ENGINEERING PORTFOLIO TEAM-24474

TEAM-24474

LITUANICA X-VILNIUS LYCEUM ROBOTICS

AUDENTES FORTUNA IUVAT

SECTION A
MEET THE TEAM

- Team and mentors
- Sponsors
- Outreach

SECTION B
ENGINEERING

- Design
- Autonomous
- Testing

SECTION C
TEAM PLAN

- Goals
- Strategy
- Future plans

SECTION A
MEET THE TEAM

Vilnius Lyceum Robotics is a team of passionate **engineers** and **programmers** who wish to make their mark in the robotics world!

Standing: Nojus, Jokūbas, Martynas, Viltė S., Marius, Augustas, Povilas, Domas.
Sitting: Lina, Saida, Viltė Sc, Adam.

CAD design
Povilas
Domas
Saida
Augustas
Martynas
Jokūbas
Viltė Sc

Coding
Saida
Lina
Adam
Marius
Viltė S

Captain	Lead CAD	Lead Coding	Driver
Povilas	Povilas, Domas	Nojus	Nojus
Human player	Lead Outreach	Web design	**Media**
Viltė S., Saida	Viltė Sc	Saida	Viltė S

Instagram:
@24474_vilnius_lyceum_robotics
@lituanicax

Facebook:
Lituanica X – Team Lithuania

WE ARE PART OF...

VILNIUS LYCEUM

The **top-ranked** high school in Lithuania.

MISSION

to **provide** opportunities to talented and bright students with various interests with a focus on STEM education.

LITUANICA X

Lithuanian ambassadors in the world of robotics.

GOAL

to support aspiring robotics teams by providing opportunities, hosting training events and organising skill acquisition.

MEET OUR MENTORS!

Algirdas

Mentor at **Lituanica X** since 2018, known for his involvement with **FIRST.**

OUTCOME: introduced First Tech Challenge, its values. Lessons learnt include organizational, teamwork and communication skills.

Justinas

A true expert in the field of **CAD design,** a consultant from our dear sponsor company **INRE.**

OUTCOME: CAD design, brainstorming and developing ideas.

Darius

A superb professional in the Lithuanian education system, one of the two main **mentors** in Vilnius Lyceum. Among other things, he is responsible for communication between the team and the **Lyceum Community Fund.**

OUTCOME: Provided and taught how to use school's equipment (e. g. using 3d printers)

Bronius

Most decorated Vilnius Lyceum teacher in the field of computer science, second of the two **mentors** in Vilnius Lyceum.

OUTCOME: Helped in the creation of the team, communicating with the school administration. Taught us organizational and computer science skills.

SECTION C
TEAM PLAN

ENGINEERING

1. Develop **new versions or models** of the existing **systems** with **improved features** (e. g. enhancing the elevator's gearbox, experimenting with different materials for the arm mechanism)
2. Explore new **markets** or **applications** for the **team**'s products, potentially branching out to different **industries** where their technology could be **beneficial**.
3. Integrate more **advanced technologies**, such as **AI** and **machine learning**, especially in areas like **sensor development and automation**.

OUTREACH

1. Form **strategic** partnerships with other **companies, research institutions, or industry experts** to leverage external **expertise and resources**.
2. Engage in **educational initiatives, workshops, or public demonstrations** to showcase our **work**, **attract talent,** and **inspire innovation in the community**.
3. Develop a **long-term vision** that aligns with emerging trends and technologies, ensuring the team remains at the forefront of innovation.

SUSTAINABILITY GOALS

1. Using Google Forms and social media we share our achievements and try to recruit new members to the team. New member recruitment is done every Spring, however people can join all year around.
2. Consistently build our social media presence and gain popularity.
3. Continue to host seminars, workshops and other forms of education and encourage FTC related activities throughout our school community and Lithuania.
4. Communicate with other teams and gain experience in the process, learn to maintain consistency and stability within the team.
5. Do team-building activities such as escape rooms, have a ritual for rookies as a welcome ceremony to the team.
6. Maintain constant funding, including long-lasting sponsorships and new partnerships.

Long term goals

- Ensure a long-lasting team in and a thriving community within Vilnius Lyceum
- Establish a local FTC league
- Continue educating the youth about the thrilling world of robotics!

Skill development goals

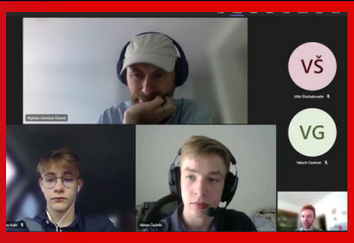
Programmimg:
Durinmg the off season, rookies will get projects assigned by the programimng lead which will teach them how to use libraries like **roadrunner**, **ftclib, OPENCV** and dynamic programimng.

CAD design:
Every single rookie will have proper training how to use **SOLIDWORKS** and will be assigned to at least one small project during and off season.

SKILL ACQUISITION

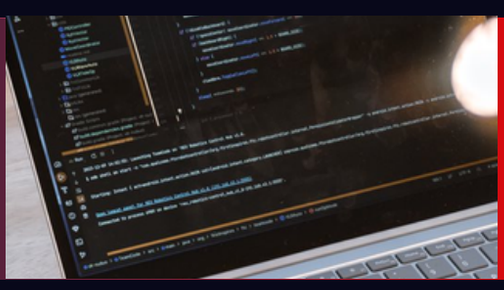
CAD DESIGN

Thanks to our dear sponsor INRE UAB for hosting weekly consultations on CAD application **SolidWorks** our designs each Wednesday. Our esteemed **mentor Justinas** was the central consultant during these sessions.

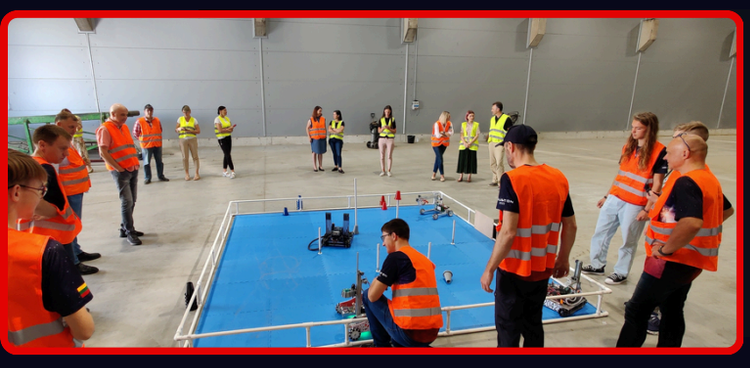


PROGRAMMING

By virtue of our **mentors Bronius and Darius,** our coding department members had the opportunity to acquire guidance and recommendations for our programming during weekly meetings.



MEETING WITH OUR SPONSORS



ŽALVARIS

- **Žalvaris** is a Lithuanian innovative waste management company that has produced an invaluable partnership in our robotics journey.
- In 2023 on September 25th our team had a unique oppurtinity to demonstrate our work to our partners in Žalvaris facilities.

LIGHT CONVERSION

- **ACME Grupė** is a group of Lithuanian capital companies that bring the latest technologies to the Baltic and other countries.
- Our team had the opportunity to demonstrate our work to the younger generation which was a very emotionally rewarding experience.

CITY OF VILNIUS

- **Vilnius city municipality** invited team LITHUANICA – VILNIUS LYCEUM ROBOTICS for a visit.
- During the visit, we were warmly welcomed by the mayor of the Lithuanian capital Vilnius Valdas Benkunskas and Vice-Mayor Donalda Meiželytė.

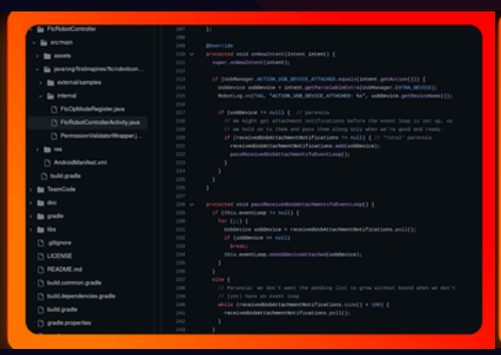
NON ROBOTICS RELATED OUTREACH ACTIVITES

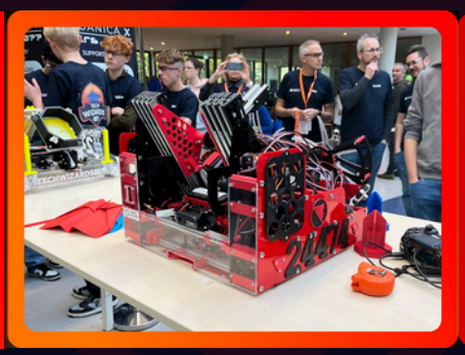
WEBSITE

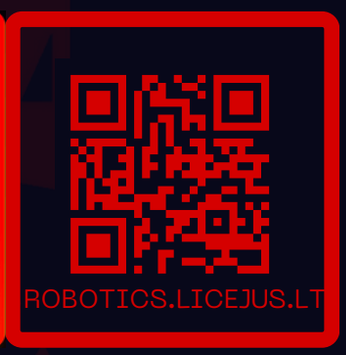
Comparing ourselves to other FTC teams, we decided that our strong suit is **CAD design**, therefore, we decided to give back to the community by sharing our creations. In our website anyone can find a useful design to use in their robot or just to gather inspiration – all **open source.** In addition, our website also provides **a respository on Github with our robot code** for anyone in need!

Dive into a wealth of **innovation** and **creativity** as you explore our project database. Each entry represents a part of our journey of learning.

You can access our project database by clicking on the pictures:







The main purpose of the website is:

- Share knowledge and experience.
- Inspire other people in STEM to join robotics.
- Introduce people to our team.
- Serves as a portfolio of our work and is accessible all around the web.
- Helps share the values and ideas of FIRST.

NON FIRST AFFILIATED TECHNOLOGICAL COMPETITONS

Adam, Nojus and Domas from Vilnius Lyceum robotics took on the "Ventspils IT challenge 2023" and obtained silver medals along with cash prizes.

Our team member Lina participated in the 2023 Vilnius Hackathon which was about solving safety hazards and received 5th place.

Domas and Saida competed in the EDTECH WEEK LITHUANIA 2024 hackathon and received a 2nd place.

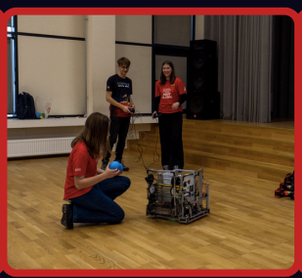
NON-TECHNICAL COMMUNITY OUTREACH ACTIVITIES

DECEMBER 18TH RAISING MONEY FOR BLUE/YELLOW UKRAINE CAMPAIGN

Vilnius Lyceum Robotics organised a "Cake day" fundraiser with the goal to gather money from selling cakes, pies, and all sorts of desserts for Blue-yellow charity. We raised a total of 1007 euros.

DECEMBER 22ND PRESENTING OUR TEAM TO VILNIUS LYCEUM COMMUNITY

Vilnius Lyceum Robotics along with team PlumBum presented our work to our school community with an interactive presentation and introduced FTC and FGC competitions.



MARCH 23RD – APRIL 15TH WORKSHOPS AT THE LITHUANIAN NATIONAL LIBRARY

Our team is organizing an educational program **later this April** for primary to middle school students to teach them about FIRST LEGO league.

FIRST RELATED OUTREACH ACTIVITIES

FIRST GLOBAL CHALLENGE, SINGAPORE 2023

Our team captain participated in **FIRST Global Challenge** which took place in Singapore, in October of 2023 as part of the **Lithuanian representatives** which received a gold medal.

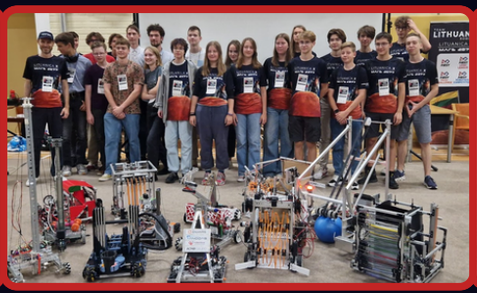
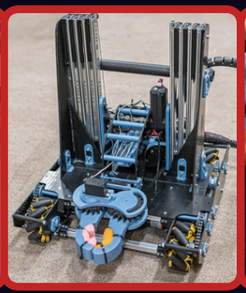
FEBRUARY 3RD, JUDGING AT THE LOCAL FIRST LEGO LEAUGUE

Vilnius Lyceum robotics had the unique opportunity to try their jury skills and participate as judges in FIRST Lego League. It was an amazing experience which taught us what makes some presentations better than others and how can we critically evaluate our own.

OUTREACH ACTIVITES

SEPTEMBER 16TH, LOCAL FTC SEASON KICK-OFF GAMES

Our team organised practice games to kick off the start of the new 2023-2024 FTC season which was our team's debut.


NOVEMBER 25TH, FTC BENELUX LEAGUE MEET AND TEAM DEBUT

Lituanica – Vilnius Lyceum Robotics attended our first FTC tournament. It was an eventful day and what is a competition without its obstacles? In the end, we managed to acquire 3rd place in ranking.



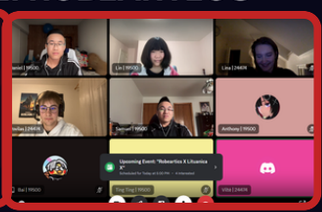
DECEMBER 9TH, LOCAL TRAINING LTX GAMES

Team 24474 once again organised a training session with other teams for a Christmas celebration in which we placed 3rd. Collaboration and communication with other teams was crucial for further development.



JANUARY 3RD: MEETING WITH CANADIAN FTC TEAM ROBEARTICS

Vilnius Lyceum Robotics joined collaboration project named World Wide Connection Project and participated in the first meeting with Robeartics team from Canada.

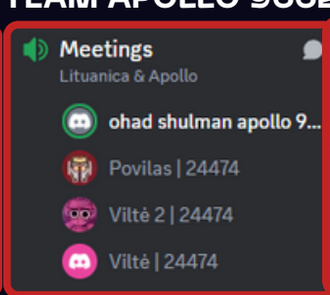


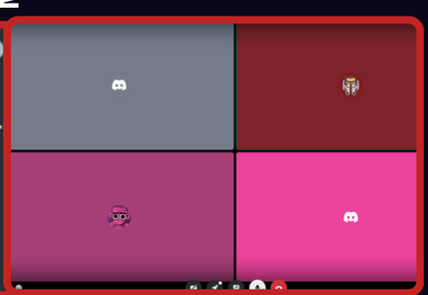
JANUARY 19TH, MEETING WITH FRC TEAM THE REMBRANDTS IN THE NETHERLANDS

Vilnius Lyceum Robotics team paid a visit to a renowned FRC team The Rembrandts. They welcomed us with open hands and showed us around their workshop, as well as introduced us to FRC, shared their experience and also gave useful advice for our FTC journey.

FEBRUARY 27TH, MEETING WITH TEAM APOLLO 9662

Vilnius Lyceum robotics team engaged in yet another meeting with a team from the WCP or World Wide Connection Project with a veteran team Apollo 9662. It was an engaging and productive meeting regarding portfolio, outreach, robot design questions.





MARCH 2ND, LTX GAMES BEING PART OF WINNING ALLIANCE

Vilnius Lyceum robotics team participated at Lituanica X Lithuanian robotics community FTC games which ended in us being part of the winning alliance.

MARCH 8TH–11TH, FTC ITALY CHAMPIONSHIP

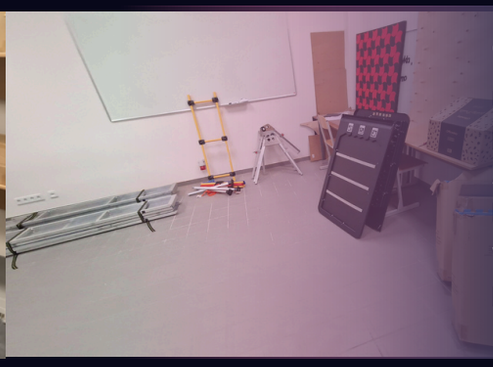
Vilnius Lyceum Robotics participated in Italy FTC Championship and received INSPIRE and PROMOTE awards.

APRIL 8TH , STEAM DAY

During the STEAM day, an event organised by our school, we spread the knowledge of FIRST and presented our team and robot to our school's younger community.

ESTABLSHING ENGINEERING ENVIROMENT FOR FUTURE GENERATIONS

Due to the **establishment** of our team this year, and our initiative, new **facilities** have been dedicated for engineering goals our school.



Thanks to our initiative a new printer will be purchased for student use. Around 1000 euros from the Lyceum's Support Fund are vowed to be allocated to the purchase of this appliance.

SPONSORS

ANODAS electronics KIRPTEX	2000€ worth of store credit Merchandise T-Shirts
Acme grupė STEAM ACADEMY Swedbank ŽALVARIS robotikos akademija	Financial contribution towards robot parts and manufacturing
CITY OF VILNIUS	Financial contribution towards travelling expenses
VILNIAUS LICEJUS	Tools, working spaces, financial contribution
IN RE	*Solidworks* consultations and financial aid
ANKST LINIJA	CNC cutting metal

ECO-SUSTAINABILITY

For our robot we usually 3d print a lot of parts and create a lot of waste. This year we partnered with chemists at Vilnius University and provided them with various samples of different plastic materials to run tests on and hopefully find better ways of removing microplastics from the ocean. We know that it's not much but we are still very happy to help out this cause.

BUDGET

2000€	REV and goBilda parts shipped from USA
850€	New 3D printer
628€	Workshop tool acquisition
873€	Locally purchased parts
450€	Robot transportation from Lithuania to competitions
2895€	Registration fees
7696€	IN TOTAL

ROBOT related content

TOOLS USED

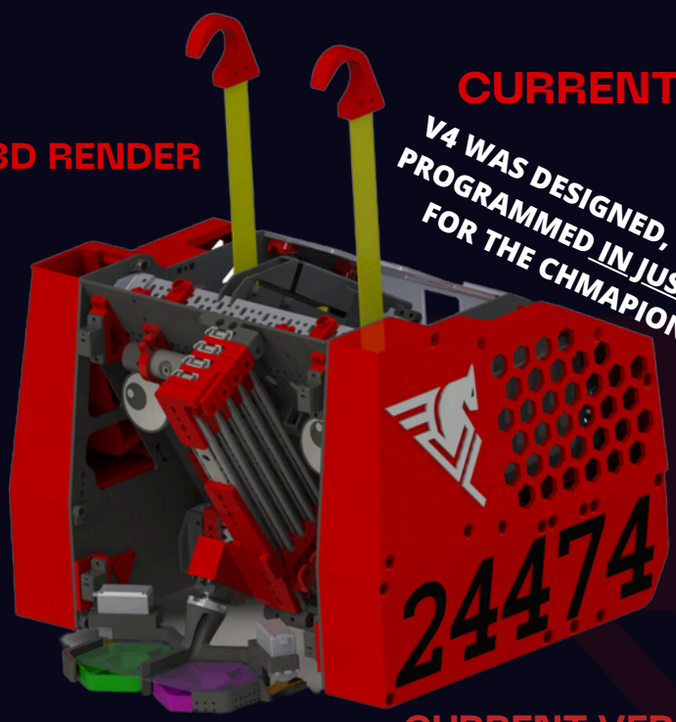
- The design of the robot was done in **Solidworks**.
- **Main tools used** were personal 3d printers and a laser cutter in the workshop.
- The parts were printed out of **Impact PLA, CF PLA, PETG or PCTG** plastic.
- **Acrylic, HD PE and wood sheets** were laser-cut.
- The suspension system uses tape measurers with 3d printed hooks for robot elevation

TECHNICAL INFO

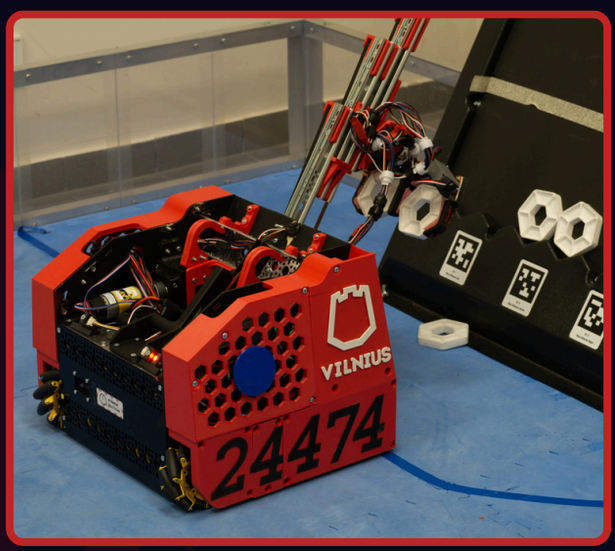
- Drivetrain: Mecanum (goBilda 312 RPM motors)
- Battery starting voltage: 13.9 V
- Lift full extension time: 2s
- Robot weight: 12kg
- Rigging suspension time: 2s
- Average score: This version of our robot has been made for the world championship after regionals so it has not yet competed in an official match.

CURRENT ROBOT VERSION

3D RENDER



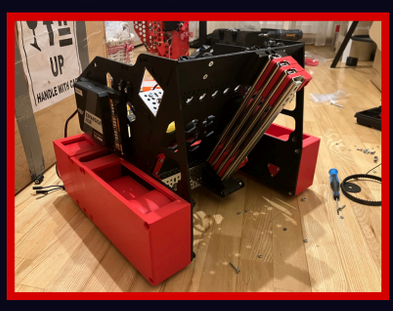
ROBOT ON THE FIELD

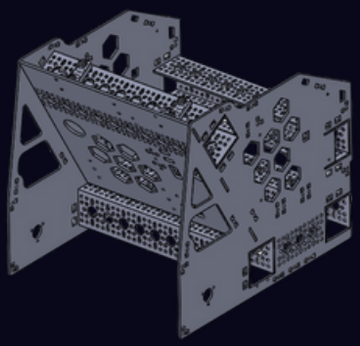


CURRENT VERSION DESCRIPTION

- **Version number:** **V4.2**.
- **Pickup and deposit:** **a double** pixel **gripper** system mounted on angled actuated pivot.
- **Structure of the robot:** goBilda U channel-reinforced frame, wooden side plates, 3d printed side armor plates
- **Drivetrain:** Mecanum wheel drive powered by **4 312 RPM goBilda motors**. 2 of the wheels are driven directly, and 2 of them are driven via #25 chain.
- **Plane Ejection Mechanism**: A custom plane launch mechanism created by our friend FTC team from the Netherlands (16409 Team Orange), that was modified by us to fit our robot.
- **Custom lift system:** belt driven, utilizes 5 goBilda 240 mm Viper slides mounted at an angle. The whole system is driven by 1 goBilda 312 RPM motor
- **Pull-up and hang:** 2 modules of the suspension system are used, each one powered by a goBilda 117 RPM motor. The lift utilizes tape from a tape measurer as a string that can stand upright on itself with 3d printed hooks attached to the ends.

DESIGN PHILOSOPHY BASED ON LESSON LEARNED THIS SEASON





- **Being a rookie team, we did not have as much experience and budget** as some of the other teams at the start of the season. However, we have learned a ton since then and have implemented the lessons into our **new robot which we are very proud of.**
- The **backbone** of the robot is the **frame assembly.** All of the other components **attach to it directly** which allows us to **change and fix systems easily,** something which was a **problem with V3.** We designed **V4** with **design modularity** being one of the main priorities.
- We tried to **combine simplicity with elegance** during the design process. The first few versions of our robots were too complicated and were prone to breaking, hence why we understood that **simplicity is directly linked to reliability** and designed V4 having this in mind.
- We **partnered up** with other teams, shared different solutions with each other and learned from one another.

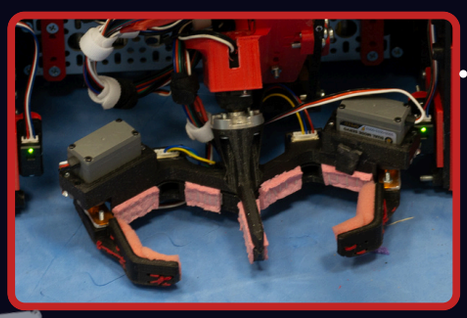
V1

CLAW

The Claw is the main pixel pickup and deposit system.

Old version:

- Used **SG90** servo motors to hold the pixels in place, which were not strong and could easily break



V5

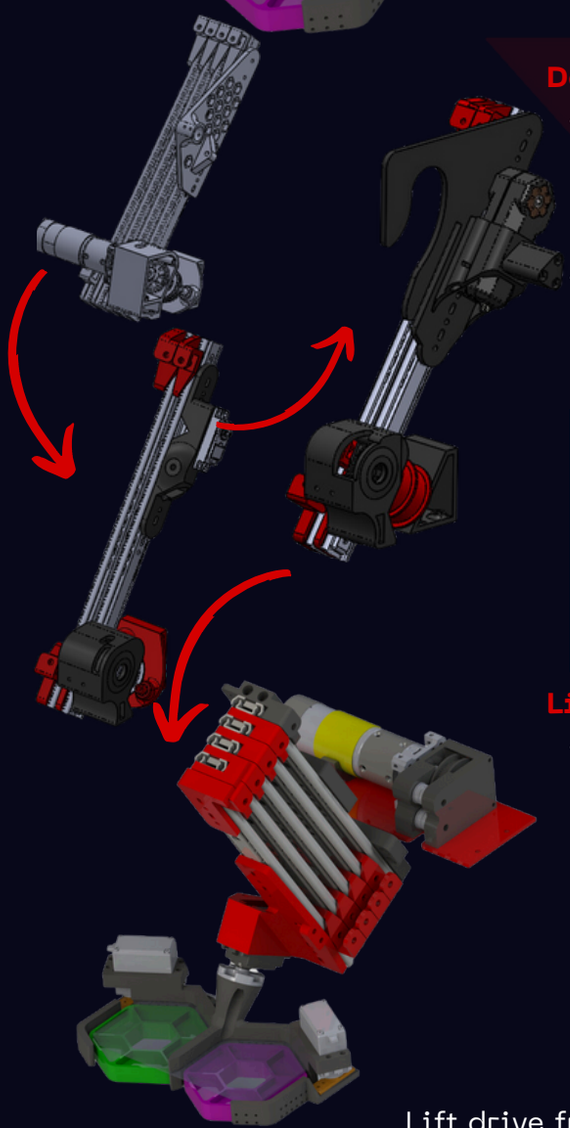
New version:

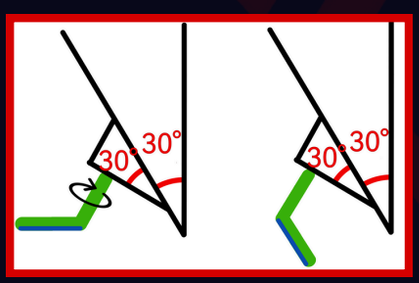
- Rotates to place pixels in front of the robot; no longer a need for the claw to rotate around the robot
- Uses sponges for maximum pixel gripping strength
- Uses **goBILDA speed** Servo motors

LIFT

Description:

- We're using a 5 stage belt driven lift (angled at 30 degrees) actuated by a goBilda 312 RPM motor. At the end of the lift there is a servo mounted at a 60 degree angle.
- The servo is attached to the claw and this specific pivot point allows the claw to pick up and deposit pixels from the same side of the claw.

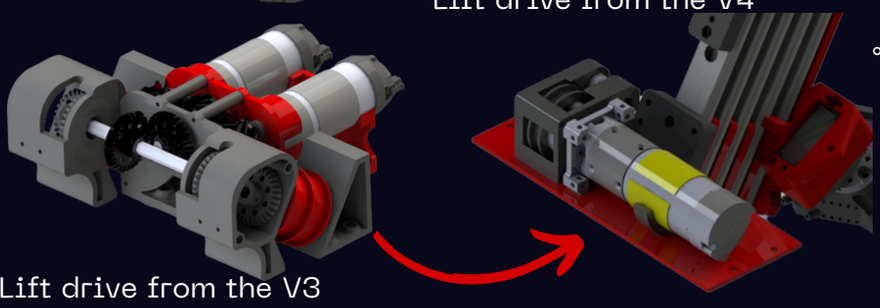




Lift version progression:

- The lift on V4 is critically different from the previous versions:
  - The new lift is using 5 224 mm goBilda Viper slides and is angled towards the front of the robot as opposed to using 336 mm Viper slides and being angled toward the back of the robot in the previous versions. This allows the robot to be more agile and fast around the field **<u>reducing the cycle time from 30s to only 15s!</u>**

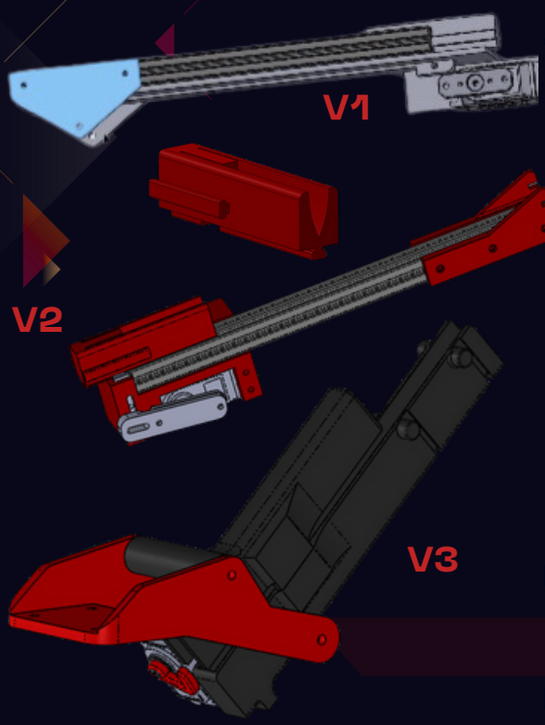
Lift drive from the V4



Lift drive from the V3

- Our previous robot versions also used the lift as a suspension system. By changing this we were able to trade a complicated 2 motor helical gearbox into a simple motor-pulley system.

PLANE EJECTION MECHANISM



Creative process:

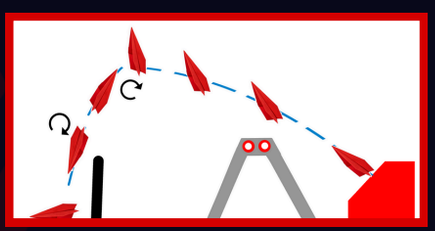
- This season we made and used 3 different versions of our PEM system that used a plane carrier, guided through a REV 15 mm extrusion to launch the drone. We tried both springs and rubber bands.
- On the current robot we have mounted the 3rd version of our Plane launcher. The base design was gifted to us by our good friends from the Netherlands (16409 Team Orange) that we met in the Benelux Championship. We have highly modified the design to suit our robot's needs better.
- The plane is launched when a servo releases the rubber band holding the drone.

Result:

- This plane mechanism allows the robot to consistently score 30 points during end game.

Plane:

- The plane is made from half of an A4 paper sheet and it has flaps on the back to slow it down during flight. This allows it to regularly land in the 30 point landing zone.



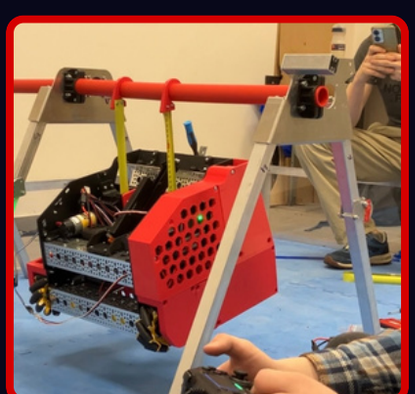
SUSPENSION SYSTEM MODULES

Creative process:

- This is the second version of this particular mechanism, however it is the 4th way we approached the challenge of a robot climb.
- Our team is using an innovative out-of-the-box solution where we used the tape of a 25mm wide tape measurer as a string that stands up on itself, but is still flexible in a way that the robot can pull itself up by winding the tape.

Working principle:

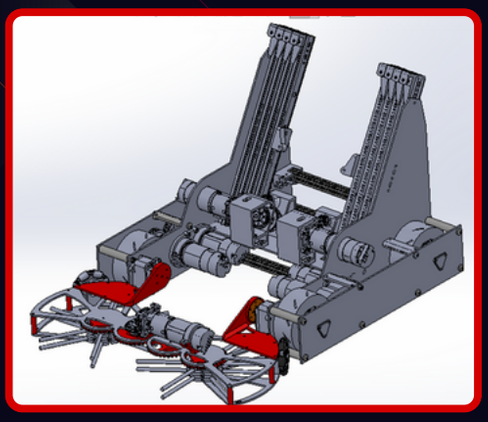
- There are 2 suspension modules on the robot that work independently from each other.
- Inside each module a pulley can be found onto which 70cm of tape is wound. The end comes through the top hole and extends with the hook attached when the pulley is unwound.
- Each module is driven by a goBilda 117 RPM (6.7 N/m) motor, which turns a pulley with a radius of 0.025m. The robot weighs 12 kg. If we calculate the maximum theoretical mass that one module can pull up:
  - **F=τ/r => mg=τ/r => m=τ/(r*g)=6.7/(0.025*9.8)=27kg**
- We understand that even just one motor can pull the robot up itself. These specific motors were chosen for this reason because if one hook failed to latch onto the rigging the robot would still be able to lift off the ground and score 20 points.

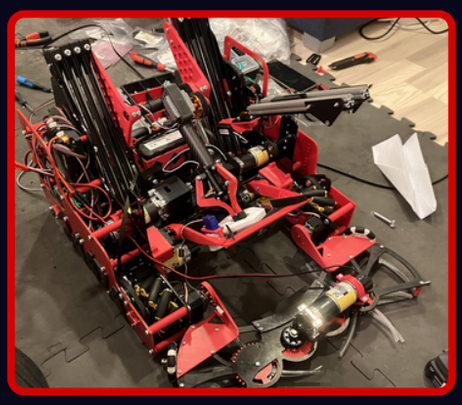


Previous Centerstage robot versions

We have come a long way in just one rookie season...

Here are all the things we learned from previous versions of our Ceterstage bot



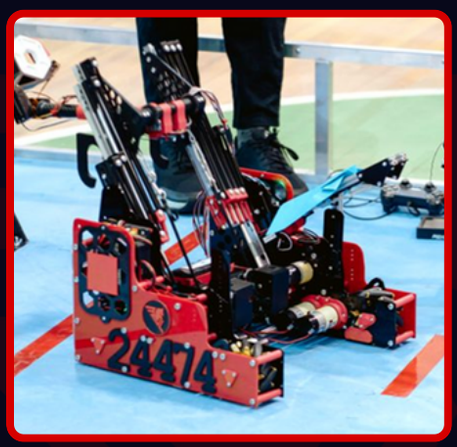


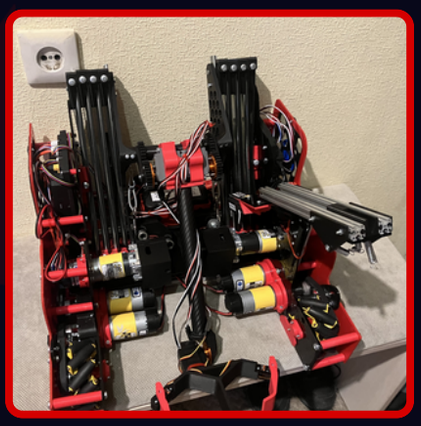
Version 1

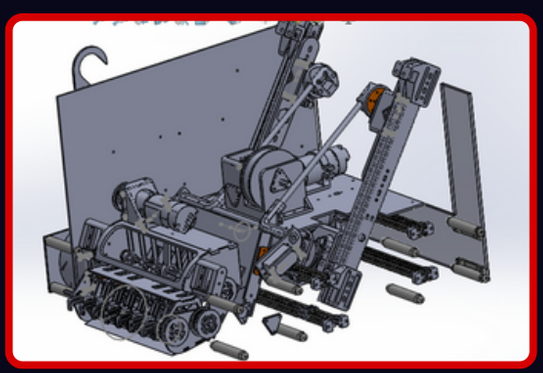
- This robot was too complicated – the pixel had to get through an active intake, a passive transfer system and center itself so it could be picked up by a inside-pixel grabber. It did not work that well. **We learned that the most simple solution is the most reliable solution and therefore the best solution.**

Version 1.5

- This was a modification of V1. We took out the complicated pixel pickup and transfer unit and installed the first claw. It worked much better, but the robot was weak, prone to breaking and not structurally stable. **We learned that structural stability of the robot is a top priority.**

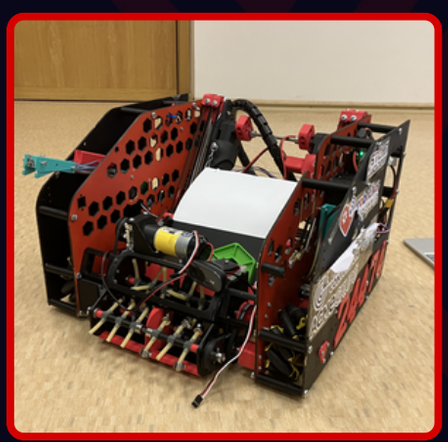






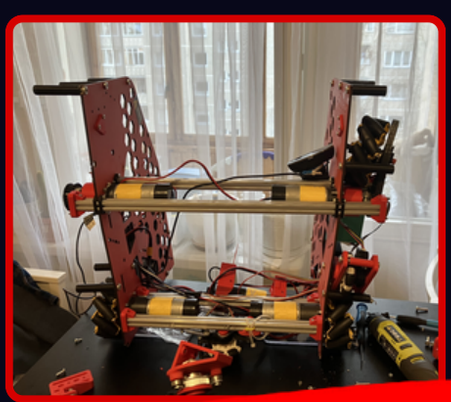
Version 2

- We redesigned the whole robot from scratch and tried making a custom vertical intake system. This time we used more structural supports on the robot. The side plates were made out of spray-painted wood. The structure was a lot more stable, but the intake was prone to jamming. **We learned that a good active intake takes a lot of time to perfect and should use an active bottom roller instead of a passive ramp.**



Version 3

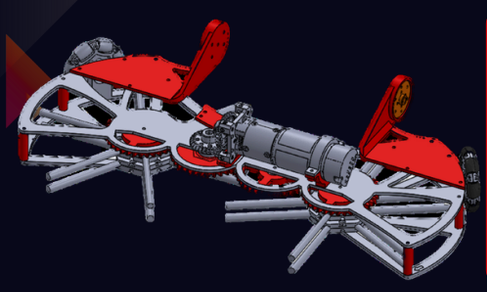
- This time we re-used the drivetrain and side plates of V2, however the lift, hang system and PEM underwent major changes. The active intake was scrapped and we modified the gripper design used in V1.5 and used it instead. However, this version had major disadvantages too. The design was non-modular, therefore to change out a single system, the whole robot had to be taken apart. Moreover, the pixel pickup and deposit was happening at different sides of the robot, which prevented us from being able to use big servos on the claw and made the deposit process slower. **The key thing that we learned was that robot modularity and fixability is a key design feature separating good robots from great ones.**

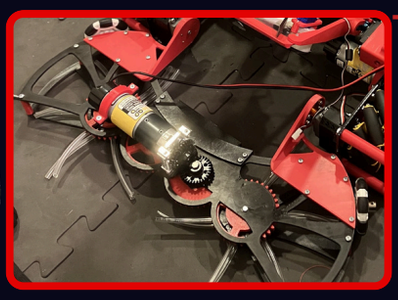


While designing the Version 4 we fixed all of the problems listed above and we consider it to be the best robot our team ever built!

Scrapped systems and assemblies

Having tried a lot of different approaches to this season's challenge, we were left with multiple unused systems that we poured a lot of hard work into. We believe that they demonstrate our team's progress over the season and wanted to showcase them here.



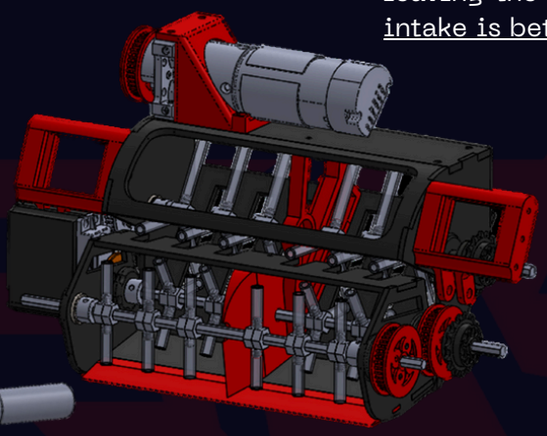


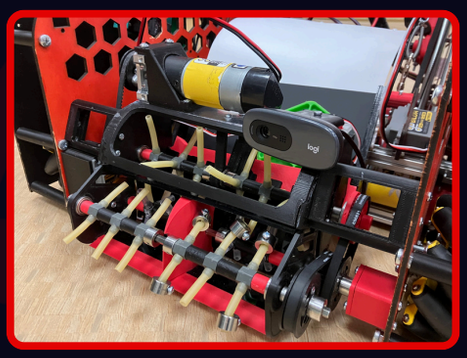
The butterfly intake

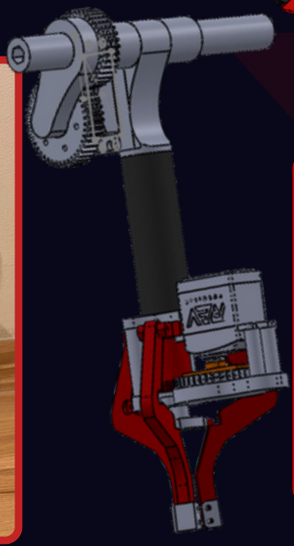
- This was the first intake system we designed this season and the 5th version of it was used in V1. It was a horizontal intake mechanism driven by a goBilda 312 RPM motor via mitter gears. The system was great at picking up pixels, but horrible at transferring them, since they could not be propelled upwards after leaving the system. <u>Lesson learned: a vertical intake is better.</u>

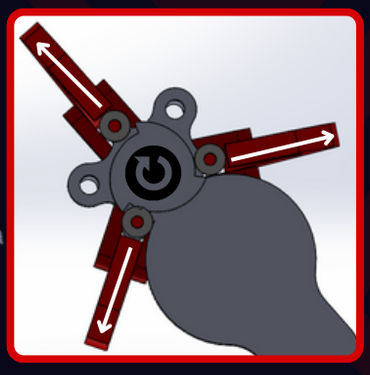
The double decker intake

- This was a vertical intake system designed for V2. It had 3 rollers, all of which were connected by belts. Because it did not have a bottom roller, the pixels were prone to jamming inside the system.







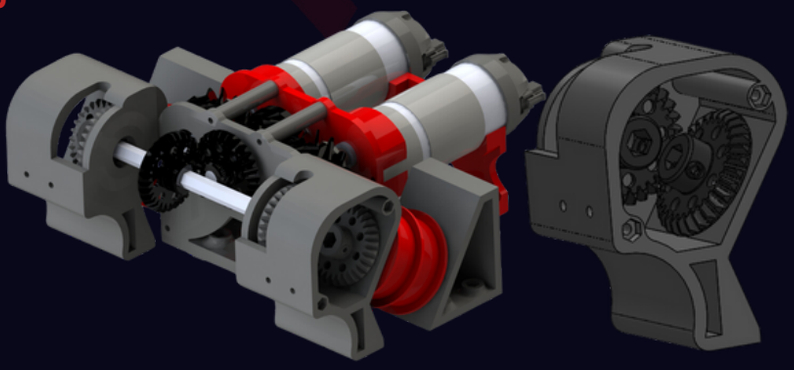


The triple gripper

- This was an alternative system dismissed after being used in V1. It was applied to pinch pixels from the inside by 3 grabbers actuated by a mechanism shown on the left. It had a few problems, like needing precise alignment, difficulty depositing 2 pixels at the same time and just being too complex.

30 degree gearbox and helical motor setup

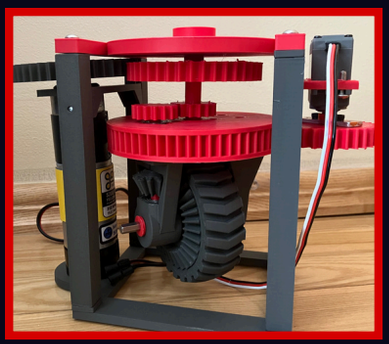
- This gearbox design was used in all of the robot versions until V4, when we switched to a single lift system. It used to have the lift driving shafts at a 30 degree angle, allowing to mount the motors parallel to the ground. On the right, the motor and gearbox setup from V3 can be seen, where this gearbox was a vital part of the design, along with other bevel and custom helical gears.



Honorable mentions:

PID-controlled carbon fiber robot arm

Custom cost-effective mecanum wheels



Experimental coaxial swerve drive

PROGRAMING

AUTONOMOUS

One of the main features of the code is it's modularity

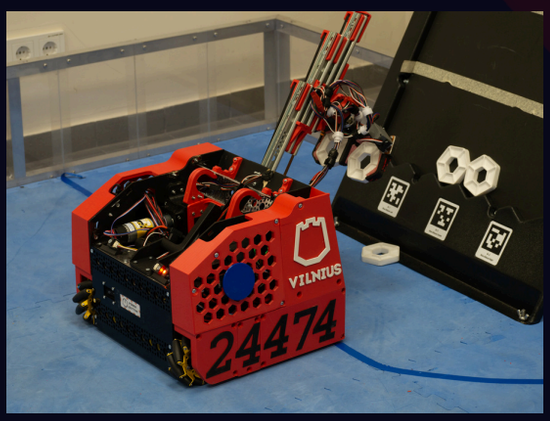
There is only one autonomous opmode that we configure with the controllers before the start of the match. During the autonomous period it is able to score up to 50 points for the team.

FIGURING OUT THE TEAM PROP'S POSITION

Using **TensorFlow**, an open-source library for machine learning, the camera looks in front of it to figure out the prop's position.

CHANGES

At first there was an attempt to write our own custom motion library, however it was inefficient and risky, so we resorted to Roadrunner. Our own custom motion library is now a project left for next season.



DEAD WHEEL ODOMETRY

The dead wheels measure displacement of the robot on the field. Not only do they play a crucial role during the autonomous period, they also have enough accuracy to place the yellow pixel on the correct position on the backboard, meaning there is no need for reading AprilTags.

CONTROLS

LIFT CONTROLS
Raises and lowers the lift.

MODE TOGGLE
Toggles between normal and backboard driving modes.

SUSPENSION SYSTEM
Lifts the hooks of the suspension mechanism and pulls the robot up.

ROTATION
Rotates the robot left and right.

DRIVING
Drives the robot forward and backward, strafes left and right.

CLAW
Opens and closes the left and right claw respectively.

PROGRAMING

LIFT & CLAW

The lift has 8 positions, 2 of which are with the claw down (ready to grab pixels off of the ground) and 6 with the claw up (ready to place on the backboard).

One of the claw-down positions is used to get pixels off the ground. The other one is for lifting the claw up just a bit to not scrape the field and cause damage.

SENSORS

CLAW SENSORS

Distance sensors in the claw are used for detecting when pixels are in or near the claw and automatically close the left or right side accordingly. This greatly speeds up teleop cycle times.

These sensors are active whenever the claw is placed on the lowest position.

BACKBOARD SENSORS

Sensors mounted on the very bottom of the robot are used to look at the flat part of the backboard near the ground. They are used to automatically align the robot with the backboard. This mode is engaged when:

a) the lift reaches any of the positions with the claw up,
b) it is manually triggered by the driver.

LED INDICATORS

The robot has two LED indicators mounted on the back. They are primarily used to indicate claw status.

Each LED (left or right) corresponds to its respective side of the claw.

An LED glowing red means that the claw is closed.
An LED glowing green means that the claw sensors have detected a pixel.
An LED glowing amber means that the claw is closed and that the claw has a pixel inside.

Both LEDs blinking red means that the claw is in its carry position and is unable to pick up pixels.