ENGINEERING PORTFOLIO

14103 AUTOSPUTNIK NATIONAL

ST. PETERSBURG // ST.PETERSBURG QUALIFIER // 11-12 FEBRUARY 2023

TEACHING OTHERS
LEARN YOURSELF

POWER PLAY℠
PRESENTED BY Raytheon Technologies

FIRST® TECH CHALLENGE

OUR TEAM

Sputnik is a big community consisting of two FLL teams, two FTC teams, and five mentors. In addition, we interact with teachers from our school and technical universities of our city. Most of the outreach activities we host thanks to our friends and parents who take on volunteer roles.

This season our team consist of 6 current team members, each of which performes their own tasks. We also have five mentors who help us and teach in all processes of our work: from robot development to holding various events and brand development.

TEAM PLAN

SPUTNIK COMMUNITY MISSION

Is to develop technical skills of the team members, by participating in real robotics competitions, create a friendly atmosphere of friendship and support to develop the entire school technical community and inspire others to become a part of the STEM community.

SUSTAINABILITY PLAN

One of the main goals of our team is to ensure the continued and success exsistance of the Sputnik community. For this we carry out courses for the FLL teams and the junior team 12524 Sputnik Original, passing on our experience to the rookie guys.

Team 14103 Sputnik Old School is participating in FTC program for:

—developing team members' skills.

—creating technologically advanced robot, new FIRST teams (FTC and FLL) and education materials, and also holding the events for development school STEM community

—attracting new people to the STEM community and inspire members of the STEM community to develop and become better.

TEAM AND COMMUNITY DEVELOPMRNT

—attract new members and mentors

—make a team members' skills development plan

—make sustainability plan

— working on community website (to attract new sponsors and share materials with other teams)

— develop team identificial

— working on social media (to share our team phylosophy with other teams, our friends and parents)

— increase the number of sponsors (to learn new skills and provide phinancial needs)

—create comfort workspace

— prepare and hold the presintatiom about out community for school teachers, parents and students

FIRST DEVELOPMENT

— create several FTC teams in Saint-Petersburg (to develop the FTC program and increase competition part)

— share our materials (to help other teams increase their skills)

— try yourself as a mentor for one of the new FIRST teams; organize and hold a scrimmage (to promote the program in the local community)

— help run championships as volunteers (to better understand how FIRST events work insides)

— hold workshops and presentations of FIRST (to increase the local community's knowledge about the culture of FIRST and the level of teams)

—create materials to distribute FIRST program

— translate official materials (to make FIRST more accessible)

CREATING COMPETITIVE ROBOT

—carefully learn the rules of the game season (to develop the most effective strategy)

— discuss various ideas for mechanisms constructions for solving game tasks (in order to identify the advantages and disadvantages of each idea)

— analyze game actions using knowledge of physics and mathematics to develop the final concept of the robot (to have an accurate idea of the final location of all modules on the robot)

— create a CAD model of each module and assemble all mechanisms of the robot; program the robot using advanced algorithms

BUDGET AND SPONSORSHIP

Our main sponsor — StarLine. Also Rubin company prints materials for us, and the Ulyanka cinema provided tickets for awarding the winners at Ulianka Scrimmage.

Bottom you can see our expenses and see the list of our sponsors.

Expenses		
1	Purchase of game elements and the field	465$
2	Payment for FLL sweatshirts	1061$
3	Instruments and electronics	143$
4	Banner for Ulianka Scrimmage	69$
5	Materials for creating a robot	133$
6	FTC India Championship	4422$
7	Room arrangement	211$
8	Subscriptions	150$
	TOTAL:	6654$

StarLine

MAIN SPONSOR

RUBIN

PLATINUM SPONSOR

ALEXANDER SKOMOROKHOV

GOLD SPONSOR

ILYA KUTKII

BRONZE SPONSOR

SKILLS DEVELOPMENT

This season the first priority for our team is to distribute acquired skills among members of the FIRST community. Despite the fact that all participants have experience of participating in FTC competitions, we devote a lot of time to developing existing and acquiring new skills. After all, in order to share experience, you need to be professionals in all spheres.

Teaching others, Learn yourself — this is what our team follows

SKILLS DEVELOPMENT PLAN

— learn how to make tasks lists and work with them

— learn to structure yhe code

—transfer the solution of the element recognition problem to a higher level of complexity, increasing the efficiency of the algorithm

— understand the principles of operation of odometry in the field of design and in the field of programming and apply them when creating a robot

—attract new mentors to help with these tasks and develop skills and/or continue to work with old mentors

—visit engineering companies and get contacts

—visit univesities' laboratories to improve technical skills.

—visit buisiness clubs and watch their video-conferences

—participate in olympiads

—learn how to write scripts and edit videos

— interact with FIRST community in Internet: on Discord and Reddit and with team members directly

—learn how to share skills more effictievly

—watch education videos and materials

The main source of new knowledge for our team is our mentors. This season, our main mentors are the teachers of our school and Sputnik alumni which help us to develop both technically and non-technical spheres. But besides mentors, we often turn to professionals outside the FTC community.

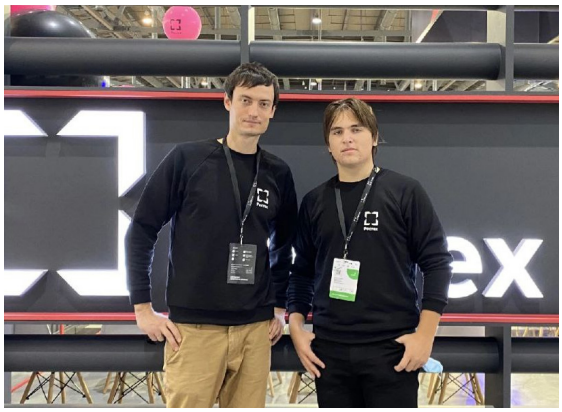
ATTRACTING NEW MENTORS
To create a cool robot, we attracted Viktor Yakovlev, a student of Polytechnic University. He helps us in developing game strategy and robot development. Also at writing program code, we turn to Mikhail Sladkov, a student at ITMO University, for help. During the assembly of the robot, as well as when checking 3D models, Dmitry Lukin, a student at St. Petersburg State University, helps us.

At the start of the season, we realized that in order to better solve tasks with recognition, we need to attract new mentors who can help us with this. One of these was the members of the 16379 KookyBotz team, who provided us with their code, with whom we contacted through the FTC international Discord server. We carefully studied and improved its code, and now we use this algorithm when creating programs for the autonomous period.

While creating new sweatshirts for our team members, we asked for help from a specialist in thermal printing - Nikolay Golubkin (KAMIKADZEE). He gave us access to a laser machine and taught us how to work on a thermal machine, with which the print is applied.

OLYMPIADS PARTICIPATING
To develop knowledge in subject areas and teamwork skills, our team members participate in various olympiads and competitions outside of the FTC program.

So, we participate in the NTO by profile «Nuclear Technologies», WorldSkills Russia and Olympiads from the leading universities of the



CONNECTING WITH STEM COMMUNITY
At the beginning of the season, we made a list of 78 organizations that we could interact with. After, we sent them letters with a offer for cooperation. In addition, we wrote to nine business clubs in Russia, and at the moment we are still waiting for a response from many, and with some we are already discussing further cooperation. We hope to be able to work in these companies in the future.

OPTIMIZATION OF WORKING PROCCESS
This season, we continue to work with the task list. This allows you to competently plan work for the weeks ahead, as well as track the employment of each participant. For more profit this year, our mentor Viktor Yakovlev helped finalize the table, and now we make a list of tasks with deadlines at the beginning of each period (1 month) and mark the current progress of the task with a color.

At the beginning of the season, Victor introduced us to the theory of machines and mechanisms, talking about the features and structure of mechanical systems. This knowledge helps us design robot modules more efficiently during the sketching and modeling phases.

DEVELOPING CURRENT SKILLS
This year, our team members continue improving the technical skills acquired during the previous seasons, as well as improve their knowledge in physics. Mostly our mentors help us with this. So, some of the members additionally attend classes on 3D modeling with the teacher of our school - Ivan Yuryevich, to whom we can also separately turn for advice on a specific issue. For questions regarding both the design of individual mechanisms and the entire robot as a whole, we turn to our technical mentor, Viktor Yakovlev, for help.

CREATING VIDEOS
To spread the message of FIRST this season, we are creating a variety of videos to promote the values of FIRST. Since this is a rather complicated process, at each of its stages we turn to specialists for help. So, during filming, script writing and video editing, we consult with Daria Igorevna, a professional videographer and editor. Also, the media club from our lyceum teaches us editing and filming.

FIRST DEVELOPMENT

STARTING TEAMS
This season we have started 5 new FIRST teams. So, we paid the registration fee for 4 FIRST teams in our community: 2 FLL Explore teams and 2 FLL Challenge teams. To do this, we raised funds from our sponsor StarLine.

Also, from the available details of the designer and REV electronics, we formed a starter kit to create a team. After that, we provided it to the beginning team 22724 BULB from school 385, which is now taught by a graduate of the Sputnik community - Mikhail Yakovlev.

HELPING & MENTORING FIRST TEAMS
We are mentoring two teams. We are activly connecting with younger teams from our community — FIRST Lego League. During their lessons we are helping them with the

In October, we took part in a scrimmage for the FLL Challenge teams from our community, where some of the members of our team took the role of judges and experts. Also, the day before the regional selection for FLL teams, we held another meeting, during which we listened to the performances of the teams, gave comments and points.

We are helping 6 FTC teams. For teams Phantom, Input/Output, Cometa and BULB we provide access to our equipment. To team Phantom handed over a laser machine and BULB, we printed rollers for the lift on a 3D printer and did video conference with Cometa and discussed their engineering portfolio. Also we are helping team 12524 Sputnik Original.

FIRST PROGRAMS PRESENTATIONS

At the end of the previous academic year, our team members held a presentation of FTC and FLL for our elementary school students. At the end of the event, the guys were offered to scan a QR code with a link to register in FLL Challenge team.

Also at the end of last season we took part in the FTC presentation at 223 school, which helped 16950 Phantom team to recruit new of people.

During the scientific-practical conference in our lyceum, we made a presentation of the FTC program for students of the 10th classes.

CREATING & DISTRIBUTING MATERIALS

At the beginning of this season, immediately after the release of the rules, we prepared Russian subtitles for Power Play Game Animation video, and also made a table for calculation of the team's own strategy.

Now you can watch the video with our Russian subtitles on our YouTube channel 14103 Sputnik Old School, and there is a link to a spreadsheet in the description. We have also translated FIRST brochures, where the core values of the programs are described.

To organize scrimmages, we prepared a content plan for teams, forms for volunteers registrations and teams, and also translated a brief description of all the roles of volunteers from the official FIRST website. We have posted all these materials on our website.

CREATING & DISTRIBUTING EDUCATION VIDEOS

In order to raise motivation and help newcomers to organize their own scrimmages, we started a list of videos about such events. We have already posted videos "How to hold a scrimmage?" and "Why are scrimmages so necessary?".

We filmed and edited a video on how to hold our own scrimmage, which was attended by members of the 16950 Phantom and 12524 Sputnik Original teams.

There we covered all the stages of holding such an event, and in the description we attached a link to a page on the community website, where we placed all the materials necessary for this. We hope that other teams will be able to use our instructions, and this will help them not to make mistakes when conducting their own scrimmage.

This video has already been viewed by 166 people.

In order to get answers to questions regarding the organization of the scrimmage, we recorded interviews with the organizers, team members and mentors of the teams.

The organizers of the scrimmages shared the problems they faced during the organization, told what they were not satisfied with during the organization and gave some advice to the future organizers. Mentors and team members told us why scrimmages are held, as well as the benefits of scrimmages both for them personally and for their team as a whole. When creating these videos at the stages of editing, media club 244 from our school helped us.

ATTRACTING PEOPLE TO THE FIRST

In order to develop FIRST programs in our region, we attract new people. So, we connecred with the head of the VK group MD Ulyanka to publish our post about Ulianka Scrimmage. Thanks to fasting and communication with friends, we managed to attract more than 40 volunteers. After the tournament, the results of the scrimmage were published in the Ulyanka newspaper. In addition, our friends, acquaintances and teachers of our school come to support us at scrimmages and regional selection as volunteers, and thus we help to hold tournaments.

ULIANKA SCRIMMAGE HOLDING

To develop the program in our region, this year in January we held a scrimmage together with the 16950 Phantom team, which provided a platform in 223 schools. And the members of our team occupied key volunteer positions, such as referees, scorekeepers, etc. Also, we created a volunteer registration form, thanks to which we were able to recruit volunteers who took part in the meeting. We conducted a separate training course with each volunteer so that no one would have any questions or problems during the competition. On our YouTube channel, we broadcast the event so that even those who could not attend could see spectacular matches. All participants and mentors of our team took organizational roles.

The winners, as well as the volunteers of the competition, were awarded VIP tickets to the Ulyanka cinema, which we managed to get directly from the cinema.

SPUTNIK MOON

In addition to helping our community's junior team, the FLL Challenge Sputnik Moon, we are also actively working on their succession to the FTC program.

To do this, we trained the guys to manage and maintain our robot. We also told them about the FTC rules and the principles of gratious professionalism.

Thus, we prepared the guys for participation in Ulianka Scrimmage with our robot. Thanks to our preparation, they successfully coped with the qualifying matches, made it to the semi-finals and stopped one step away from the final. This experience allowed them to feel the atmosphere of the FTC competitions and we hope that next year the guys will become members of our community's FTC teams.

IDENTITY DEVELOPMENT

To develop the team identity, we we are actively working on creating handouts and community branding. So, we created the design of new sweatshirts for our team members and printed prints, thanks to the help of Nikolai Golubkin and for junior FLL teams of our community, with the help of funds raised from the main sponsor StarLine.

We also printed a banner for Ulianka Scrimmage, created Telegram stickers and phone cardholders with our team logo.

To involve more people in the life of our team, we run a telegram channel, which has become the largest in Russia in just 9 months.

@SPUTNIK14103

HOW WE YOU ATTRACT PEOPLE?	PERSONS/ NUMBER
ATTRACTED AUDIENCE OF THE WEBSITE	1700
ARTICLE IN THE NEWS OF ULYANKA	20 000
ARTICLE IN THE NEWS OF ULYANKA	3200
TELEGRAM CHANNEL SUBSCRIBERS	200
YOUTUBE VIDEO VIEWS	464
BROADCAST OF THE MEETING ON YOUTUBE CHANNEL	469
VOLUNTEERS ATTRACTED	48
TOTAL	26 081

CONCEPT AND GAME STRATEGY

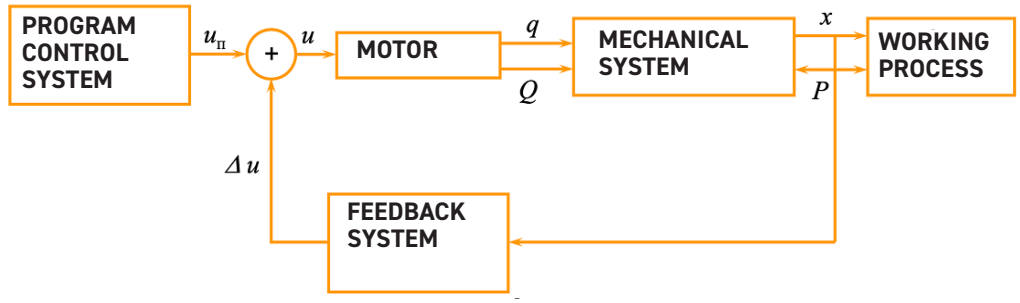
We always start the playing season with a thorough study of all the rules. After that, we discuss possible options for the strategy, after which we decide on the concept of the robot. Based on our experience and data collected during each competitive season about each team on the competitive field, we have calculated the maximum possible number of points that teams can score this year both alone and in an alliance. After that, we figured out how many points it would take to win at certain stages of the season.

		MAXIMUM		SCRIMMAGE		REGIONAL		NATIONAL	
		ALLIANCE	TEAM	ALLIANCE	TEAM	ALLIANCE	TEAM	ALLIANCE	TEAM
AUTO	High junction	12	6	3	2	5	3	8	5
	Signal sleeve	2	1	2	1	2	1	2	1
TELE OP	Terminal	2	2	2	1	2	1	2	1
	Ground junc-tion	2	1	2	1	2	1	2	1
	Low junction	4	2	2	1	2	1	3	2
	Middle junction	3	2	2	1	2	1	3	2
	High junction	15	10	10	5	12	7	14	8
END GAME	Parking	2	1	2	1	2	1	2	1
	CONE	12	6	8	5	10	5	12	6
	BEACON	2	1	2	1	2	1	2	1
	CHAIN	1	1	1	1	1	1	1	1
	TOTAL:	345	198	208	122	244	142	297	177

PRINCIPLES OF CREATING MECHANISMS

When creating any module of our robot, we adhere to certain the principles we have identified. Before starting the development of each mechanism, we analyze its structure, as well as draw up its functional diagram. They allow us to thoroughly think over the module in advance, which greatly facilitates its design in CAD, as well as its subsequent placement on the robot. Discussing the concept of a mechanism, we immediately try to choose the most effective design option, highlighting the pros and cons of each idea. Also, each module of our robot must be a mechanical system: an engine, actuator and transmission mechanisms.

FUNCTIONAL DIAGRAM



Also, during the modernization of modules, we do not make changes to them that significantly change the overall concept of the mechanism. This allows modules to be improved while maintaining their benefits.

When creating a robot, we adhere to the approach we have developed: an idea - a sketch - a prototype - a model - a finished mechanism. When creating 3D models, we can see design flaws in advance, so we rebuild the robot a minimum number of times. This allows us to save not only our working time, but also resources, spent on creating a robot, such as plywood, steel, etc.

Thus, we decided on what modules our robot should consist of:

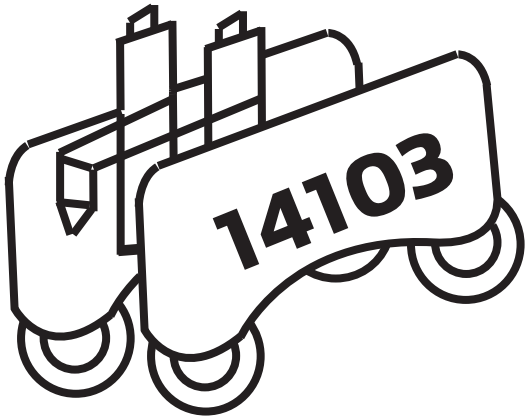
- **drivetrain**
- **cone manipulator**

After that, we began to discuss what these modules could be, and what options for modules
will allow us to solve the tasks assigned to us most effectively.

DRIVERTAIN
To implement the tasks set for the wheelbase - maneuverability and speed, we decided to design and assemble a narrow base on mecanum wheels, allowing the robot to move freely in all directions. Also, to accurately determine the position of the robot on the field, we plan to install odometry on the base.

CONE MANIPULATOR
When designing the cone manipulator, we separately discussed its two main components - the grip and the mechanism
lifting cones.

When calculating points, it became clear what is most effective with game tasks the robot copes, which can easily pass between the nodes, as well as install cones on them, without making unnecessary turns. To do this, the robot must have small overall dimensions and a mechanism that allows you to freely manipulate the captured cone. Also, an analysis of game actions showed that an alliance can get quite a lot of points for composing a chain of controlled nodes, so the robot must also be fast and maneuverable enough.



To capture we had two main concepts:
- **Claw grip**
- **Intracone grip**

The first option has a number of significant drawbacks. Firstly, this grip design will be too massive, because of which it will not be able to be manipulated easily enough during matches.

Secondly, with such a system, the process of capturing the cone will be too long, and the probability of the captured cone falling out during the movement of the robot is high.

Thirdly, such a grip design is not can be automated.

The intracone type of grip looks more reliable and faster, so we chose it as the main one in our concept.

Based on the experience of previous seasons, as the basis for the lifting mechanism, we decided to use furniture rails that move apart due to the winding of a thread on a spool, stretched through the blocks.

STRATEGY ON THE PLAYING FIELD

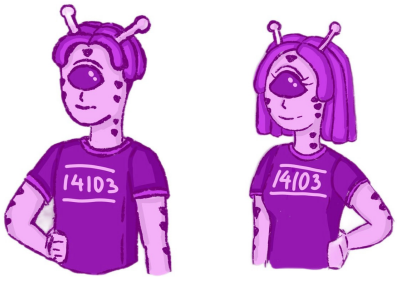
In order to maximize the technical advantages of the robot, it is necessary to competently perform game tasks, consistent with the actions of the ally team. To do this, before each match, we discuss with the allies the strategy for the most competent chain building. At the same time, we rely on the capabilities of both the ally team and the opposite alliance. We, as a rule, install the lighthouse at the very end of the match, and in this way we try to occupy the nodes that are important for building the chain.

The result depends on how detailed we plan the match.
Therefore, we have drawn up a plan of action in each of the game periods.

Autonomous period:
- setting the cone to the low and middle level
—parking in signal zone

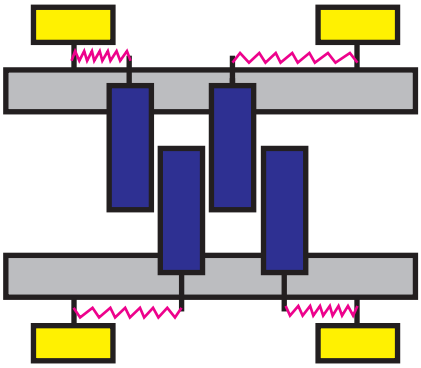
TeleOP:
-setting cones at different levels to complete the circuit

Endgame:
- installation of the beacon on the junctions required for the chain
—parking in the target zone



DRIVETRAIN

The dimensions of our robot depend on the distance between two neighboring junctions. We decided that the width of the drivetrain should be such that two of our robots can freely pass between two adjacent junctions. Since the distance is equal to one tile of the playing field, which is approximately 597mm, the width of our robot should not exceed 300mm, respectively. So, the standard arrangement of motors will not suit us, because it takes more than 340 mm in width. To achieve the optimal width of the robot, we chose the option of connecting the motors to the wheels not directly, but through a chain transmission. You can see a diagram of such a connection of motors with wheels below. This arrangement allows the collection drivetrain about 280mm wide

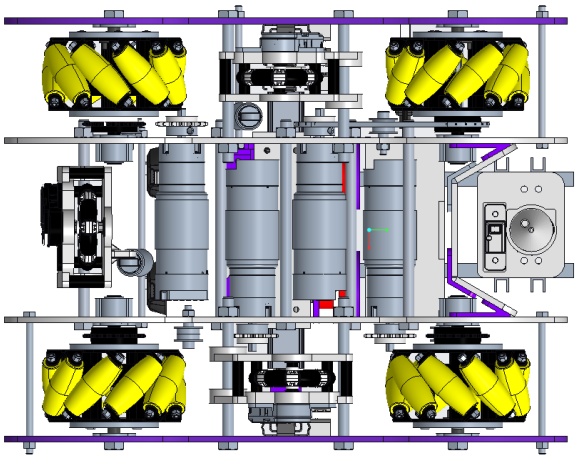


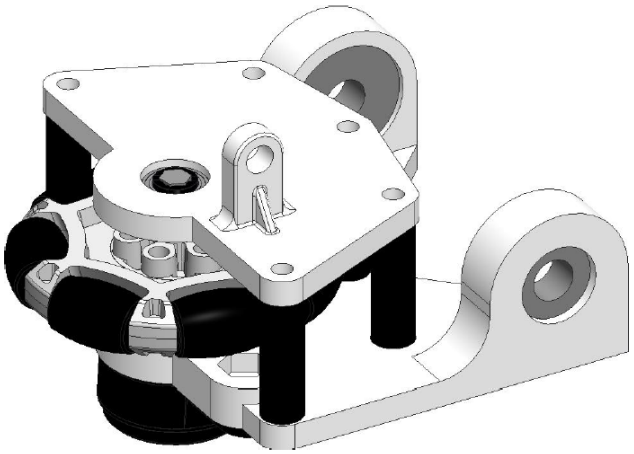
In order to be able to control the chain tension, we have added inner side tension roller with interchangeable positions. It allows the robot to start and stop more abruptly, and also simplifies the assembly and maintenance process. wheelbase. To connect the sides of the robot, we decided to use M8 studs. Such a connection is quite reliable, and at the same time very easy to operate.

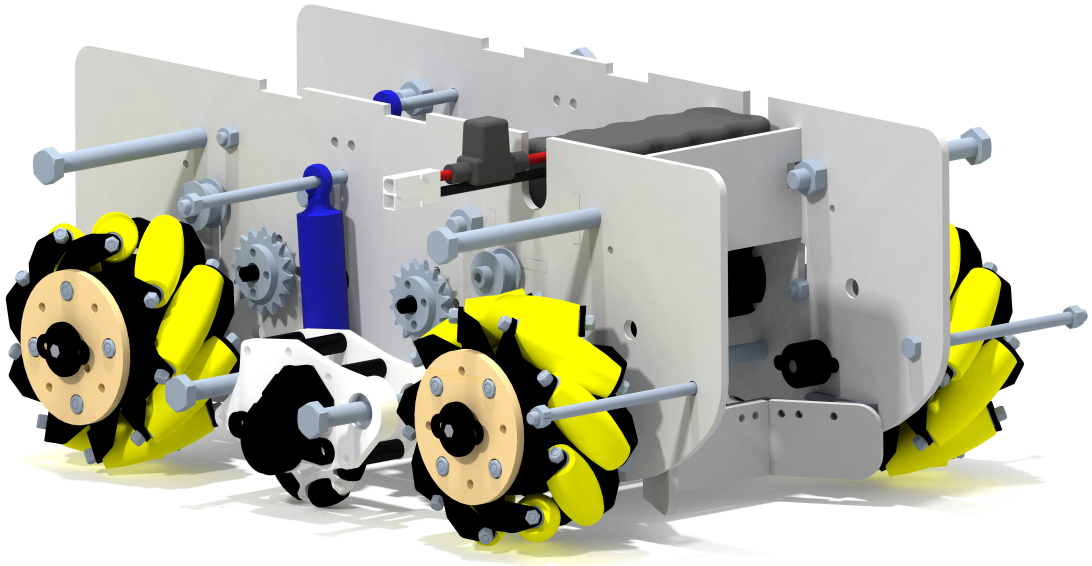
To fulfill the second important requirement for the drivetrain of the robot - maneuverability, we chose mecanum wheels as wheels, allowing the robot to move freely in all directions.

In addition, we tested two options for securing the wheels: a cross and a rhombus. After tests, it turned out that when fixing rhombus robot moves much more smoothly.

ODOMETRY SYSTEM
In order to improve the drivetrain, as well as in order to gain experience with new complex sensors, we decided to add two odometers to its design, which allow us to accurately determine the position of the robot on the field in an autonomous period. To do this, we designed a plastic case on which the REV Encoder with a wheel is mounted. To keep the odometer wheel firmly pressed against the playing field at all times, we added springs from the suspension of a 1/10 scale radio-controlled model to its design, which keep the pressure of the odometer wheel on the field constant.







CONE MANIPULATOR

VERSION 1
In the first version, the manipulator consists of two Tetrix beams driven by two servomotors of a metal plate fixed on the servomotor. The raising of the cones is carried out at the expense of two degrees of mobility, providing a maximum lifting height to the Middle Junction level.

The cone grip consists of a metal plate mounted on a servomotor at the end of the second beam. It works by pressing a cone of metal plate to the surface of the Tetrix beam.

Also, before assembling the mechanism, we calculated whether the power of the REV servomotor (25kg/cm) would be enough to

$M = 25$ кг/см $= 2.5$ н/м - SERVO MOTOR TORGUE

$d = 0.6$ м - REQUIRED TORGUE

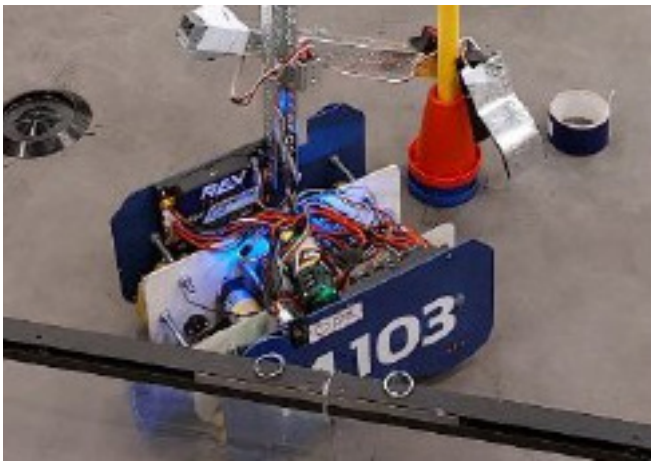
$F = M/d$

$m = \frac{M}{f*g}$

$m = \frac{2.5}{0.6*10} = 400$ г - REQUIRED MASS

The construction that we need to lift (2 beams, a servo and a cone) weighs clearly more than 400g, so we reduced the arm on one side and increased it on the other for counterweight.

This version of the mechanism had a number of disadvantages:
- Inability to climb to the High junction level
- The need for precise manual control of two degrees of movement of the mechanism, and, as a result, the duration of the execution of game actions
- Sub-optimal gripping of cones - difficult to find the right position for grabbing during a match, as well as a high probability unintentional loss of the cone during robot moving.



VERSION 2
In the second version of the manipulator, we completely changed the mechanism. The new manipulator is a correct mechanical system in which the role of the transmission mechanism is performed by a system of furniture rails, and the gripper is the executive. The gripper of the cones is completely designed in CAD and printed on a 3D printer.

In order to be able to aim faster when capturing a cone, the new mechanism is shaped like a cylinder with a truncated cone at the end.

On one side of the cylindrical surface, a hole is made with an arc of 180 degrees. Inside the cylinder on the servomotor is fixed a movable rotating element, which, when rotated, is taken out of the cylinder and clings to the technical protrusions inside the cone. Thus, the capture of the cone is carried out.

The cone lift in this version of the manipulator consists of one block of three linear guides. The rails are unfolded by a REV-motor with a spool pulling the rope stretched through the blocks attached to the rails. To understand what gear ratio should be put on the motor shaft, we carried out the following calculations. In this case, the radius of the coil is 2 cm, and the minimum time for which we want to raise - 1 s.

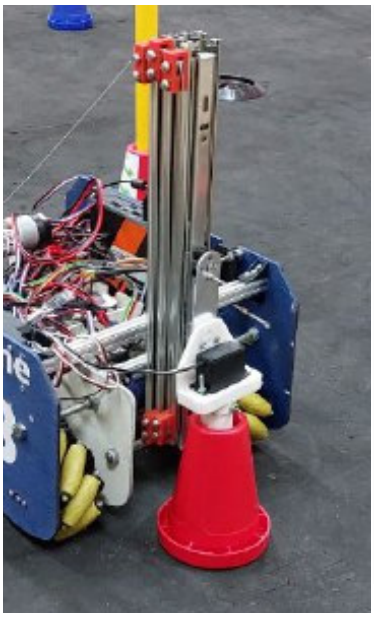
$V = 6000$ об/мин $= 100$ об/с - MOTOR SPEED

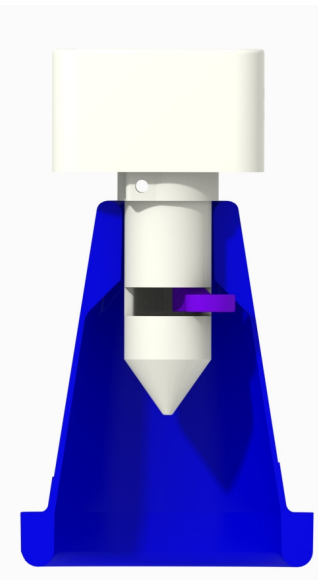
N - GEAR RATIO

$\frac{V}{N} * 2 * \pi * R * t = H$

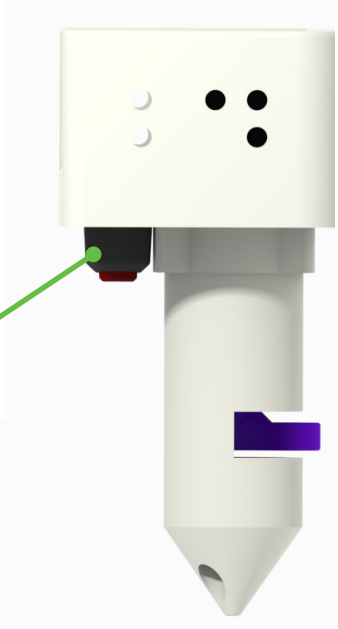
$N = \frac{V*2*\pi*R*t}{H}$

$N = \frac{100*2*3.14*0.02*1}{1} = 12$ - REQUIRED GEAR RATIO

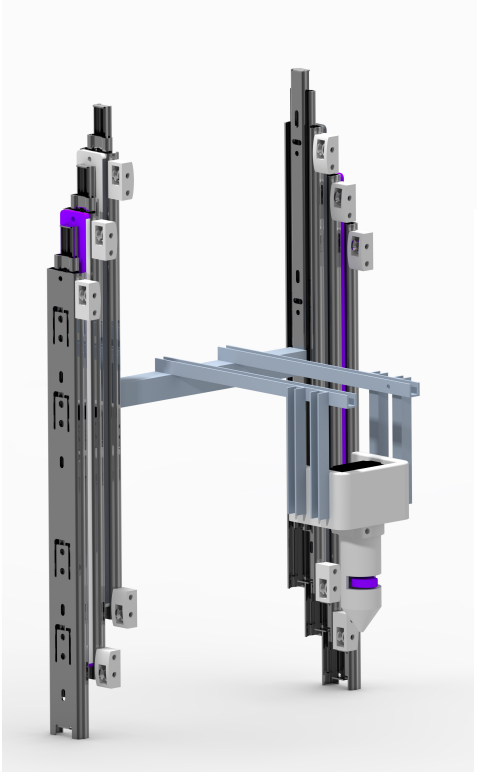




This version of the manipulator also has disadvantages:
- The pickup cylinder was too long, which could cause us to accidentally grab two cones
- One block of guides does not provide sufficient structural stability
— The capture of the cone was carried out manually, which significantly slowed down the work

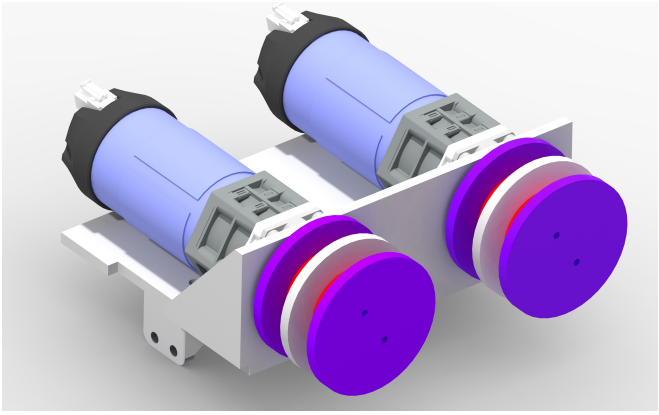


VERSION 2.1
In the previous version of the manipulator, the role of the transmission mechanism was performed by one block of linear guides. Such a design had a strong backlash, due to the fact that, due to the force of gravity created by the grip and the cone, at the upper point of the guides, the moment of force created a force, compensating moment and pressing on bearing separator.



Therefore, in the new version, we added a second block of guides and eliminated the backlash. First, we connected the guides to each other with two profiles, eliminating the moment of gravity in this plane. Secondly, we fixed the guides on the sides of the robot, and now any counterforce acts on the sides, and not on the separator.

We also reduced the length of the cylinder to eliminate the possibility of capturing two cones. We also added a REV touch sensor to the gripper body, which is triggered immediately after the cylinder is lowered to the desired depth to capture the cone. At this point, the movable part automatically rotates, capturing the cone. In the previous version, this action was performed by the operator.



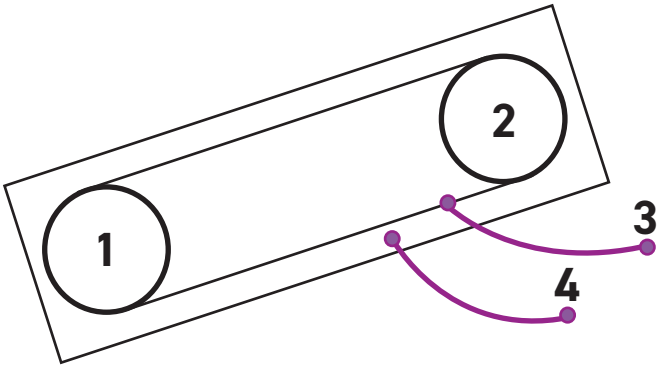
This version of the module had one significant drawback, which limited and slowed down our actions on the playing field: every time we placed a cone on a junction, we had to turn on 180 degrees, which turned out to be an inconvenient action that did not correspond to our game
strategies.

VERSION 3
In this version, we have eliminated the main drawback of the previous version - added the ability to install the cons both on one side and on the other side of the robot. To do this, we have developed a swivel mechanism that transfers the gripper, along with the cone, to the opposite side of the robot.

In this mechanical system, the role of the transmission mechanism is performed by a structure of two parallel beams driven by a motor. The main task that we had to solve was to decide how the actuator of this system (capture) at any time would be parallel to the floor plane. Indeed, otherwise, installing a cone on a junction will impossible.

In order to fix the grip in one position relative to the floor, that is, to prevent its free vibrations around the axis, we designed a damper for mechanical vibrations. It is a system of two stars (1, 2) connected by a chain (3).

In order to make sure that the damper will work, we calculated the number of degrees of mobility of the system using the Chebyshev's formula.



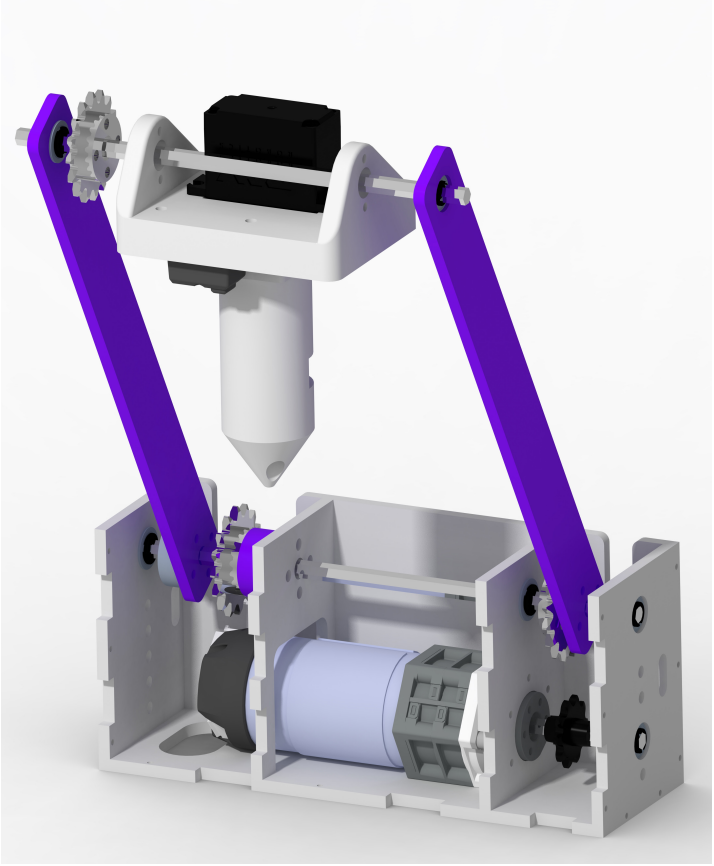
$W_n = 3n-2n_н-n_в$,
where W_n - number of degrees of mobility; n - чnumber of moving parts; $n_н$ - number of lower kinematic pairs; $n_в$ - number of higher kinematic pairs

number of moving parts in the system is 3 and the number of lower pairs is 4

$W_n = 3*3-2*4-0 = 1$
so the system has one degree of mobility

Составим структурный граф механизма:

Our mechanism has two structural groups:
- the first one (motor and beam (4)) has two links and one degree of mobility. From this it follows that in the second structural group there are 0 degrees of mobility and 3 links. Therefore, the second group is the Assyrian group. Therefore, the capture will not oscillate, because it has no degrees of mobility.



PROGRAMMING

This season, we decided to use the Anroid Studio program and the Kotlin programming language to write the robot code. The Kotlin programming language is widely used in the Android OS development industry, which allows us to get to know and learn the tools that will help us in our future job search. We chose to use Kotlin because it is a concise and type-safe alternative to Java and can be replaced in place without porting the rest of the code. Our choice will allow us to write more readable and concise programs while doing less errors related to data types.

VERSION CONTROL SYSTEM

The version control system allows us to quickly update to the latest version of the FTC Robot Controller and, if the code changes, in case of an error, roll back to the previous version and use the working version. Version control systems are widely used in the industry and allow us to get acquainted with technology that will help us in future work. Also, using the version control system, you can implement various systems independently of each other, and then merge them into the main branch. We chose Git as our version control system because it is reliable, easy to learn, and has a large database of questions and answers. We decided to store our repository in the GitHub cloud service so that other teams can see the implementations of interest to them. algorithms.

DRIVER-CONTROLLED PERIOD

To control the wheelbase of the robot in the controlled period, we wrote equations for the mecanum wheel, since such wheels have a shifted motion vector. Power, applied to each of the motors depends on the desired movement in x and y coordinates, as well as rotation r. Also, in order for the power not to exceed the values [-1; 1] and changed more smoothly, we divide the obtained values by the sum of the powers by coordinates or 1.