FTC 2017-2018 Engineering Notebook
Team MazeMasters

Team Background:

We started our FTC journey in 2015 as sophomores in high school. We are a group of 7 high school seniors who love to build things, program algorithms, and have fun together. The goal of our team is to truly enjoy the process of building a robot, and as such, we are a completely student run team (in terms of robot construction). Of course, we owe lots of thanks to Mr.Oyama, our coach, who manages our funding/budget. However, we, as students, are the ones who apply for grants, construct the robot, and conduct outreach.

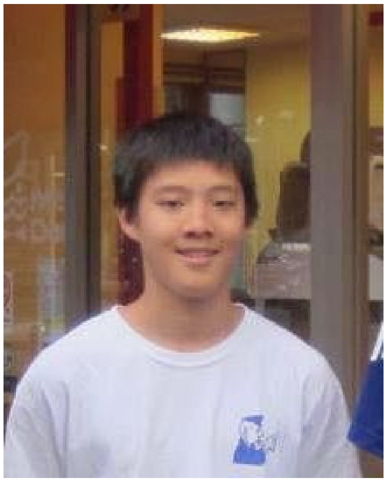
This year, we were able to reuse many of our parts and also continue to use our Lockheed Martin grant (which we received last year) of 2500 dollars to fund our efforts. Unfortunately, we exhausted our grant money this year, and we have been heavily reliant on using school resources which our Robotics teacher was generous enough to supply us with. Moreover, we used custom laser-cutted and 3D-printed parts extensively this year, compared to our previous year robots. This is a major part of what makes our team unique, since approximately we have manufactured about 70% of our robot's design by ourselves. As a result, we have not had to pay for expensive systems that come pre-manufactured (aluminum channels, gears, etc).

While our meetings are only 6-hours on the weekends, we pour our heart and soul into the robot. You'll find each and every member of our team working on a CAD file throughout the week or 3D-printing pieces for the robot in the morning or during lunch. As a result, each team-member works an average of 3 hours outside of team meetings.

Even after our third year, our planning skills are still not perfect. We still make mistakes and experience setbacks. We don't have access to members who are able to tell us the ideal approach for problems, but that's how we like it. We love to make mistakes ourselves, and fix them by ourselves. It's hard to learn why something doesn't work until it actually happens, and we have truly improved ourselves as engineers.

Yuki Oyama

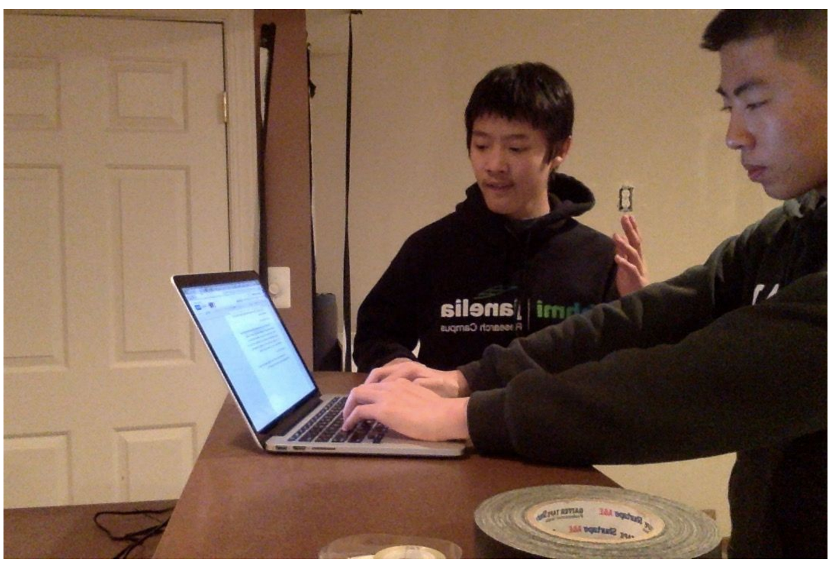
Leader, Builder



PASSION FOR ROBOTICS…

Robots are cool. I remember feeling like a child on Christmas morning when my parents bought a Roomba cleaning robot…

Until FTC, I had never truly explored the field of robotics. I'd competed in FLL with NXT legos, and maybe I had dabbled with a few basic arduino functions, but I had never made an advanced multi-functional robot with arms and other "ligaments".



Forming the Team…

I'm not the most outspoken person, so I didn't feel initial confidence in my leadership skills.

In addition, I didn't feel initially qualified. I didn't think I knew nearly enough about robotics to lead an FTC team.

Still, I knew I wanted to compete in this extraordinary competition, so I stepped up to the challenge. I was banking on my work ethic and drive. The best part was, I was lucky enough to have understanding teammates who helped me throughout the process.

Things I Learned…

PROBLEM SOLVING…

Maybe I thought I was good at it, but I got even better at it in FTC. I remember the first, classic, and somewhat stressful problem my team encountered.

Every time we turned on our robot, after a few minutes, we would hear a ***POP***.

At first, we almost had a panic attack. We hoped in vain that it was the battery, but unfortunately we found out something was wrong with the core power module.

Checking the price of the module was not reassuring. We began looking for clues for a fix, and eventually we realized that the fuse was blown. Personally, I hadn't even realized that there was a fuse in the power controller, but taking it out of the module, I was relieved it was indeed a blown fuse.

TEAM ORGANIZATION:

It's hard to keep a team working with 7 High Schoolers crowding a basement.

Division of labor is, in my opinion, the biggest decision a leader has to make.

Having everybody do things that complement their skills and interests is the most efficient way of getting work done.

Niki Subramaniam

The motivator

Background:

I am currently a 17 year old twelfth grader at Thomas Jefferson High School. I enjoy reading, playing video games and watching Food Network and Masterchef. I am interested in STEM subjects such as programming, computer hardware, electronics, and robotics.

Experience:

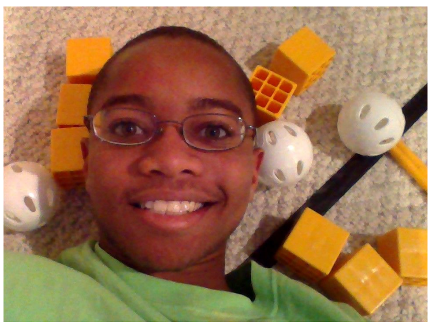
This was my third year at FTC and I had a blast. It was very fun to go through the process of designing, cadding, building, programming, and testing the robot. This year I learned a lot about teamwork as I had to lead some meetings. I learned how to make sure everyone was on task to keep up with our schedule. I also learned more about robot design and spacing. Last year we didn't use much space for our robot, but this year our robot is close to the size limit. We had to find interesting ways to make everything under the size limit, but still function properly.

What I learned: Troubleshooting is the hardest part of building a robot.

Throughout the building process, we had many problems with our robot and went through many designs. With our shooter, we redid it because it took too much space. Even after we redid it, it had to undergo many iterations to shoot correctly. Another part of the robot we constantly changed and played with was the collection system. We had to keep changing it to make sure it was rigid enough to collect balls, but not to hard that it wasn't flexible.

Antioch Sanders

Builder



Joining MazeMasters

When team leader Yuki Oyama first introduced me to FTC, and shortly after I joined FTC team MazeMasters. I was intrigued by the idea of being able to use problem solving skills to help integrate hardware, programming, and design to create a working robot.

Experience

There's a lot that I've learned from FTC. One big thing is that I've learned more about the process of working in a team. At first, I thought having ten people on a team might be too much. In earlier, less-organized meetings, this proved true. Without organization, it's hard for everyone to find their niche working with lots of others on the same thing. However as the team got to know each other, this changed.

The physical building aspect of FTC has also taught me a lot about robotics, and I've been able to apply past experiences. Here's an example. A LOT of wires can go into building a robot. In the analog electronics class I've taken, I learned how important managing wires is. Unorganized wires make making changes to an existing system more difficult, and may lead to unintentionally damaging a connection. In electronics, this can interfere with an electrical signal. In robotics, there's the added risk of a servo or motor wire actually getting caught in a motor, which can break the wire or stress the motor.

Sarkis Ter Martirosyan

Programmer

Background

Ever since elementary school, I had a deep rooted interest in robotics. I first began working with the Lego NXT when I was in 5th grade. During middle school, I did many science projects based on quantitative analysis of various sensors and incorporating those sensors into working autonomous code. In high school, I shifted my interests more towards microelectronics (analog and digital) and computer science. IU participated in the USA Computing Olympiad (USACO) as well as the American Computer Science League (ACSL). I was able to represent my school's Intermediate Computer Team at the National ACSL All-Star contest in New Hampshire. At a fundamental level, the field of robotics is a symbiotic mix of CS, Electronics, and Mechanical Engineering. The FIRST Tech Challenge offers me a unique opportunity to mix these disciplines to create a truly amazing robot.

Role and Responsibilities

Computer Aided Design (CAD)

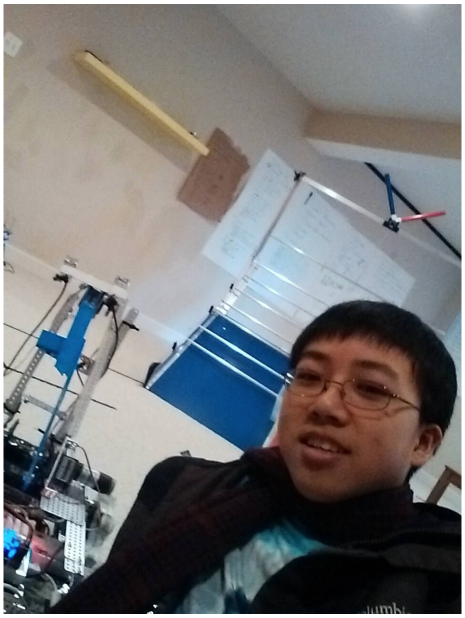
As a member of the team, my responsibilities included creating CADs for 3D-prints and laser cuts. In my capacity as Vice-Captain, I chose to use OnShape as our CAD platform. OnShape is akin to a simplified version of SolidWorks, but able to run entirely in a browser. OnShape offers a unique degree of flexibility, allowing multiple group members to work at once on the same design. OnShape also offers version control similar to GitHub’s, which made it an invaluable tool.

Programming

As Vice-Captain, I determined the general autonomous strategy and gave out code assignments. I also figured out how to use sensors with the Android System and the Modern Robotics Core Device Interface Module. This module allowed us to use the MR Color Sensor and Optical Distance Sensor as well as 3rd party sensors such as the Sharp Infrared Distance Sensor and the Pololu Maxbotix LV-MaxSonar-EZ1 Sonar Range Finder.

Ethan Liu

Builder



Background:

I have been interested in robotics for a long time, but finding peers with the same interest has been difficult. My interest in robotics began in fifth grade when I received a lego robotics kit. To advance my understanding in robotics in general, I read a few books about building and programming. The next year, I participated in FIRST Lego League, however I quickly realized that many people did not have the same dedication to the team that I did. I still continued FLL for three years during middle school and elementary school. The most important thing I learned from my experiences with FLL was how to work with others. I learned to develop patience with group activities because, in general, progress tended to be slower.

FTC:

FTC was the best experience I had working with robotics. I finally met some people with the same interests as me. Everyone on the team worked so hard, which I really appreciated. I felt like we really bonded as a team, whether it was eating pizza or working. When we worked during meetings, the time seemed to fly by. What I thought was the hardest part of FLL became the easiest part in FTC.

FTC was also a great learning experience for me. I worked with different materials than I was used to, and the extra weight made all the difference, especially with this year's challenge. Metal is strong, but sometimes the connections between pieces is weak because it is heavy. This makes some parts of the robot less sturdy.

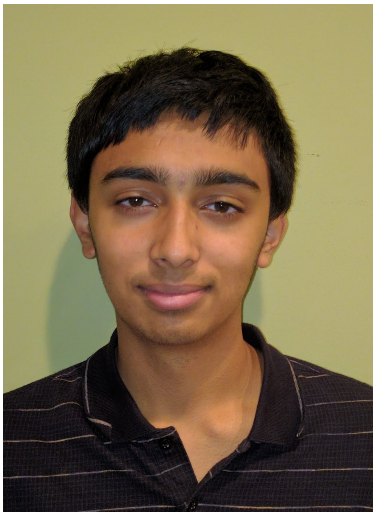
I found the challenge very thought provoking because the problems we seemed to face were mostly design issues. We had to build and rebuild due to weight and material restrictions. For example, the task of climbing the mountain and doing the pull up for our design seemed to need more than the four motor that we had access to. So we had to adapt and drive with only three motors and use the fourth motor to do the pull up.

With these material restriction, I learned to think more outside of the box. We had to use other common materials around the house because we lacked the necessary pieces. Every material has its strengths and weaknesses for the task at hand. Cardboard and duct tape are good for making sturdy shapes, but they do not have enough traction to be used as proper wheels. I learned that we need to combine various materials so that they cover each other’s weaknesses.

The biggest lesson I learned from FTC was to never expect for things to work the first time. During the process of building the robot, we constantly had to change the design. It never worked for the first time, so I learned not to be disappointed when it did not work. We just had to keep trying different ideas because in the end, we always got the robot to work right.

Mihir Patel

Head Programmer



Background:

I'm a 17 year old senior who is really into computer programming and design. Prior to FTC, I had done a lot of computer science related topics but hadn't done much into robotics. I'm really interested in real world applications of CS beyond development, and FTC has allowed me to see how this can be done.

Experience in FTC:

FTC taught me a lot about teamwork and getting things done in a much larger group. While I have worked in teams before, I've never done such a large project like this and has been a really interesting experience in seeing how the can do things together. In FTC, I've learned to be able to efficiently subdivide work and plan ahead using a schedule to accomplish things on time and keep people on track. I've also learned a lot more about the design process and how to integrate different tasks to make sure everything is consistent. Another thing that has been very important throughout this process is teamwork, which is something very important in this situation. Typically, in smaller groups I've tended to do a lot of work and taken on the bulk of the load, but in FTC due to the large variety of tasks at hand, I've had to rely on others with different skillsets and not only work hard, but work smart.

Kai Amelung

Programmer

Background:

I'm a 17 year old senior and an avid programmer who, prior to FTC, had no real experience in robotics outside of school. I love making things from scratch, and challenging myself, both of which FTC allowed me to do.

My Experience in FTC:

In FTC, with a timetable like ours, there was no possible way that we could get the robot done without some input from every member on the team. In FTC I learned more of how to rely on others to produce results, so I could be as productive as possible without worrying about other aspects of the robot. This is not to say that we all did not impact the overall design and creation of all facets of the robot, but we all believed in the fact that the other members could help bring our design to fruition. As the head programmer, sometimes had to ask other programmers to write segments of code, and continue working assuming that their code would be done on time, and as a programmer in general, I was trusted to get the robot moving after it was built, and I trusted the builders to make a robot that my code would work for. This was all so the brainchild of all of our hours of discussing design could end up working. FTC taught me a great deal about the importance of putting trust in others, and maintaining the trust others have in you, in order to work together for a common goal.

Gameplan

Autonomous

Jewel - 30 pts

Parking - 10 pts

Driver Control - **ideal**

Score Glyphs (2 every 18 seconds) total: 12 glyphs

6 seconds - Getting Glyph 1

6 seconds - Getting Glyph 2

6 seconds - Scoring

Last 10 Seconds - Park on balancing Beam - 20

Driver Control - **realistic with lots of practice**

Score Glyphs (2 every 24 seconds) total: 8 glyphs

8 seconds - Getting Glyph 1

8 seconds - Getting Glyph 2

8 seconds - Scoring

Last 10 Seconds - Park on balancing Beam - 20

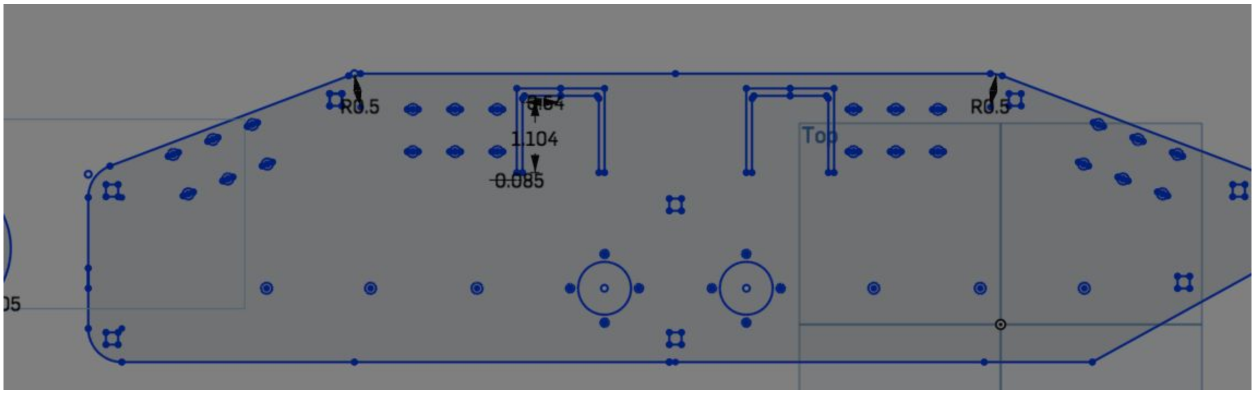
Robotic Design

Design Flow

This year when we were thinking of how to build robot, we first broke down the challenge into priorities. We determined the most important part of the challenge would be to score glyphs in the crypto box. The second priority would be to have an autonomous that could hit off the correct jewel and score the glyph in the correct column based on the pictograph. Our third priority would be to score the relic in the 3rd zone. Once we had our priorities straight, we broke each priority into robot components. We decided that we would need a chassis capable of strafing and parking on the balancing stone. We would also need a arm to score the glyphs and a way to knock off the jewel during autonomous. To determine our actual plans, we would first throw around ideas as a team. Once we had an idea, we would CAD what we needed and during school we would lasercut and 3d print components. During meetings, we would put the component together and test it out.

Chassis

We wanted to make our chassis able to easily mount and dismount the balancing stone. To do this, we had to lazercut a special piece.



The piece is raised in the front so the wheels can get onto the stone without the chassis impeding movement. We would print 4 of these pieces, a pair of pieces would be enclose the wheels and the 4 pieces would be connected using 2 C-Channels.

We decided to use mecanum wheels so the robot would be able to strafe. We wanted the robot to strafe because that would make it much easier to line up the robot when scoring glyphs. We have a 4 wheel drive that is wired for torque so that the wheels have enough force to strafe.

During the building of the chassis, we realized that the worm screws attaching the mecanum wheels to their axles would quickly loosen when the robot was being driven. To combat this, we 3D printed our own clamps.

Arm

For our arm, we had to make a fast way to score 2 glyphs at a time. We decided to score in columns instead of rows because scoring a full column is double the points of a row and the glyphs are easier to stack into columns opposed to grouping into rows.

There were three main designs that we considered to use for our block deposition system. First, we considered using a scissor lift. A scissor lift would only be able to stack one block at a time, but it would be advantageous because of its stability. In addition we would not have to deal with the jankiness/friction resulting from linear slides. Second, we considered using a wheel-based system, but this design we found would be too slow/impractical to implement. Finally, we decided to use linear slides to lift the blocks to any level. We decided to have 2 sets of claws to separately pick up the glyphs. We would use a servo to rotate between the two sets of claws. Moreover, we would be able to pick up two blocks at a time without having to stack them on top of each other. Stacking blocks perfectly is a time-consuming task, and it is much easier to have two separate grabbing mechanisms for two separate blocks.

To create our claws we used Rev Servo motors that fit into the pitsco servo mounts. We then created a plate on which the pitsco servo mounts fit onto with laser-cutted holes.

Electronics

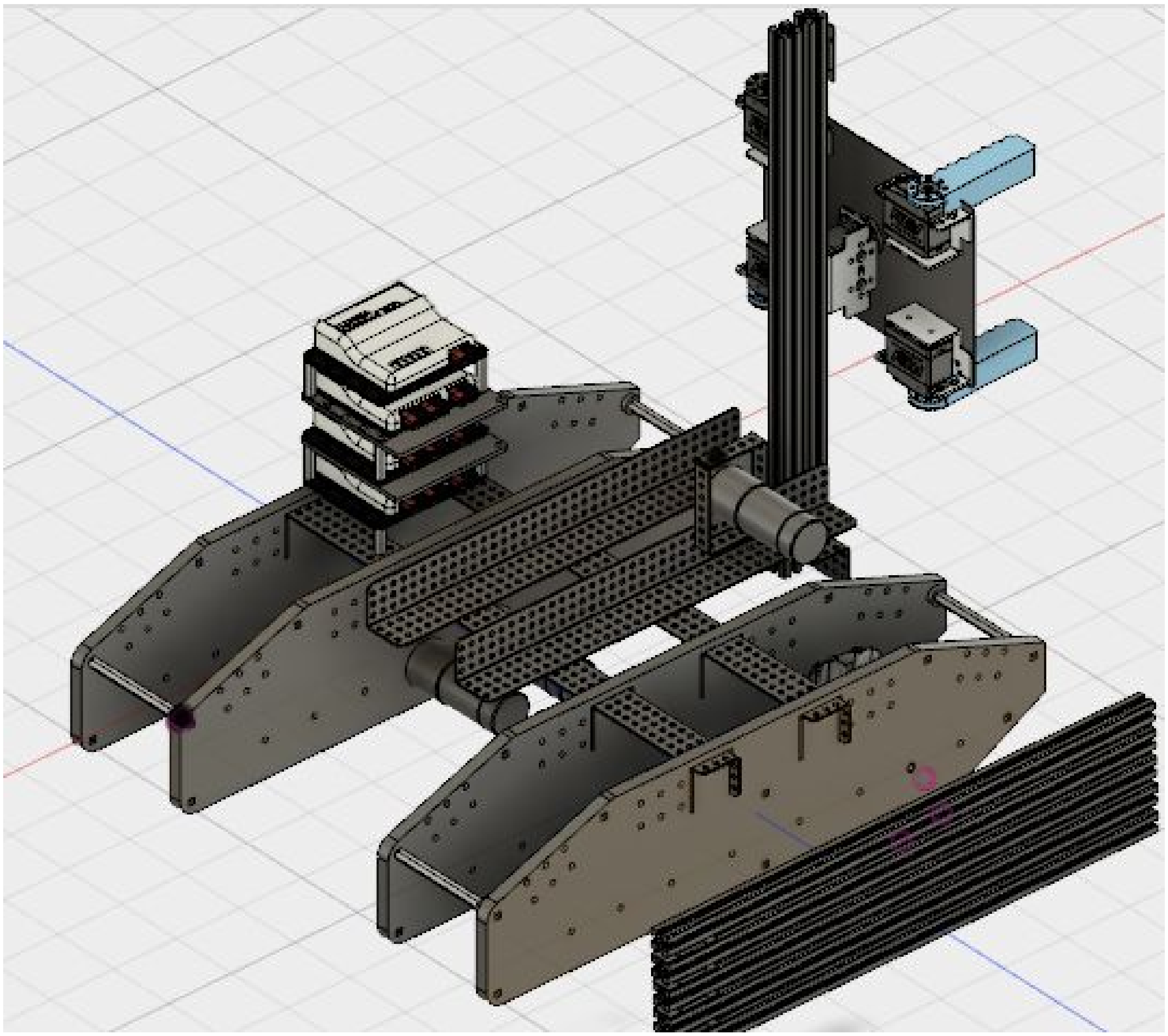
For our electronics, we used the Modern Robotics control system, with the ZTE Speed phones connected to the Core Power Distribution Module. From there, work is dished out to to the individual modules (Motor Modules, Servo Modules, a CDIM). Our robot had three Motor Modules to drive the 4 drive motors and the reel motor. The Motor Modules also have pins for encoders, which allowed us to drive to a specific distance. We used the Servo Module to drive the angular servos for the paddles, the paddle rotator, and the jewel arm. The CDIM allowed us to interface with various sensors, both Modern Robotics ones (Angular Gyroscope and Color Sensor) and 3rd party ones (Limit Switches).

Autonomous

In the scheme of things, we decided to prioritize TeleOp over Autonomous. In Autonomous, we use a PD to strafe and turn. The robot is able to knock the correct jewel off and move into the safe zone. The most technical component of our autonomous is our use of PD drive. Unfortunately, the ZTE speed is too slow to perform PID (Proportional-Integral-Derivative) reliably, so we instead went with PD (Proportional-Derivative). The formula for PD is shown below. The variables are as follows: ‘u’ is the PD compensation function, ‘θ’ is the robot’s current heading, ‘φ’ is the target heading, and ‘ω’ is the angular velocity of the robot.

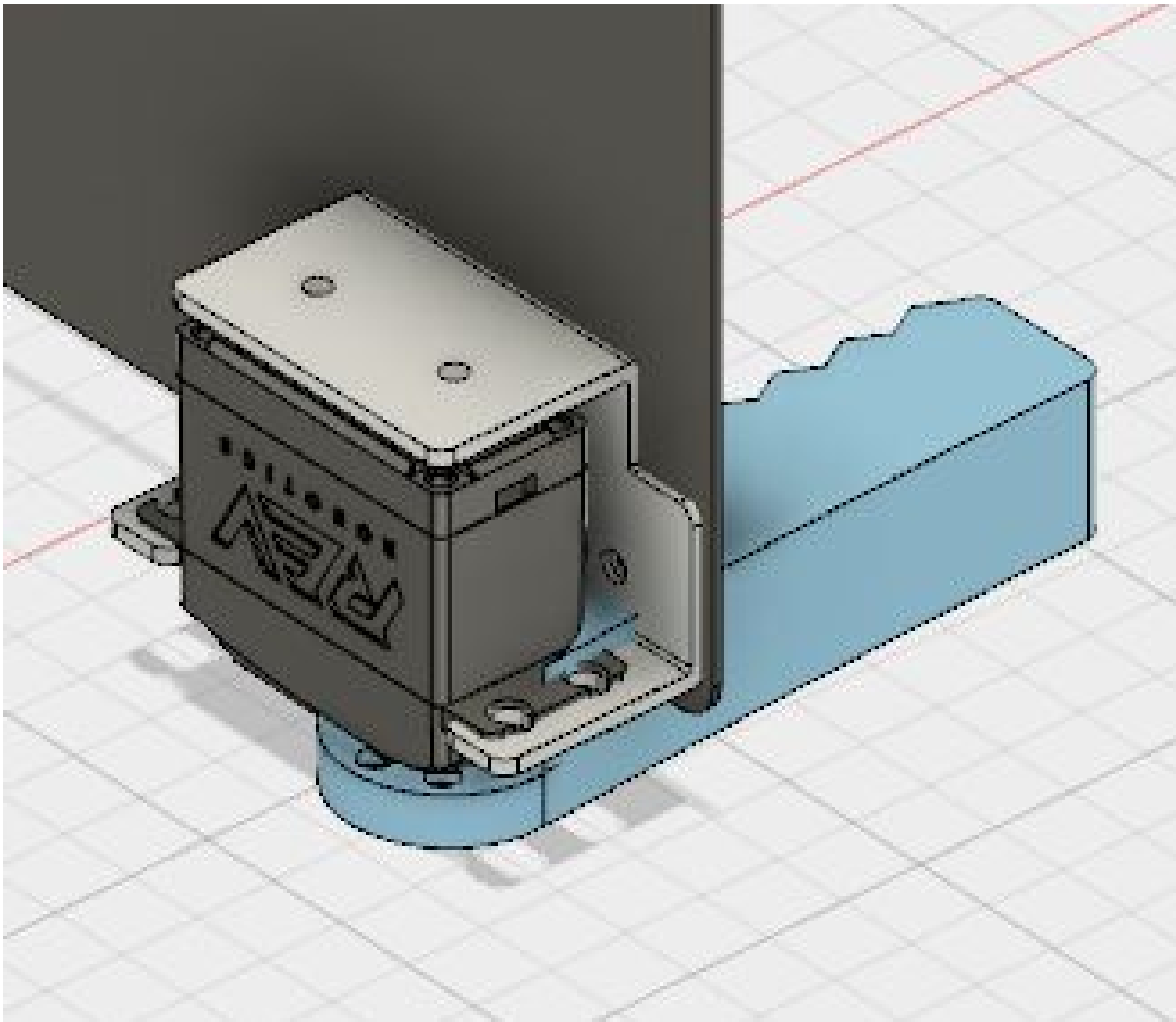
$$u_{PD}(\theta) = K_p(\theta - \varphi) + K_d(\omega)$$

Computer-Aided-Design



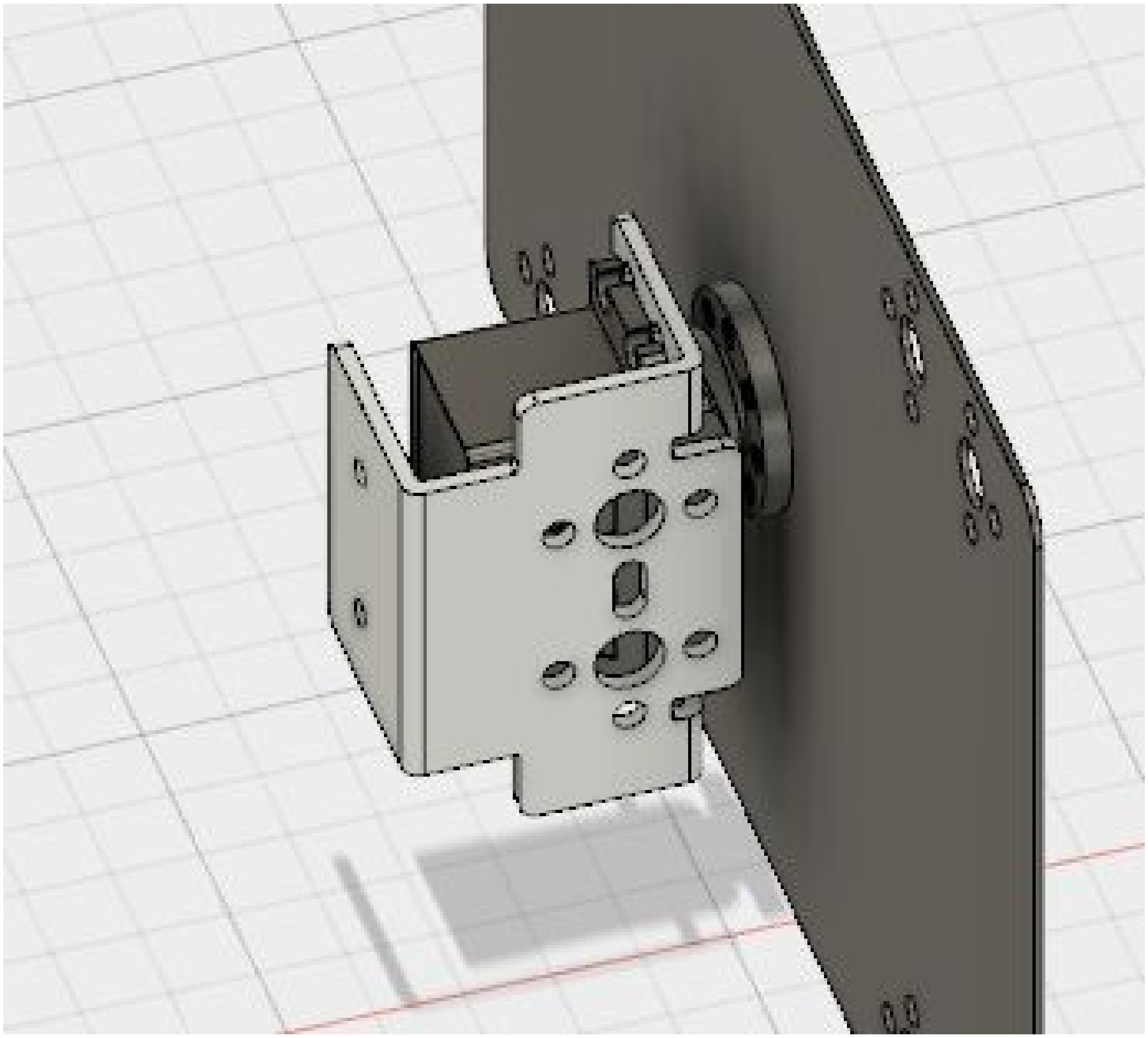
As we worked on our robot, we realized it would be wise to use computer aided design (CAD) tools to improve our workflow. Before we had used cardboard to prototype - with CAD, we could waste less materials, and prototype much more quickly. By using CAD, we would also have a list of all of our components. Thus if a part broke, it could be easily laser printed or 3D printed, and then replaced.

One of the hardest parts of using CAD was deciding what software to use. At first we used Onshape, but because Onshape is cloud based, it tends to be very slow. Thus we switched to Fusion360. Fusion360 is also cloud based, but has a desktop version, making it much more powerful



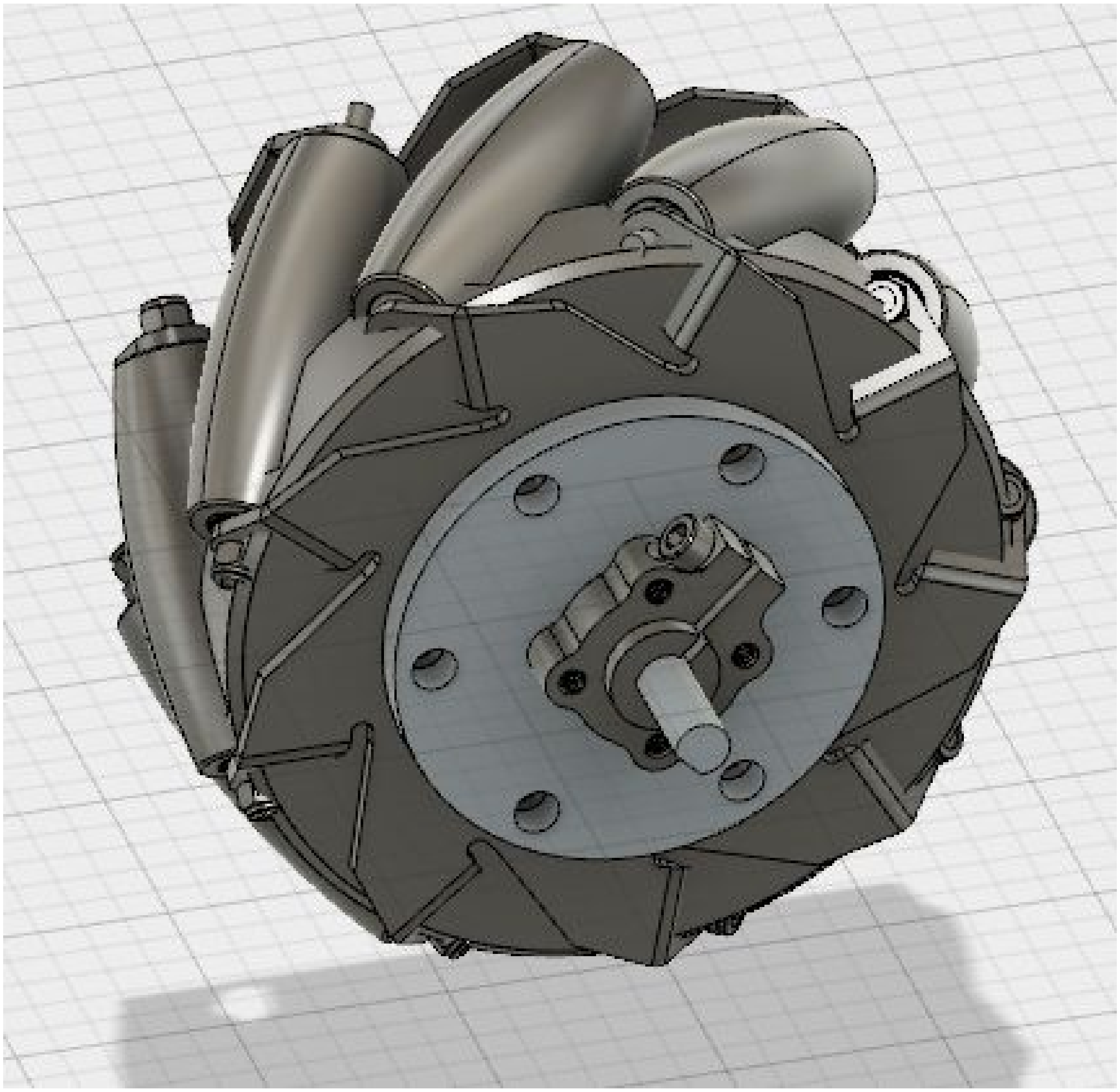
This image is part of the claw of the CAD. The claw was used to pick up the blocks. The first time we made it, it snapped, as it was too thin. Additionally, it had very little gripping strength. Thus we decided to create a CAD version, so it could be 3D printed. Thus, if it broke, it could be recreated instantly. Additionally, we added ridges, such that it was much better at gripping the blocks.

This shows some of the limitations of CAD. For one, when different objects are jointed together in Fusion 360, they can still intersect, and don't always behave as real-world objects. For prototyping however, Fusion 360 is still good, connections are usually reliable.



This shows the servo socket for our robot. This was important in ensuring the body of each servo did not undergo too much stress. Instead, the servo would only have to bear the stress of whatever they were moving. This is opposed to bearing the stress of whatever the servo was moving, and what the servo was attached to.

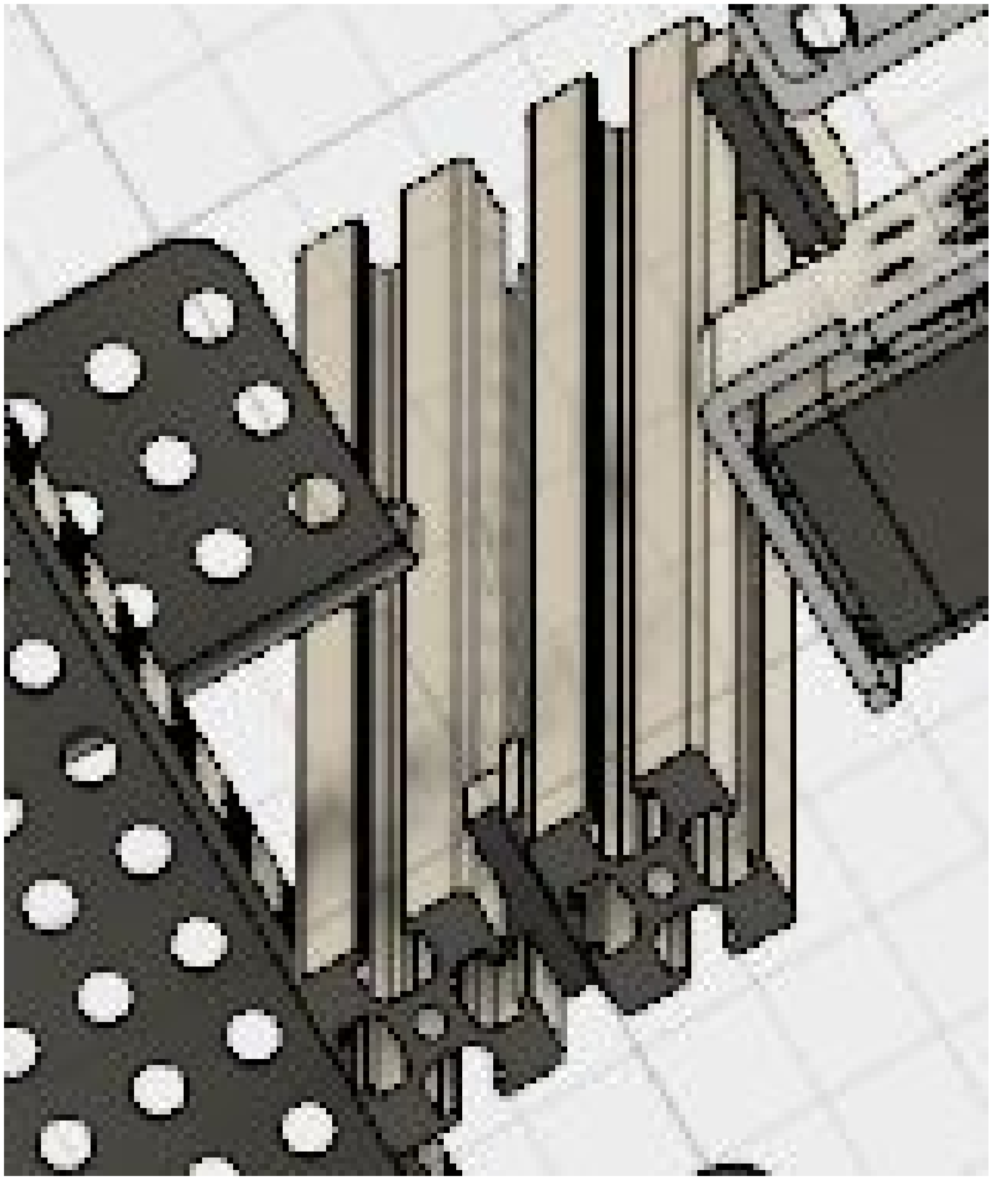
This is another image of the claw. To keep all of these components together, the servo head had to be jointed to the plate, and the servo mount had to be jointed to the servo. However, if one of the components was grounded, the claw as a whole couldn't be jointed to the rest of the robot. This is called a joint conflict. This could take up to 30 minutes to fix, but after the first one, the conflicts were much easier to fix.



This is the mecanum wheel we used for movement. Because of the rollers on the wheels, and the angle of the rollers, depending on which wheels move in which direction, the robot can move directly to either side, diagonally, forward or backwards, or even rotate in place.

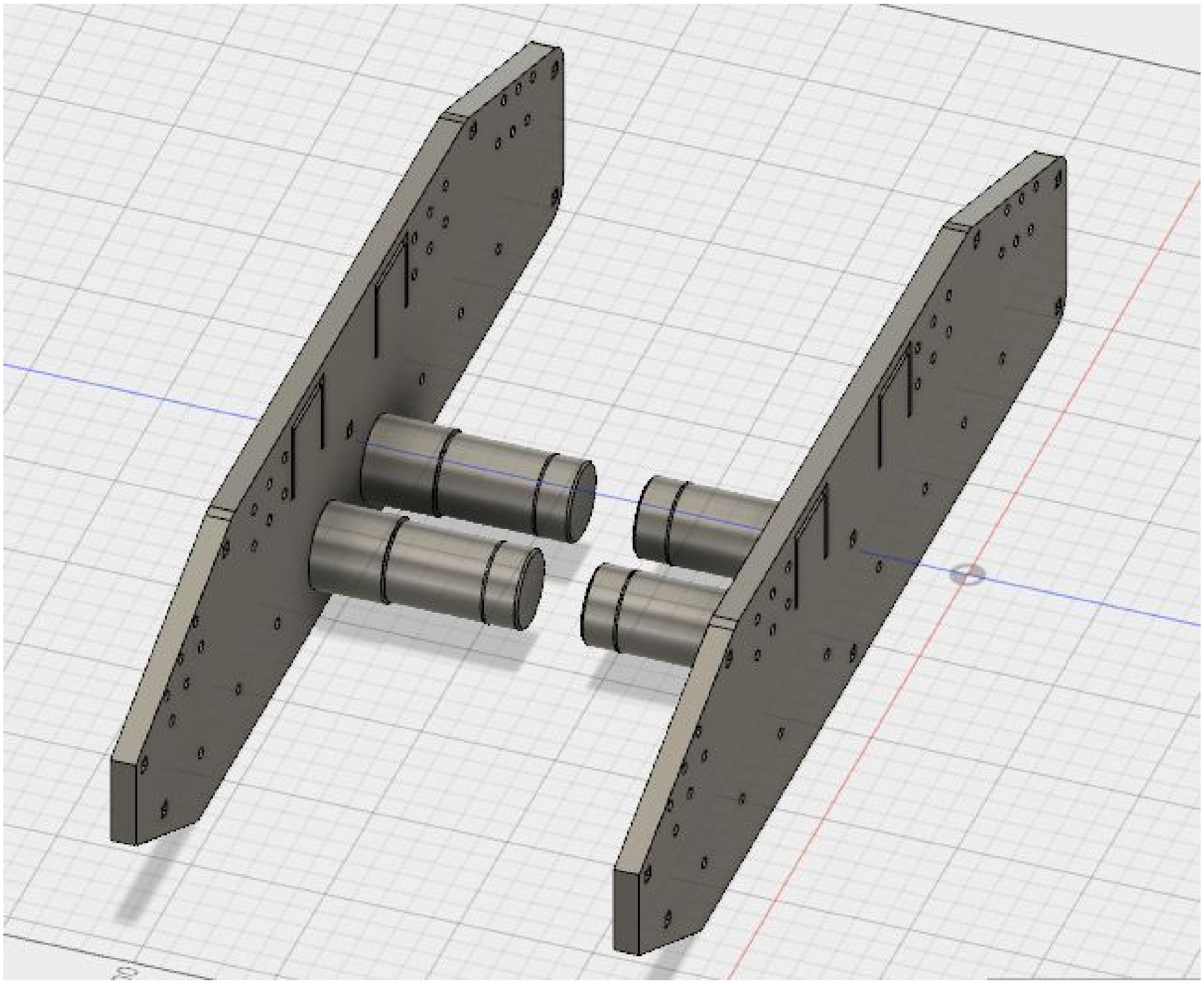
Some components like the mecanum wheels were much more complex CADs. Fortunately, we didn’t have to CAD complex components such as this, as robotics suppliers create components with CAD users in mind - they release appropriate CAD files. At times these CAD files would be in a format that Fusion360 would not accept - thus we had to use a program such as Onshape temporarily to convert files.

Because our mecanum wheels did not come with a set, we had to laser cut our adapters which would attach the screw clamps to the wheels. The clamps then are secured on a .25’’ axle.



This particular linear slide was used for the claw lift mechanism. The piece in between the two linear slides was used to give freedom to the connection. Because the piece was built in CAD, we actually created a 3D print for the piece.

One advantage of Fusion360's joint system is that some joints can be flexible. An example is the joint for our linear slides. The degree of freedom can be set to the z axis, and then the linear slides can actually move in the cad. This is useful for determining, for example, how far our linear slide could go up.

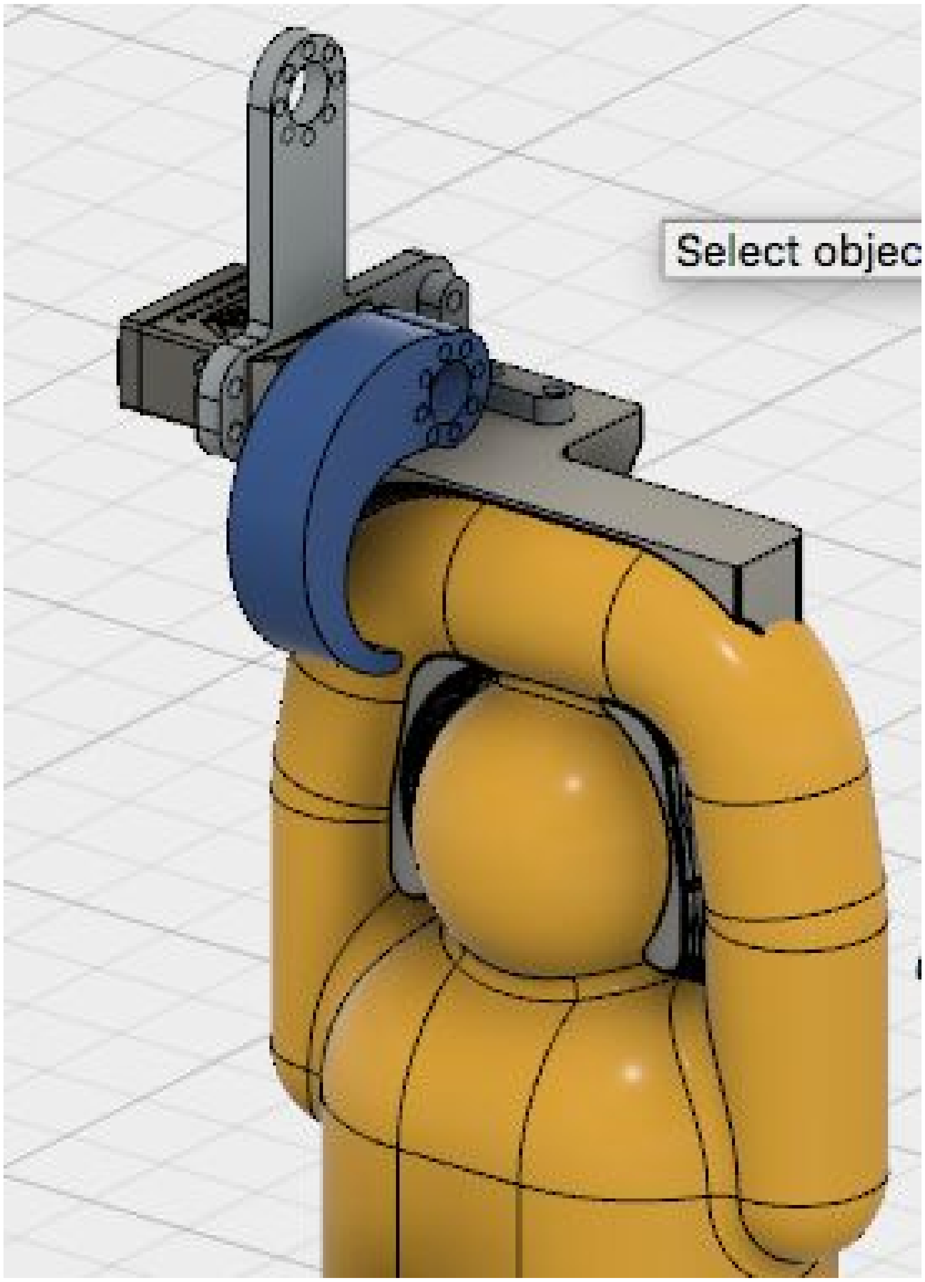


This picture is of the main chassis for the robot. The two pieces support the rest of the robot, and the motors are what move the robot around. This is an improvement from last year, where there were four separate pieces for the chassis. With less pieces, we have more structural stability.

The four motors are also an upgrade from last year. We learned that with four wheel drive, the robot is more stable in movement. The four-wheel drive was also necessary for using mecanum wheels.

Once, our chassis snapped due to an accident. However, because we had made a CAD for the design, it was easy to just lasercut an additional chassis piece, and replace the other one.

This claw was separate from our block-lift mechanism, and was used to pick up the figurines in the matches. At first, the claw was not curved enough, and had to be recreated in CAD. Still, it was not curved enough, and had to be made again. Then, it turned out to be too short, so it was lengthened. Because we used CAD, 3D printing a new version was fairly straightforward, and faster than if we had used another process to make the claw.



When the claw was finally created, the next part of the claw mechanism, the mold, was created. This CAD was created by subtracting the CAD for the figurine. Thus, it would fit exactly as it was supposed to. Again, because this was made as a CAD, it was easy to 3D print.

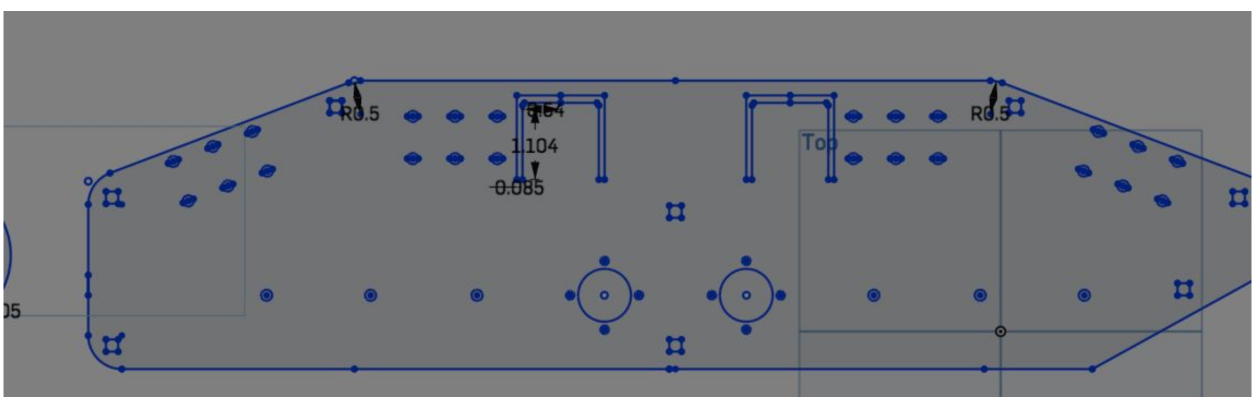
Meeting 9/16 12:30-5:30

Planned Agenda

12:30-1:00 Watch video & have a short discussion about general ideas
1:00-3:15 Brainstorm specific strategy for autonomous and teleop game. Draw prototype designs for mechanisms we would like our robot to have. Determine the optimal chassis design for the robot.
3:45-4:30 Create list of materials to buy. (Programmers think of sensors)
4:30-5:00 Break down design and split members into groups and assign roles]

Today Ethan, Yuki, and Niki attended the meeting. We started off by watching the FTC game video. After analyzing the video, we decided that we want our robot to be able to knock off the jewel, score the glyph based on the cipher, and park in the safe zone in autonomous. During driver control, we want to complete a glyph grid, and score the relic in the farthest goal.

For this we broke the robot into three components: Chassis, Relic dropper, and Glyph scorer. We then watched YouTube videos of how other teams had tackled this challenge. We saw a claw attached to linear slides for the glyph scorer and saw an arcade-like claw using a rack and pinion for the relic dropper. We realized that we don't have much time during driver control to score the glyphs, so we needed a fast and reliable method to score them. One idea we had was to use mecanum wheels in our chassis so our robot could strafe left and right, making it easier to aim and score glyphs. Yuki used OnShape to CAD a chassis plate that we would use.



Our plan was to lazercut 2 plates to enclose a pair of mecanum wheels, meaning we needed 4 total. We would connect the 2 plates using standoffs and axles, and connect each pair of plates with 2 C-Shaped metal pieces.

We also created a list of parts we would need to buy. Our servos needed to be replaced from last year.

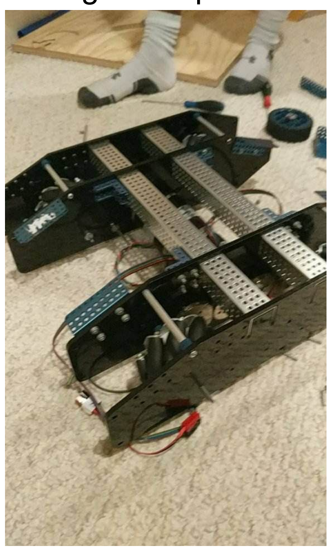
Part	Cost
Rev Robotics Servo/Horn (x4)	136
Registration	275
Drawer Slide	7
Screws M4	20
Mecanum Wheels	220
Total Expense	658

Meeting 9/16 12:30-5:30

Planned Agenda

12:30-5:30 Put Laser Cut pieces together and build robot Chassis. Continue designing our glyph grabber.

Yuki laser cut the pieces during the week at our school's robotics lab. We also received the mecanum wheels in the mail, but during the meeting we realized that we needed longer screws to fit hubs onto the Mecanum wheels. These screws were bought at Home Depot along with longer motor screws that would help us connect the motors to the chassis. We connected the pairs of chassis parts using standoffs and geared our wheels for speed. Then we used a long metal piece to connect the two chassis pairs.

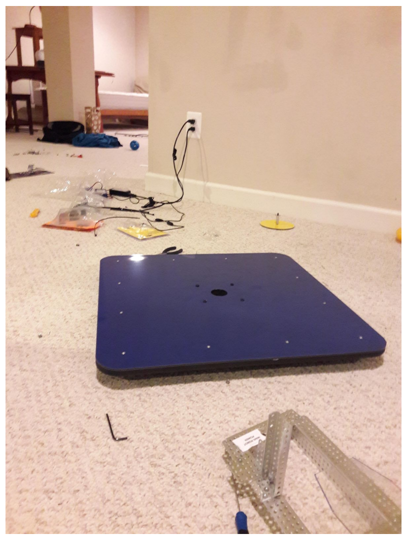


We added blue corner pieces onto the chassis to secure the metal beam. The trapezoid shape of the chassis pieces also makes sure that pieces don't get stuck when the robot is climbing back onto the balancing beam. After we added the two beams, we realized the robot was not as stable as we liked, so we screwed on a third metal piece in the back.

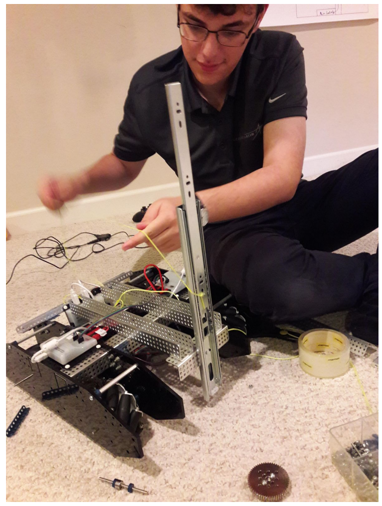
Meeting 9/23 12:30-5:30
Planned Agenda
Program Robot
Create a lift using Drawer Slides
Set Up Board

Mihir and Kai created a basic program during the week that would give the robot tank drive and strafing capabilities. In the beginning of the meeting, they tested and fixed their program, and our robot was able to move. Unfortunately, the gears we used were not working well, and we decided to a chain to connect the motor to the wheel instead of gears.

We also received the board and assembled it. We ran into a challenge as we did not have a rivet gun, but we were able to buy one and learn how to use it. The balancing beams were really fun to stand on after we had built it!



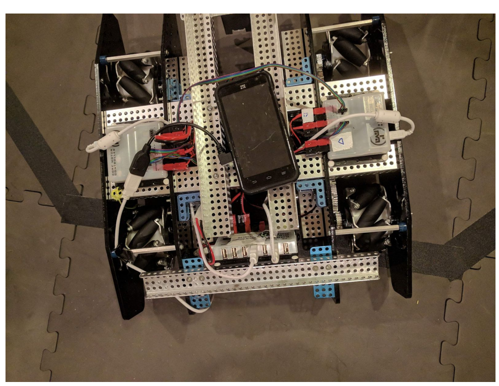
This meeting we focused on our lifting mechanism. We looked at drawer slides and how we would be able to lift them. We knew we would need a string to pull it up, but we weren't sure exactly how. We tried a simple pulley, but that kept on breaking the drawer slides. Instead we decided we would likely have to drill holes into the sides of the slide and create a complex pulley.



Meeting 10/08 1:00-6:00
Planned Agenda
Finish drive train with chains
Finalize plan for claw with CADs
Finish drive program for robot and practice driving

Yuki and Ethan worked on configuring the drive train with the chains. Unfortunately, the chain cutter broke so we had to resort to setting up gears for drive testing. The plan is to complete the chains over the week before the next meeting. After reconfiguring the gears, which took several iterations due to shakiness, we moved on to testing.

After Mihir updated the driver code, we tested how the robot moved. While the vertical movement and the turning performed decently, there were issues with horizontal strafing. Specifically, the gears would bend and the motors wouldn't overcome the friction. We decided the best way to handle this is to re-gear the robot to go for torque as the power applied to the motors from the code was already at 1/3 max and we couldn't use the full strength of the motors otherwise.

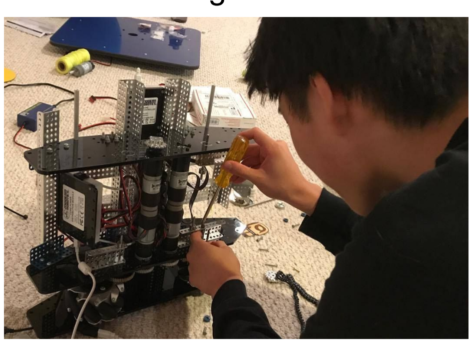


We then worked on the claw. We firstly created a CAD of the grabbing mechanism. This will consist of a horizontal plastic with servos attached on each end to grab the blocks. Another set of servos is attached above this row to grab a second stack. There is also a servo attached to the center to rotate the entire sheet, allowing us to determine which set to use and grab two blocks. We have three possible ideas for vertical movement. Firstly, we can create a servo that rotates the entire assembly for the top portion. Secondly, we can continue using the draw slides as we worked on previously. Third, we also set up the linear slides from last year's challenge and are planning on testing them. Finally, we created a prototype for using a parallelogram lift and began doing some early testing after finishing the required CADs.

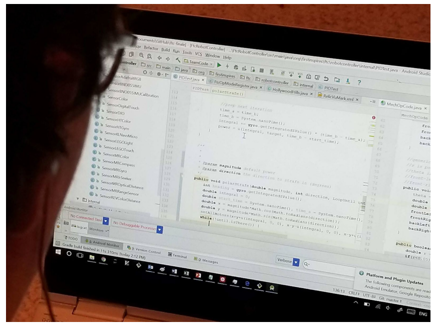
Meeting 10/15 12:30-5:30
Planned Agenda
Finish drive train with chains

Builders kept working to replace gear trains with chains. One builder worked to cut and connect chains, while others took out gears. Tests showed that using chains increased reaction time of the robot, and team members theorized reliability will also be increased.

In addition to changing to chains, much work was done on the block-lifting mechanism. The linear slide was was installed on the robot, and servos were installed on the claw. The linear slide had to be reinstalled with the claw connection further up, in order to allow the claw to be as high as it needed it be.



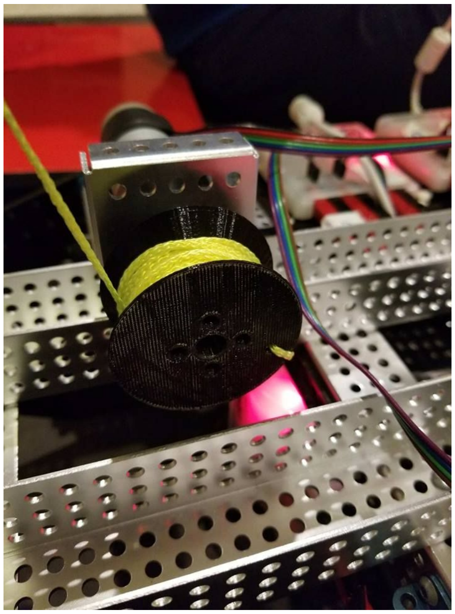
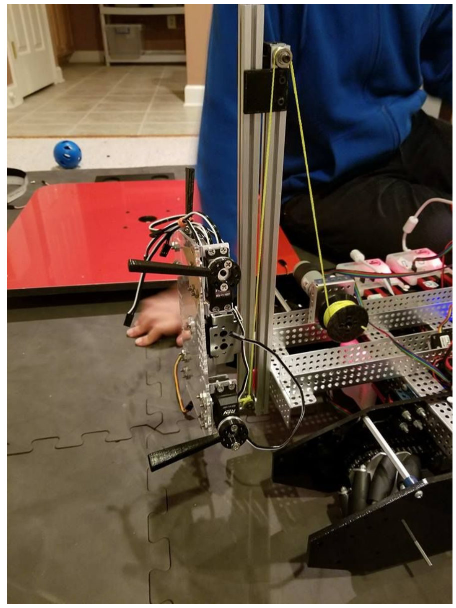
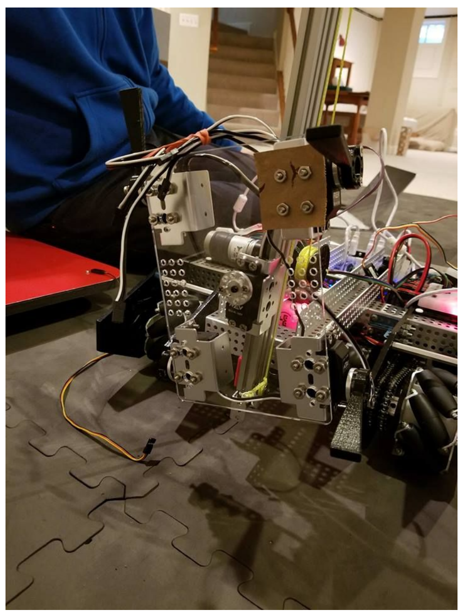
Programmers continued work from the previous week. This work included working on proportional integral derivative, used to correct for error in the robot's movement, and working on code for the strafing. Several methods for strafing were removed, as they were redundant, and more methods were added which relied on angles to strafe in the cardinal and intercardinal directions.



Near the end of the meeting the robot's movement was tested. Strafing forward and backwards was deemed a success. Everyone cheered when sideways strafing worked as well. Strafing diagonally did not work as well. Everyone was also happy when the robot easily climbed the balance pad. The robot was able to do so backwards and forwards.

Meeting 10/21 1-6
Planned Agenda
Continue movement programming
Start claw programming
Finish claw installation

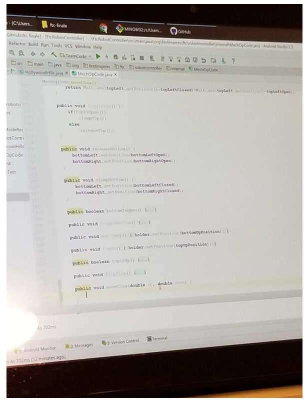
This meeting much of the time was dedicated to finishing the linear slide mechanism. A new spool was created for the linear slide, to allow the spool to be closer to the motor. A hole was drilled in the spool to anchor the string to the spool, and the motor and spool were installed onto the robot. Next the string from the spool was spooled through the linear slide. This was to move up and down the claw system.

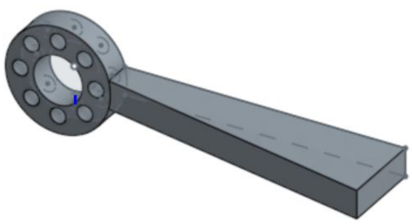
After finishing the linear slide mechanism, builders focused on the claw. Five sets of wires came out from the claw. Thus, when the claw was rotated, the wires would tie up. To avoid this, all of the wires were threaded through one part of the claw. In order to accommodate the claw servo wires, a servo controller also had to be moved closer to the claw.

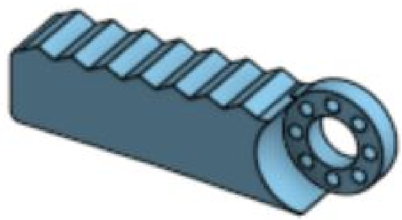
When programmers tested movement, they found the top-left wheel did not move at all. In order to fix this, a builder had to redo the gear-chain system for that wheel.

Programmers spent a healthy amount of time tidying up code. Because multiple programmers are working on the code base, clean, readable code is vital to ensuring productivity. Programmers also added a color sensor and gyroscope to be programmed. The gyroscope was needed because strafing is not exact. The color sensor was removed however, because it has a very limited range, seeing up to only an inch in front. The team expects to use more accurate ultrasonic sensor in the future.



In addition to testing movement and rotation of the claw mechanism, the functionality of the claws were tested. Controlling one claw at a time, a programmer attempted to pick up glyph resulting in breaking the claws. Although a minor setback, the builders learned that the claws were too thin and needed redesigning.





Original New

Although the claws were broken, the servo positions were able to still be calculated. The programmers found the optimal positions for each servo to pick up a glyph, which will be programmed. Next meeting, the team will be ready for autonomous and TeleOp practice.

Meeting 11/5 1-6
Planned Agenda

This meeting was a shorter meeting, and we attached the 3D-printed phone mount onto the robot. This fixed our disconnection problems, since with our old, less secure phone-slot, the phone would keep shaking which weakened the USB connection.

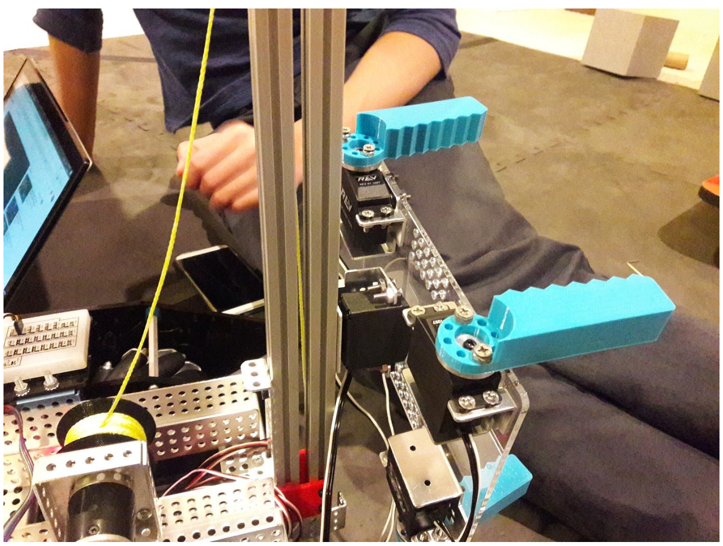
Next, we tested the clamps that we used last meeting. Unlike the old thinner claws, the thick claws did not break and were able to grab successfully. We were also able to lift the blocks with our linear slides up and down without the block slipping out of orientation. This was essential for our design, because when we flip the gripping mechanism it is essential that the blocks remain in place without slipping.

Meeting 11/7 1-6
Planned Agenda
Test scoring mechanism
Fix and improve claw.

11/7

First we began to drive the robot around, and we realized that the the wheels weren't spinning in conjunction with the axles. Upon inspection, we saw that the worm screw connecting the wheel to the axle was loose, as well as the sprocket's worm screw. We took apart the chassis and tightened everything. This fix was temporary as we knew the worm screw would soon become loose again. So decided to 3D print our own clamps. We planned to CAD and then 3D print in school during the week.

Once the chassis had been fixed, we tried scoring 2 blocks. We saw that the claw wasn't reaching high enough to score the blocks on the highest position of the goal. We moved up to the highest position where it would still be able to grip the block. This allowed us to have greater flexibility and move faster. Previously, we would use momentum to swing up the blocks, which would waste valuable. This method performs far smoother and gives better performance.



We decided upon a scoring method that would make it possible for the robot to score on the high goals. First we would pick up our 1st block. The claw would grip the block at the top. Then we would flip our claws and get a 2nd block. The first block would know be gripped by the bottom while the 2nd block would be gripped by the top. Then we would release the 1st block to fall on the 2nd block. Now gripping both blocks by the top, we would flip the claw and lift. This would make it possible to score in the highest goal. We would need to practice a lot to be able to score quickly, but we would also need to be careful to make sure the top block would not fall over when we drop it.

Meeting 11/12 1-6
Planned Agenda
Vuforia
Jewel knocker

This meeting, the autonomous team continued work on knocking the correct jewel off and recognizing the VuMarks and using that information to move the robot to the in front of the correct cryptobox column. By the end of the meeting, the robot was able to consistently identify the correct color of the jewel and knocking it off. The robot was also able to strafe off the balancing stone after identifying the VuMark. During our scrimmage on 11/18, the autonomous team will work on tuning PID and placing a block in the correct cryptobox column.

Meeting 11/18 9-3
Planned Agenda
Calibrate autonomous
Practice Driving
Work on PD

We arrived at Flint Hill for a scrimmage. In the morning, some of our members scouted other teams and watched some matches. The rest of the team worked on autonomous. Yuki had rewired the electronics so the servo for lowering the jewel arm had been moved. We reattached the balsa wood arm and calibrated the servo to account for the new location. We also included some movement before knocking the jewel to get a better angle. Unfortunately, the balsa wood proved too weak to knock off the jewel. The robot did, however, successfully determine which ball to knock off. The color sensor appears to be performing well.

In between autonomous testing, we installed the new bump sensors. Sarkis had obtained four limit switches and each pair had been attached to a sheet of wood. Niki and Antioch hot glued these sheets onto each side for autonomous. The old sensors were removed as they were rather glitchy and not very accurate.

After, we worked on upgrading the apps. We had been using outdated versions of the FTC software, so we migrated to the latest editions. After, we reworked the configuration file and dealt with various connection issues. The spool motor proved to be very problematic and took quite a while to figure out. We then practiced driving. Kai primarily worked on the practice field in grabbing blocks faster. Antioch also went to the workshop for the engineer

Once Sarkis and Ethan came at lunch, we switched to implementing and tuning the PID. We spent quite a bit of time getting this nailed down and worked on reconfiguring the chains for smoother movement. The wheels are still squeaky and might need oiling. We then practiced with the robot. After, we celebrated with some victory german chocolate cake that Mihir brought. Kai brought plates and Ethan brought forks. We also underwent a sample inspection and were told we would be good once we added on the switch that was still shipping.

Before leaving, Sarkis updated the code to handle the switches we had installed earlier. We plan on using these next meeting to develop the autonomous code for placing blocks into the slots. They will help us determine which slot to put it on as we can use them to identify how many slots we have passed.

Meeting 11/26 12:30-6
Planned Agenda
Resize
Jewel
Autonomous

The first order of business in this meeting was resizing the robot. In construction we had exceeded the dimensions because we had reshifted certain parts around. To account for this, we sawed off a few inches of the chassis from the back and smoothened out the front so everything fit. We also extended the jewel knocker to the maximum possible size to minimize any movement that would be required when hitting the jewels. Finally, we reattached the bump sensors after cleaning up the connections. Previously, they had been too loose and as a result would not properly function or would fall off.

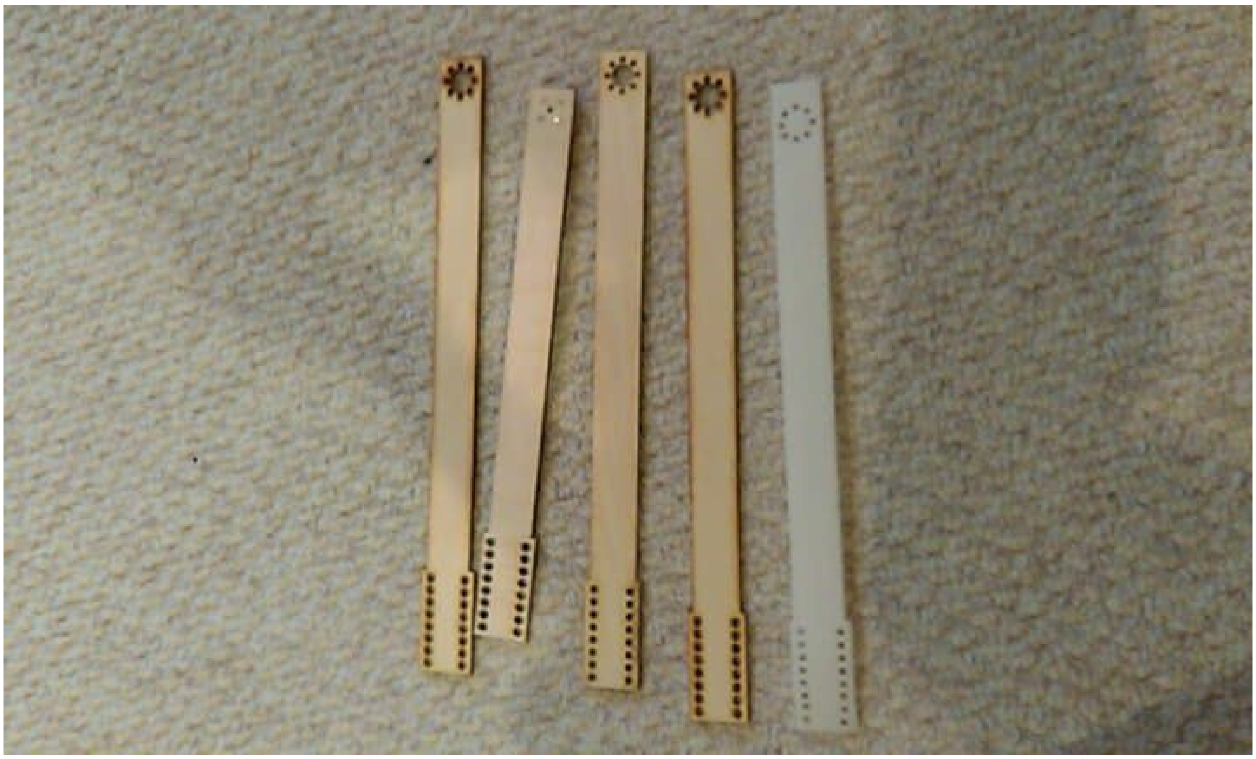
After, we worked on the jewel knocker. Due to the shift in the location of the jewel servo, we now have to move the robot forward before being able to knock off the jewel. After the rebuild yesterday, we have to retune some hyperparameters through empirical measurement. Sarkis focused on obtaining the correct values

We had planned on working on the rest of autonomous but Sarkis was not able to finish his part. He left with Kai.

Mihir took over and reverted back to his code. He fixed the placement of the sensor. The jewel hitting began to work again with 80%ish success based on how well the robot was aligned. The remaining time was spent trying to get the robot to correctly move into the zones. The decision was made to ditch Sarkis' bump sensors.

Meeting 12/10

In this meeting, we lazercutted longer jewel sticks during the week. We attached one jewel stick onto a lower position than before, which made the jewel stick reach out far enough to comfortably hit the jewels without having to move the robot during autonomous. The autonomous team worked on making the robot hit the jewel off and then move off of the platform onto the parking space.

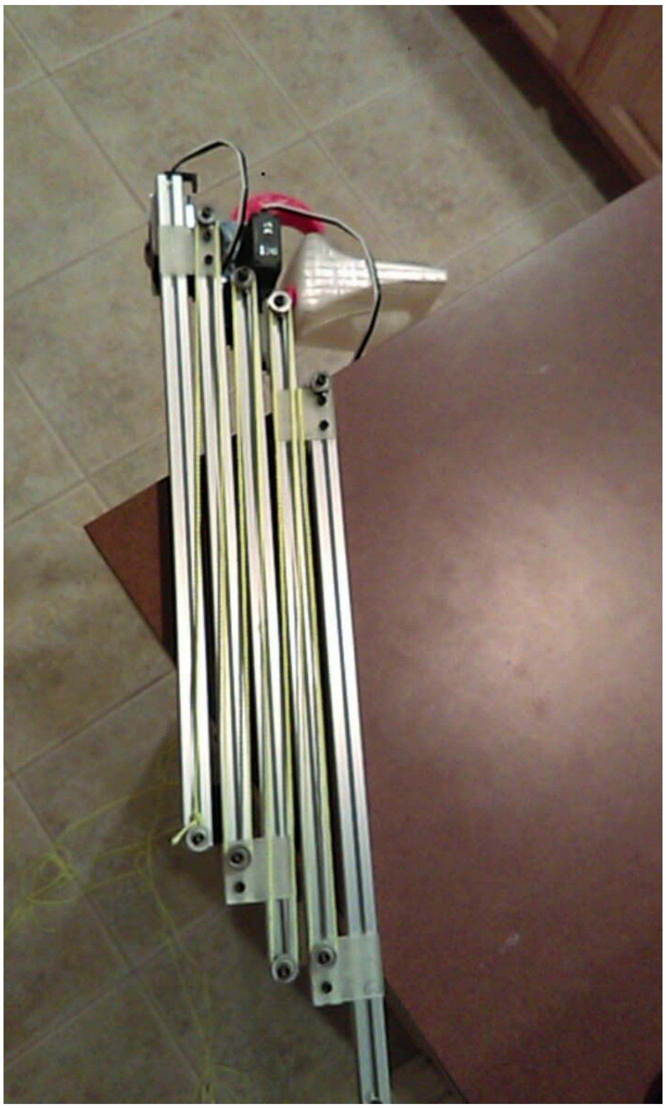


We also started to talk about a design for the relic. We like a design that uses linear slides and a claw with two servos to pick up the relic and place it in a upright position. This design's linear slides are raised one feet to go over the wall and the two servos allow for the rotation of the relic, allowing us to place it in an upright position.

Meeting 12/31

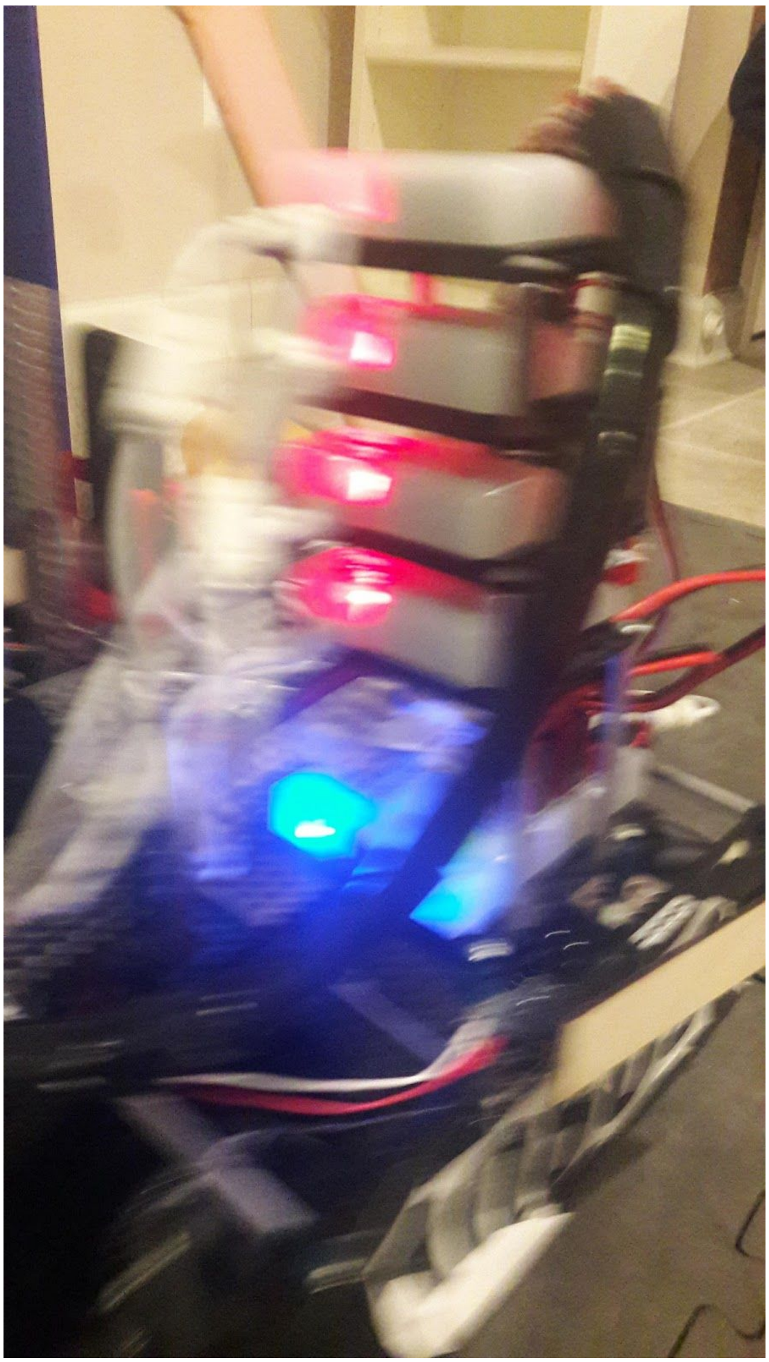
We decided to change the axles on our chassis. We wanted to use D axles and better clamps so our wheels would be more reliable during the competition. We first had to drill bigger holes into our spacers and side chassis panels. Then we had to take off and disassemble our wheels, then replace the clamps with our new clamps.

We also had a team working on creating the linear slides for our relic. For our relic claw, we decided to have a mold of the relic that would form the back of our claw.



Meeting 1/7

This meeting we addressed one of the main problems of our first competition. At Battlefield, Virginia, we faced multiple disconnection issues. In fact, our robot disconnected in three out of our five competitions, and we were unable to perform anything. The typical solution for this problem is to unplug and replug USB ports.



However, our electronics were inaccessible because they were stored under a hood we had laser-cutted. While this did contain the mess of wires, we were not able to unplug or replug USBs. We decided instead stack our electronics in a way that they were accessible.

Meeting 1/14

This meeting we used parts we 3D printed throughout the week to build our relic claw. We attached the linear slides and claw, but realized that the claw made the linear slide sway to one side. To combat this we moved some linear slide stoppers to the other side. During the meeting, we did not have an extra servo module to attach the relic claw, so we have ordered one.

Outreach

Our team is dedicated to helping foster an interest in robotics in younger students. To accomplish this, the team has been involved in numerous outreach events. Once, team members brought the robot to the Children's Science Center at the Fair Oaks mall to teach and inspire elementary and middle school students to pursue STEM. There, the kids were able to watch the robot function and even handle it themselves. They were also able to see a lot of what happens the behind the scenes, including the actual code and pictures of early prototypes. We plan to hold similar events in the future, and have one scheduled at Providence Elementary School in four weeks.