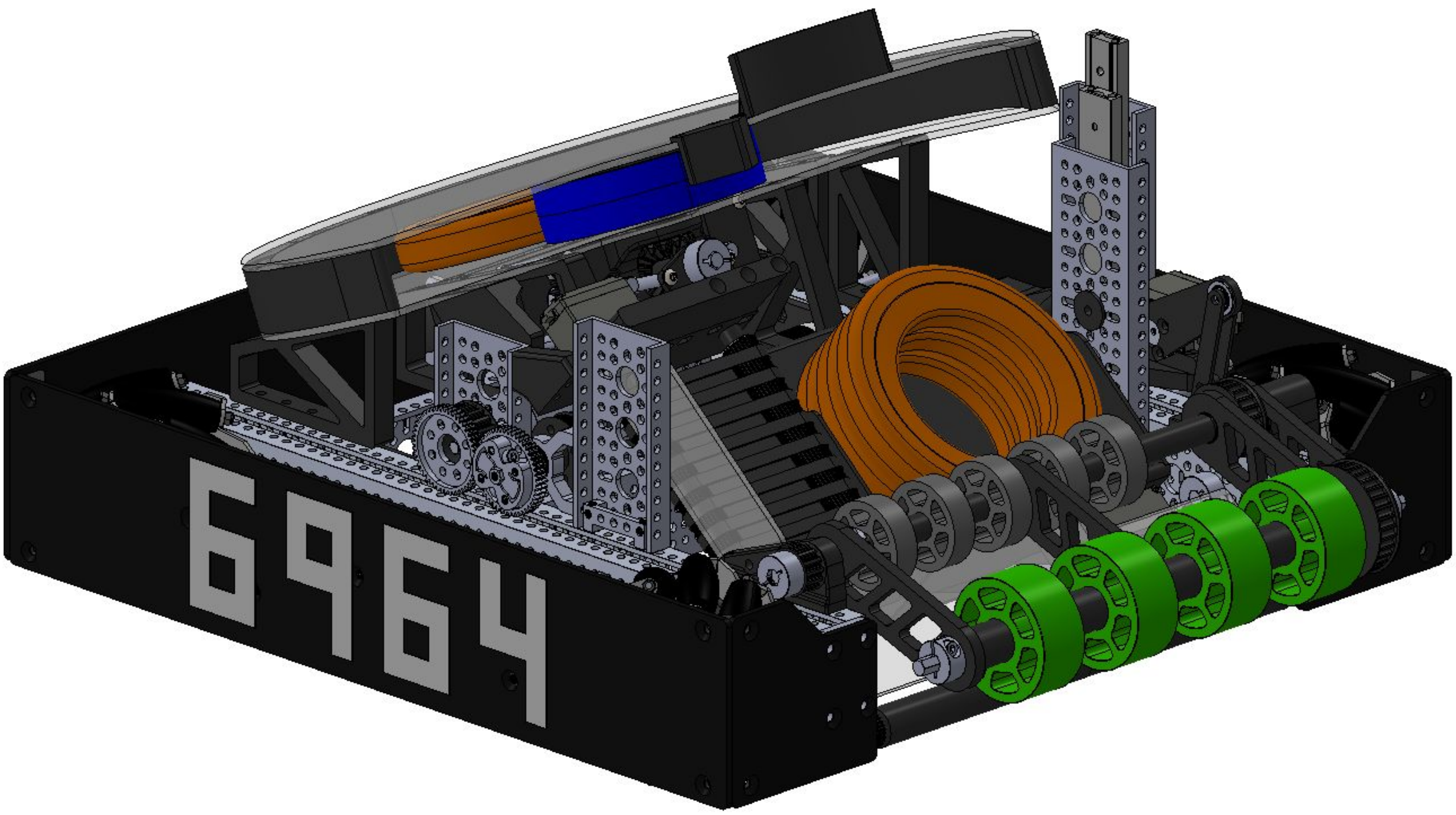
Wobble Goal Arm

- High torque rotation arm
- Geared gripper for wide collection angle
- Polycarb arms prevent damage from high-force impacts

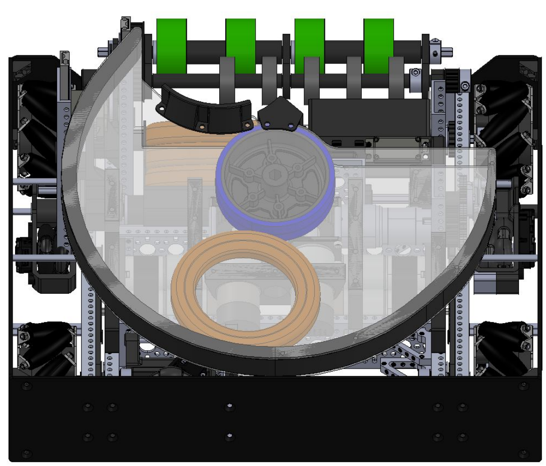




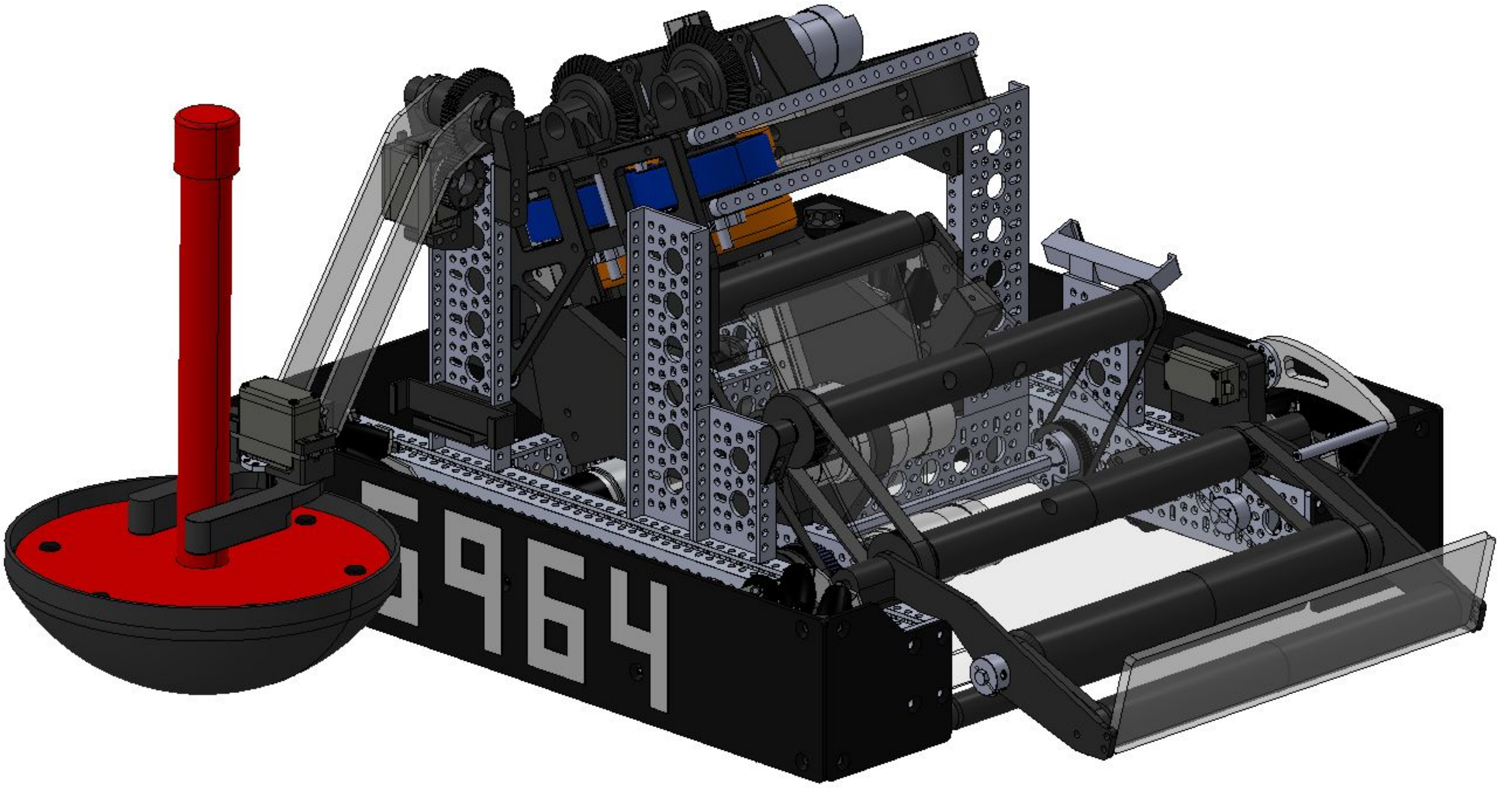
V1 Robot



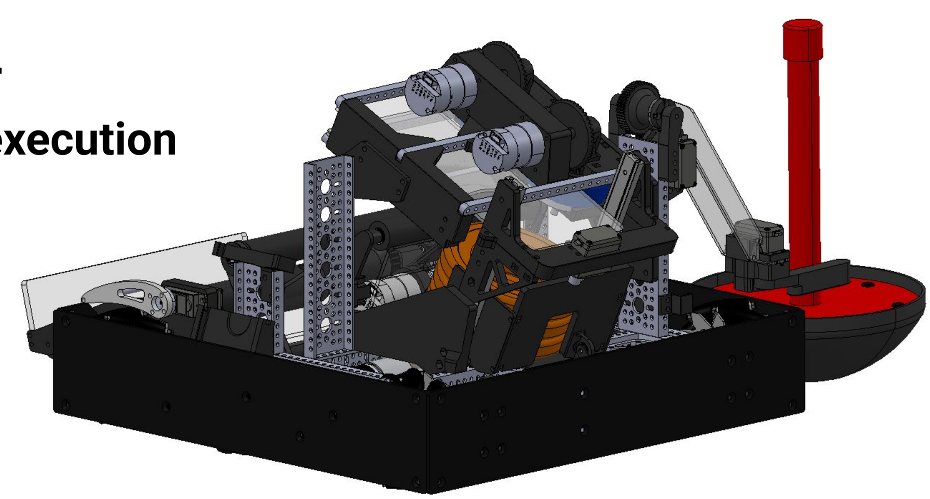
- Highly accurate 180° central wheel shooter
- High friction intake
- Intake path susceptible to jams
- Slow and unreliable indexer
- Simple design, complicated execution



V2 Robot

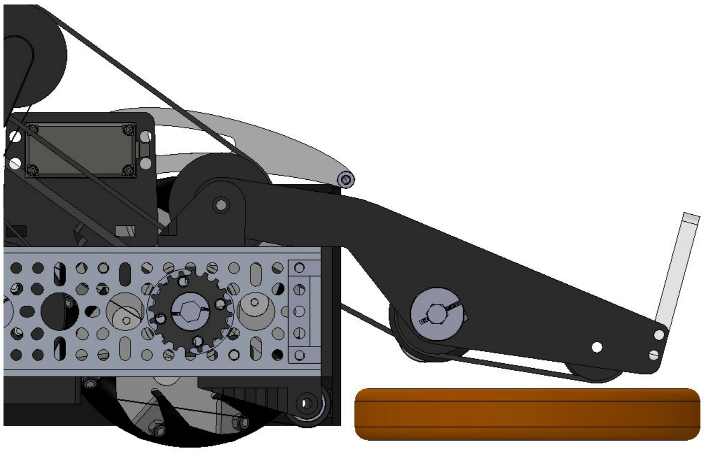


- Dual flywheel linear shooter
- Dual Motor 1000RPM intake rollers
- Intake easily breakable
- Moderately fast indexer
- Simple design, simple execution
- Easily serviceable



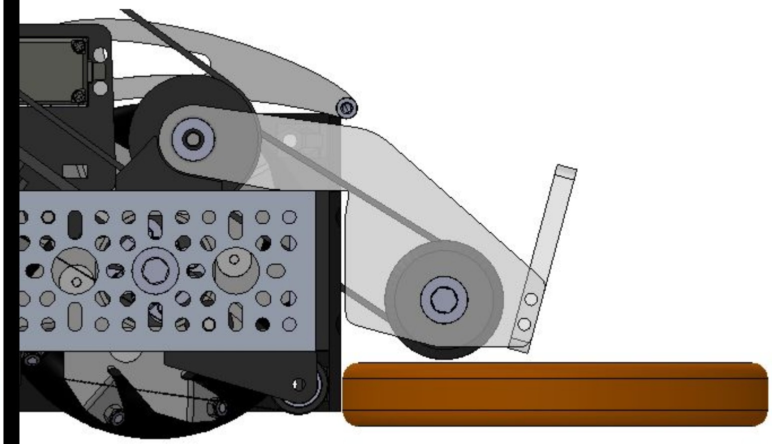
Intake Iterations

Old

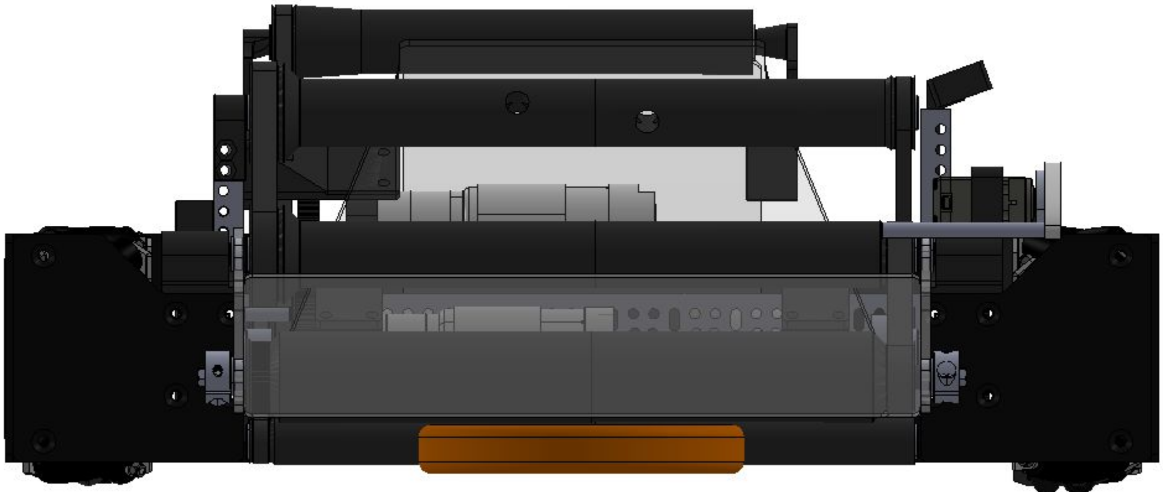


- All impact forces directed to arms and mount points
- Thin 3D-printed arms snap easily
- Very fragile
- Difficult to drive

New

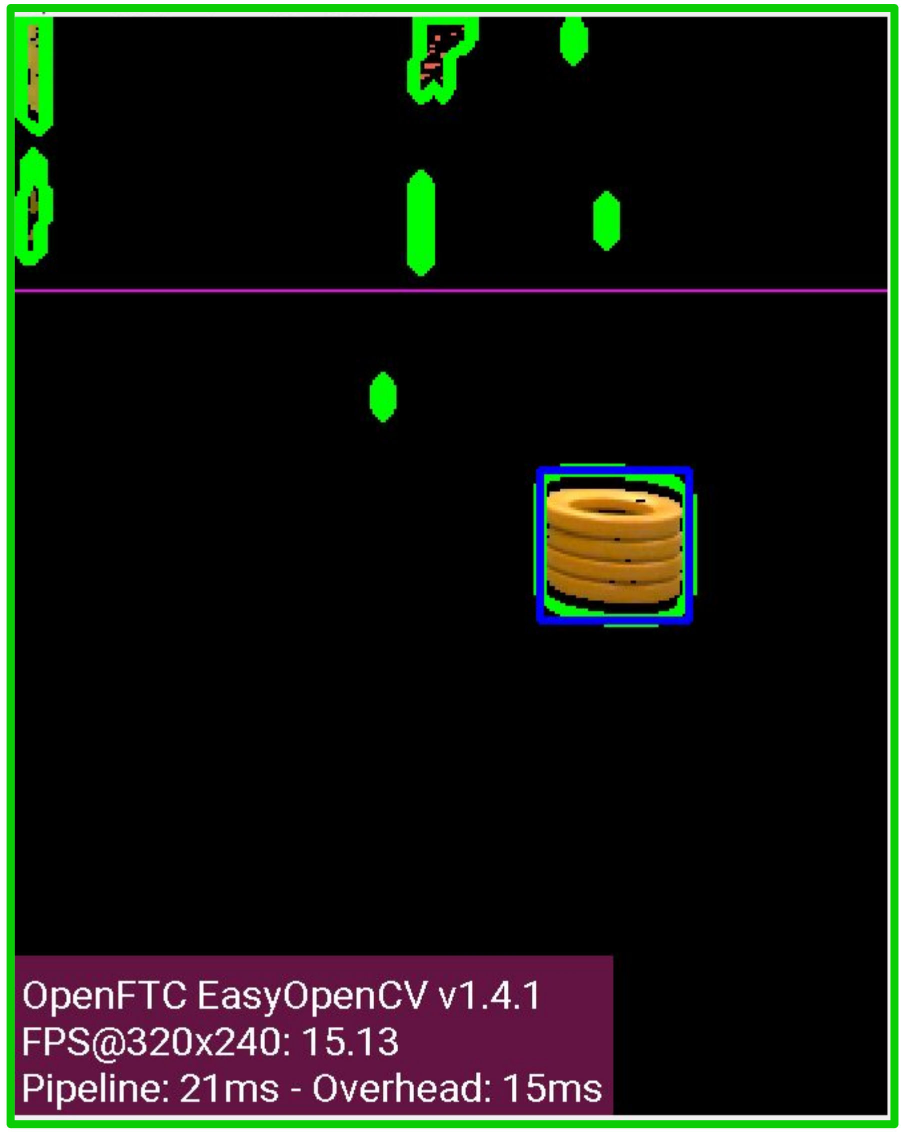


- All impact forces directed to drivetrain rail
- Easier to drive
- Faster Cycle times
- Increased strength with polycarbonate construction



Ring Stack Detection

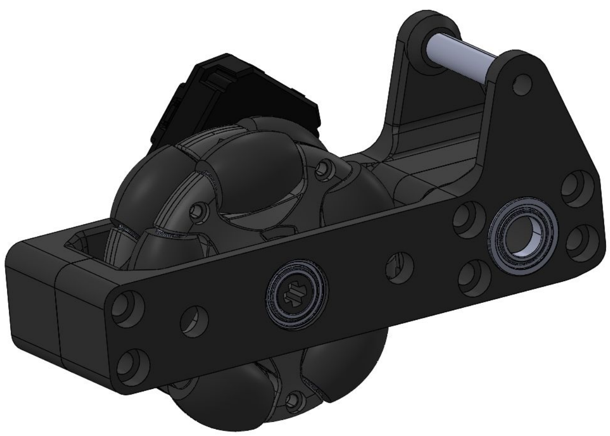
- Custom Opencv Pipeline base used on contours for detection
- Highly resistant to light differences from using YCBCR color space to filter instead of RGB
- Reliable as the shape of the ring stack never changes
- Easy to set up
- Functional as long as the ring stack is visible



Odometry with Motion Profiling

By tracking the velocity of our three deadwheels, we can easily integrate the velocity to receive information on our position. Doing this allows us to track the position, and heading of the robot. Because they are unpowered, the wheels will track any collision or slip. We correct this error with a PID controller. Using a motion profiling library, we can create complex path following and generation while maintaining an accurate control of our velocity and acceleration. This enables us to have a smooth and precise path following capabilities.

$$\begin{bmatrix} \frac{dx_{t+1}}{dt} \\ \frac{dy_{t+1}}{dt} \\ \frac{d\theta_{t+1}}{dt} \end{bmatrix} = \begin{bmatrix} cos(\theta) & -sin(\theta) & 0 \\ sin(\theta) & cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{dx_t}{dt} \\ \frac{dy_t}{dt} \\ \frac{d\theta_t}{dt} \end{bmatrix}$$

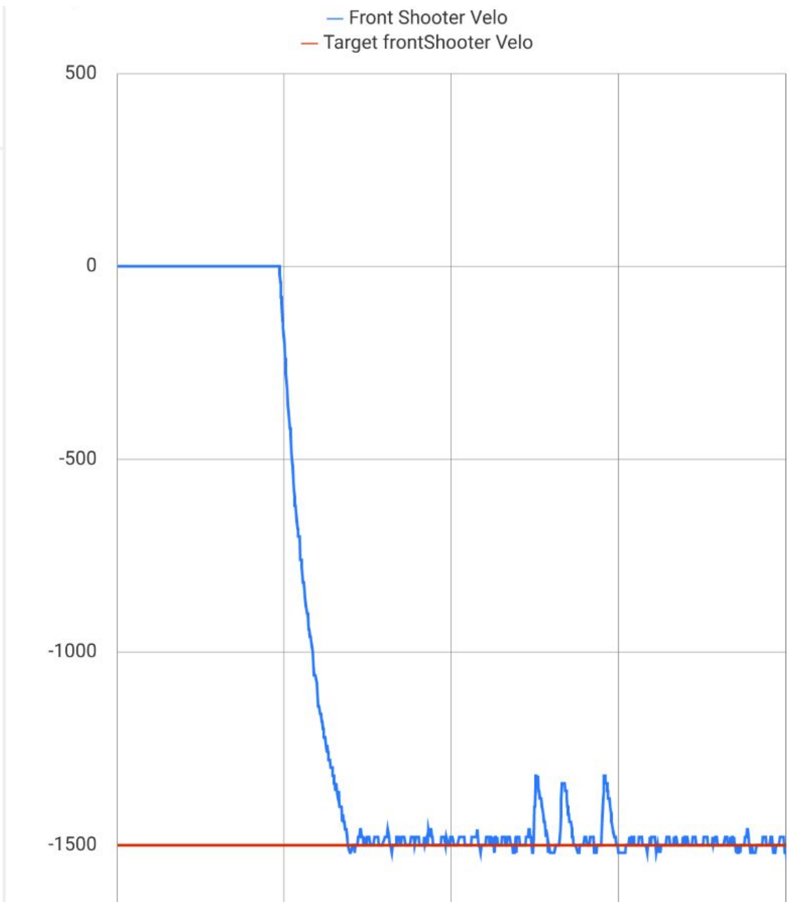


Teleop Shooter Line Up

Lining up to shoot into the high goal is the most time consuming part of our cycles. To combat this, we use our highly accurate odometry localization and motion profiling systems to drive to the shooting position and point towards the high goal. This significantly decreases our cycle time and increases our potential scores. During the course of the two minute teleop period, the localization system drifts. To correct for this, the driver can manually line up and reset the localization position.

Custom Tuned PID Controller

We implemented a custom PID controller to maintain velocity of our shooter. This allow us to get great accuracy without a consistent battery voltage. This gives us an added benefit of faster recovery time between shots compared to a conventional raw motor power controller.



Automation

More automation was required this year due to our driving situation. We implemented a system that uses two button presses to shoot 3 rings and reset back to an intaking position. This makes it very easy for our drivers to focus on intake pathing and increasing cycle times.

Finite State Machine

Our autonomous is build around a finite state machine. Every action is known as a **state.** An example of a state is moving to the ring stack, shooting, etc. Every state then has a follow up state that they enter once they finish. This creates a chain of states. For example, once the shooting state is done, the code transitions into the wobble transportation state. What this design allow us to do is quickly change the flow of code execution and reduce code duplication. We can effectively shoot 3 rings multiple times by referring back to the shooting state. This makes debugging code so much quicker which allows for better autonomous programs.

Outreach

FTC-LIB

Many teams often lack mentors to teach programming. There is a big scarcity on programming resources specifically for FTC. We created a library with a couple of teams to combat this issue, https://ftclib.org/ . It includes everything needed to program in FTC. The library is extremely flexible for both rookie and experienced programmers. We have premade systems for teams to build upon with clear documentation for ease of use. We hope FTCLib can be the FTC equivalent of WPILib from FRC. There have been over 2500 downloads of the library this year.

COVID PPE

Early in the pandemic there was a shortage of PPE for local firefighters and hospitals. We 3D-printed over 150 face shields and over 200 ear savers for the local hospital and fire station.

Caravan CAD Challenge

We co-hosted a summer CADathon along with teams 3658 and 6832 and designed a fictitious FTC game for teams to CAD a robot for. We had 29 teams compete in our first year.

Other

We have helped many teams this season with various things such as CAD and software. We are thrilled to have a positive impact in the local FTC community.

Business Plan

Mission Statement

Our mission is to inspire young people's interest in a science and engineering career by engaging them in exciting mentor-based programs that build science and technology skills, foster teamwork, enhance self-confidence, and teach other life skills like problem solving, creativity, communication and leadership.

Our Services

Igutech Inc. is a volunteer-based organization that offers mentor based programs in the field of science, technology, and engineering. The programs are meant to go beyond the scope of the STEM education offered in public schools and allow children to unleash their creative engineering potential in a challenging yet fun environment.

Igutech Inc. encourages middle and high school students to join teams that participate in national science and engineering challenges and competitions. The goal of these programs is to stimulate the children's curiosity and train them to work creatively and efficiently as a team to solve tough engineering problems as well as develop social awareness for real-life problems in their community. These goals are accomplished by participating in non-profit science & engineering programs like the ones offered by the FIRST organization, based in Manchester, NH. All teams are mentored by volunteer coaches, parents and subject matter experts that teach engineering principles while increasing the participant's self-confidence, deepen their science knowledge and building life skills.

One key aspect of Igutech Inc. is to allow all participants to develop responsibility toward a self-motivated ownership of progress and achievements. Coaches and mentors are always present to provide a safe environment and to offer guidance, however, the children are encouraged to actively participate in all aspects of project management of the programs. This way, all participants can develop leadership, practice their communication and presentation skills, and become proficient self-motivated team leaders toward a successful engineering career.

Igutech Inc. offers in-depth technical programs in the field of robotics. Best-engineering practices, mechanical design skills as well as computer programming are taught in small team settings. To motivate young people to give their best, Igutech teams participate in challenging national science and engineering competitions.

Sponsorship

We are registered as non-profit organization in the State of Pennsylvania with the federal tax-exempt status 501(c)3. All donations are tax-deductible by law.