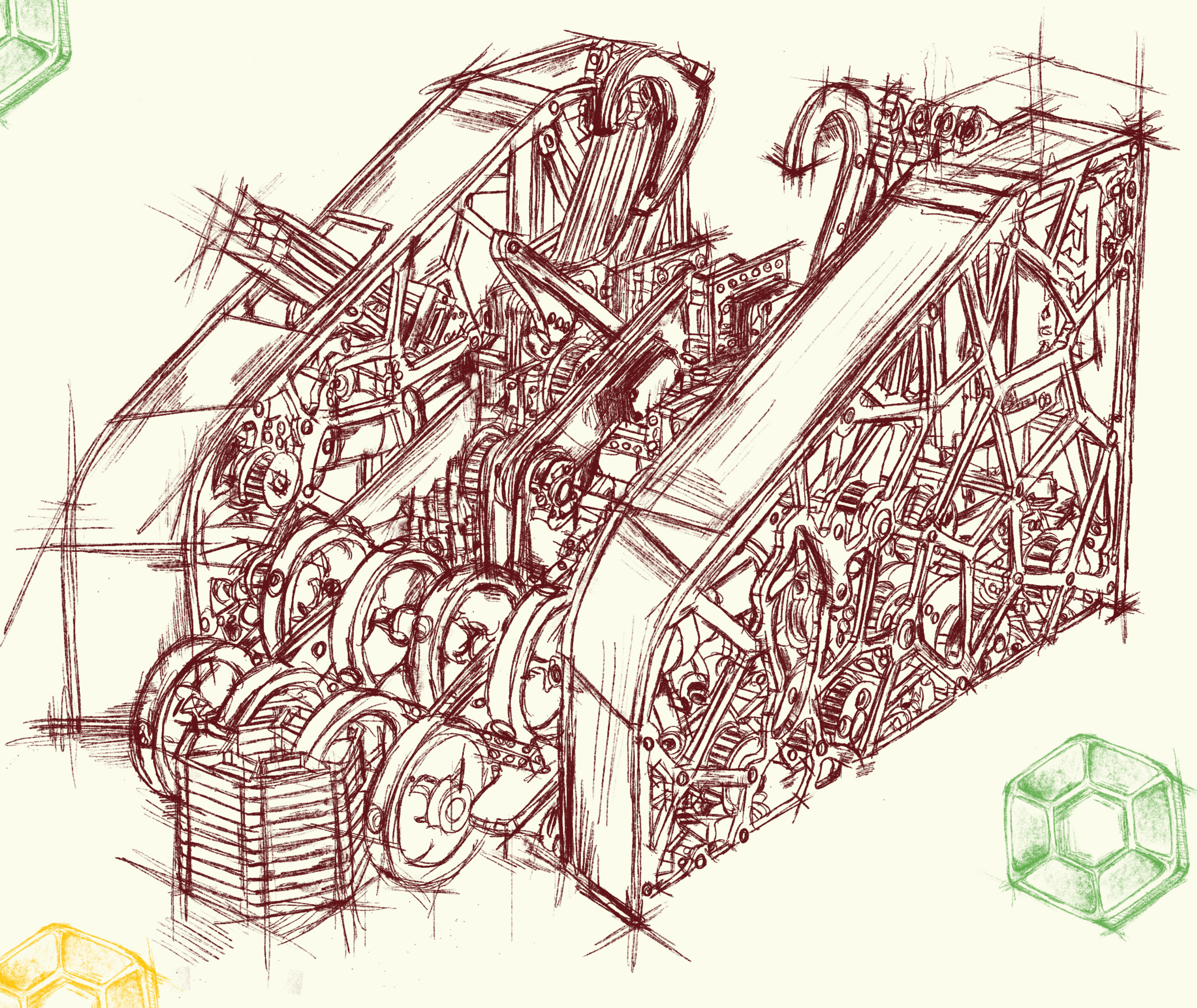
Engineering Portfolio

19044



Peppers

English Version

OUR TEAM

WHO ARE WE?

In the last 5 years we managed to establish our team's identity in the FTC community through a well-thought -out sustainability plan and a strategy that evolves every season, following our needs in order to organize the team, an aspect which ensures the continuity and the evolution of our events quality and the performance of our robot. We are team Peppers 19044, from the Computer Science High School "Grigore Moisil Iasi", Romania, a team made up of 15 members, 6 volunteers, 5 peer-mentors and 4 mentors. Our members are passionate about everything they do, looking for new principles to discover in order to learn as much as possible. They constantly promote the fundamental values of our team, these being visible on the bottom of every page. In the past years, we evolved from a team that does not participate in the regional competition to one that qualifies for the international stage.

OUR MISSION

Although we try to build competitive robots and participate in international competitions, achieving the best results possible during the matches, our main goal is to attract as many people in the world of robotics and FTC. We want our events to be all-encompassing for as many applicable fields, with the purpose being to reach a variety of age groups. Since the beginning of our activity we managed to actively promote the STEAM core values, both through the events we organized, but also through our sustainability plan.

TEAM GOALS- PEPPERS STEM HUB

A STEM HUB's purpose is promoting and guiding students passionate about science; it also represents a safe haven that unites people through research, creativity and innovation, with the goal of promoting an inclusive education accessible for everyone. We did this both through the offered mentorship, but also through the events we organized, exceeding our objective with an impact of over 9350 people, increasing our impact by 375% compared to last season with 12 events. Since the beginning of our activity we have managed to inspire 5 schools from rural areas to open their own robotics club, continuing our mission of spreading the appreciation for STEAM domains.

OLD MEMBERS - 6 | NEW MEMBERS-9

TEAM PHOTO

TEAM STRUCTURE

Mentors
|
Peer- Mentors
|
Captain
Technical Leader — Non-Technical Leader
Members & Volunteers

This season was about the training of the new members, calling on qualified professionals to share their knowledge and experiences with us. We also put in effort to offer mentorship in order to follow our sustainability plan.

100 hrs

OUR OBJECTIVES

This season we oriented our objectives both on spreading our knowledge and our experience and on making our passion for STEAM and the importance of the domains in which it can be applied visible, whilst also maintaining our performance on the playing field. Our plan to achieve these things is based on a well thought-out team structure and on the members ability to work towards a common goal. One of our most important internal ways of training is based on assertive communication and how to complete your tasks through the creation of efficient strategies. Our members have the occasion to work on both the technical departments and the non-technical ones, thus training their analytical thinking and problem solving skills.

Our team assures its continuity through the mentoring of young students in 2 competitions- FLL and NextLab- preparing them to join us when they get to high school. Our strategy consists of incorporating the values STEAM promotes through interactive activities.

100 mentored

The older members prepare to become mentors by collaborating with our alumni, and by offering advice and taking care of organizational tasks and events, working close to sponsors. They are the main source of information for the leaders.

8 future mentors

The new members are trained to be future leaders, preparing by building their own robot, organizing their own events and documenting every task they receive, whilst also improving their communication skills.

4 future leaders

We manage our workload through advance preparations, planning every event a month before it is put into motion. Our robot is built using the principle of fast prototyping, which stands for testing every mechanism, whilst projecting another.

4 robot versions

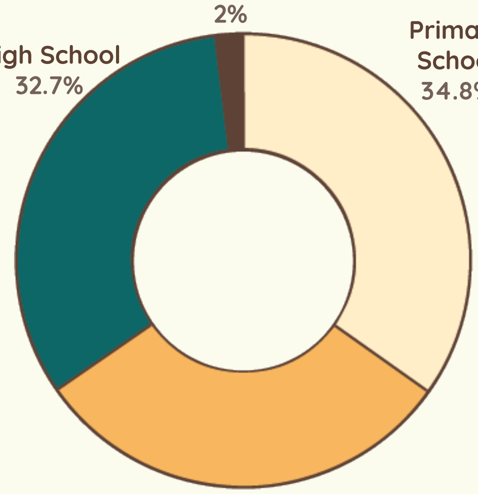
BRANDING

After we established our identity as Peppers and finished the transition from Cyliis Peppers to Peppers, we had the opportunity to further individualize ourselves. Peppers is, by all means, an organization responsible for national and international events, that connect people from all age groups and from various social categories. In this season, our influence was widespread, with a total impact of 9350 people. Our brand consists of everything we do - our events and how well they are organized, every post we make and every conversation we have with other teams or our sponsors. Because of this, our projects are varied - a newspaper, a podcast and social media campaigns.

We also make our presence known in the media in order to increase the visibility of our activities, using interviews as a part of our marketing strategy for various campaigns. We appeared on newspapers, radio interviews and on TV, through contacting these media companies, resulting in almost 50 interviews in the last 6 months.

We started a new initiative to reach the people passionate about STEAM through every way possible. This is how PeppNews appeared - a newspaper with news about the STEAM community in Romania. Through this project we appreciate the associations who are specialized in research at a national level. Until the 22nd of March, 5 articles have been posted, with over 1500 readers. We also post fun facts about these organizations on Instagram.

IMPACT ON DIFFERENT AGE GROUPS THROUGH OUR ACTIVITIES

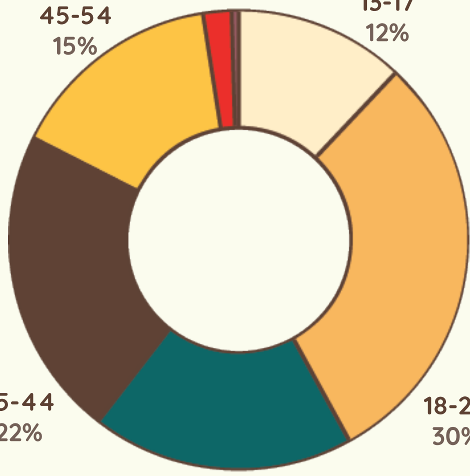


AI ART VS HUMAN ART SOCIAL MEDIA CAMPAIGN

We created a social media campaign through which we want to show the effort that artists put in and to appreciate creativity, comparing their creations with the ones realized by AI. Other FTC teams provided us with themes, and our members and other highschool students and artists, students of "Octav Bancila" Arts High School interpreted the themes given.

3000 views

IMPACT ON DIFFERENT AGE GROUPS ON SOCIAL MEDIA PLATFORMS



GROWTH RATE ON SOCIAL MEDIA PLATFORMS IS 447% HIGHER THAN THE LAST SEASON

The visual identity of the team is improved and better contoured every year. We have a mascot and a color palette, its hues changing based on the event we are trying to promote and logos for tradition labeled events.

VISUAL IDENTITY

0A1B2F

056566

PEPPIE

D94446

FDEC60

PEPPERS IN NUMBERS

This season, our impact on social media platforms increased by 118% - we appeared on the feed of 12000 people in the last 3 months, by posting approximately 30 times a month and by receiving 150 likes on our posts. We create our posts based on the target audience - on Instagram we target the younger audience, whilst on Facebook we post for sponsors, professors and parents. The branding was also easier because of our consistently well-performing robot and thanks to our competitions results. Since the beginning of the season we focused our attention on the autonomous aspects and on the time reserved for training the driving team in order to help them improve their communication skills.

OUR APPEARANCES ON FUN (FIRST UPDATES NOW) TOP 25 - 24 JANUARY & 14 MARCH 2024

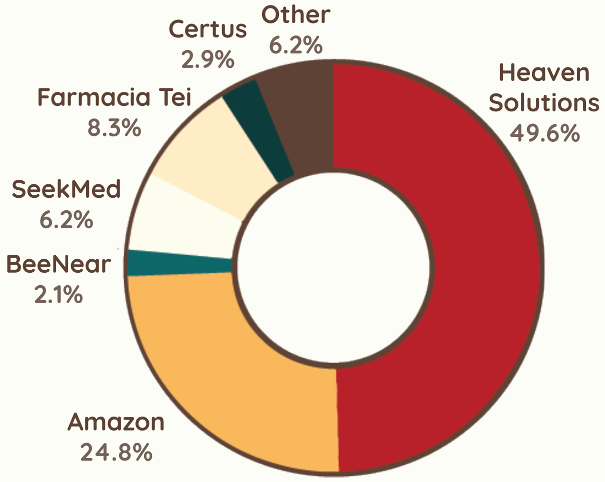
Our members on the technical departments are also involved in marketing and branding in their own way, by promoting our robot to other teams. Because of their efforts, we achieved 11th and 16th place on Top 25. With their help we create alliances for competitions and train with other teams.

TEAM VALUES — We are full of compassion, trying to create an ideal workspace where everyone can feel welcomed — **EMPATHY**

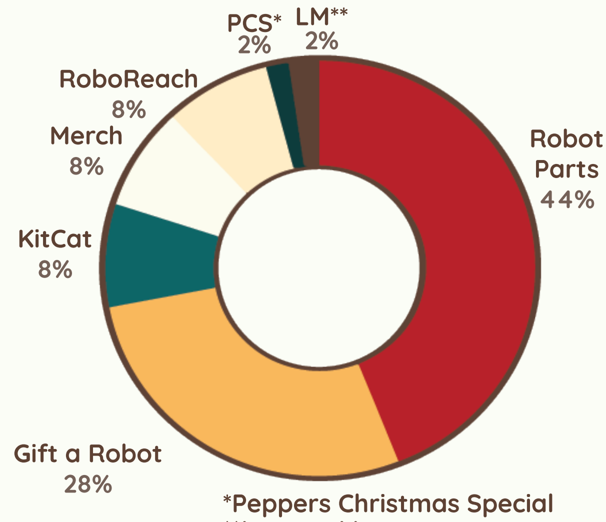
FUNDRAISING

This season we put in the effort of raising enough money in order to improve our robot. We established our image as a trustworthy team with a tangible impact in our community, which gave us the opportunity to collaborate with companies oriented on STEAM, who wanted to offer us their support. We managed to raise 121.000 RON, their use being visible on the charts below. A part of the money raised will be kept for the possible participation in MTI.

SPONSORSHIPS - 121.000 RON



SPENDINGS - 25.000 RON



*Peppers Christmas Special
**League Meets

Our fundraising strategy and the sponsorship packages that we perfected and are now used in NGOs made of students from all over our city. We have a list of 600 sponsors from all categories - hotels, restaurants, coffee shops and IT companies, whom we contact based on the necessities we have at the moment.

FUNDRAISING OBJECTIVE
70.000 RON

TIMELINE

SEPTEMBER
8-10 -> BRI & Kickathon
12 -> Team rules revision
14 -> Visit from the Senior Advisor at Heaven Solutions
20 -> Visit at Exonia in order to plan our partnership
29 -> Participation at Noaptea Cercetatorilor
29-31 ->Event organized by Casa Auto, Back to school

OCTOBER
2 -> Restarting the mentoring of the FLL teams
3 -> Interview with TVR
7 -> Training with Adia Romanescu from ASII
18 -> First meeting with RoSophia in order to organize our first League Meet
20 -> First PeppTalks interview
22-31 -> Peppween
28 -> Meeting at FabLab Iasi

NOVEMBER
4 -> FII IT-ist conference
9 -> Training with Adia Romanescu from ASII
11 -> Teambuilding
18 -> First meeting with VoltaCircuits for our League Meet
20 -> We started working on our Portfolio
23 -> Training with Catrinel Zaharia
24 -> Driver try-outs
25 -> Training with Adia Romanescu

● Technical departments events
● Non-technical departments events

DECEMBER
1 -> Marea Unire a Roboticii Demo
11 -> Erasmus+ presentation at Hotel Traian
11-19 -> Peppers Christmas Special
20 -> Interview with CyLiis
28 -> Training with Victor Tcaciuc
30 -> Teambuilding

JANUARY
3 -> Interviews for the Dean's List semifinnalists
9 -> Visit from the town mayor
10 -> Last meeting with Volta Circuits before the League Meet
20 -> League Meet with Volta Circuits
22-23 -> Meeting with Vreau sa Studiez in America
30 -> Meeting with Adia Romanescu

FEBRUARY
3 -> Rosophia League Meet
10 -> PeppNews preparations
13 -> Interview Trainings
20-> KitCat preparations
25 -> AI Art vs Human Art Social Media Campaign
27 -> Dean's List interviews
29 -> Interview trainings

MARCH
5 -> First PeppNews article
8-11 -> Regional Championship
13 -> Starting KitCat
14 -> FTC Top 25 - 16
15 -> PeppTalks with RoSophia
18 -> Podcast Alecsandri
18 -> RoboReach at Liceul Special "Moldova" Targu Frumos and the Special school "Ion Holban"
22-24 -> National Championship

TEAM VALUES

All members work equally, everyone doing it for the love of robotics and this team

PASSION

MENTORSHIP

OFFERRED MENTORSHIP

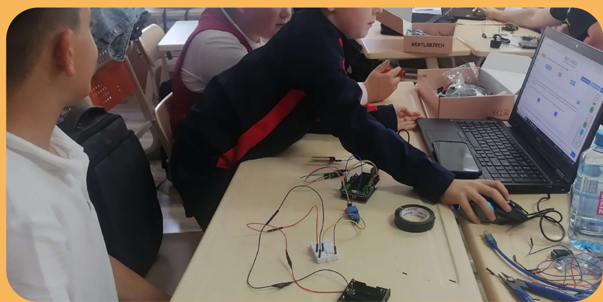
100 MENTORED IN TOTAL

FIRST LEGO LEAGUE EXPLORE

For the past two years we have been collaborating with "Carol I" primary school by mentoring 100 students, maintaining our sustainability. Last season we focused on making them understand the basic principles of robotics, setting the foundation of their team, whereas this season we managed to guide them into becoming a truly competitive team, whilst also maintaining their image as a united collective. They learned introductive marketing and design notions, made tshirts, stickers and a team logo, thus creating a well-defined visual identity for their team. As a result of their consistent work both on the technical and the non-technical departments, they managed to achieve first place in the programming and innovation sections at the national stage of the competition. When they get to middle school they will attend a FIRST LEGO League Challenge club, later joining us in FTC.

NEXTLAB

We wanted the FLL Explore students to experience more complicated competitions where they could use their programming knowledge in programs such as C++, Arduino, Python and Java. Through this they managed to evolve both as a team and as individuals. This competition also gave them the chance to become truly innovative and creative people. They participated in the first two stages that included courses followed by the building and programming of a line follower robot. Their biggest achievement this year was not only surpassing their limits but also learning elements and Arduino basic projects, training their analytical thinking. We were there for them at every step, offering them courses and necessary resources, from Arduino kits to laptops and tablets.



FTC TRAINING

AVOCADO ROBOTICS

We always try to share our experience and inspire other students to truly understand the way FTC works. This year, when facing the problem regarding FLL, our colleagues from middle school decided to tackle FTC, viewing it as an opportunity to develop their knowledge in programming, CAD, design and marketing. We mentored them throughout this change, helping them with their robot and their Engineering Portfolio. Even though they will not attend the National stage of the competition, they have hope and activities prepared such as the STEAM Mentoring Weekend planned for the upcoming period.

PEPP HELP

Finding out that both the regional and national stages of the competition will be held in our city, we decided to view it as an opportunity for our team. We established a project through which we want to help other teams with anything they need. It started with the team StefTech, who needed us to print robot parts and roll-ups for the competition, followed by Robozzi, who required practice on our playing field, also needing help with the autonomous programming. We reached a total of 20 teams helped until the current moment, including Ro2D2, who used our launcher design for the regionals, CyberLis and Volta Circuits. Up until the regionals, our plan was simply to help teams from Moldova, with the hope to expand and offer assistance at the nationals with anything they might need, including finding food and accommodation options. We also started filming reels with advice from experienced mentors of teams with members who are just starting their journey in FTC.

Another important step to increasing the FTC community in Romania was publishing our Engineering Notebook, sending it to other teams such as Delta Force and offering them ideas and advice on how to work efficiently and correctly in order to finish it on time. The international and the regional Engineering Portfolio & Notebook are public.

20 teams helped

TEAM VALUES

We are focused on achieving success regardless of the problems we face

PERSEVERENCE

MENTORSHIP

RECIEVED MENTORSHIP

100 HRS

MENTOR TEACHERS

They are our guides in the financial decisions of the team and in our connections with sponsors. Their role is organizational, whilst also helping us evolve as leaders, creating a suitable team plan and a structure that can help us both as a team and as individuals.

OUR ALUMNI

We were guided by 6 alumni who helped us not repeat their mistakes and prepare the future generations regarding all aspects of the team. They also helped us by establishing contact with various companies who trained us by organizing workshops regarding fundraising strategies or assertive communication for the improvement of the course of our activity. We spent a total of 100 hrs learning from others.

ORGANIZATIONS

We reached out to different organizations to support us by promoting us on their social media platforms, in exchange for our presence at their events. We participated in events such as FII IT-ist, organized by ASII(Asociatia de Studenti Informaticieni Iesenì) where we had the opportunity to learn beyond the base of frontend development and test large language models and AI generation. We received specific mentorship for some events, such as the one offered by Sorbonne University of Medicine for KitCat. For our robot, we discussed with a physics professor from Aalto University in Finland, who is also a Senior Advisor at Heaven Solutions. He offered us numerous ideas and advice.

FUNDRAISING	GRAPHIC DESIGN
Catrinel Zaharia, Manager at FabLab Iasi and our alumnus, Ana Acsinte	Adia Romanescu, Graphic Designer at Heaven Solutions ASII (Asociatia de Studenti Informaticieni Ieseni)
MENTORARE TEHNIC - Matti Hämäläinen from Aalto University and Exonia Theodor Bulacovschi - Student at University of Pennsylvania	

INTERNAL TRAINING

HOUSE OF ROOKIES

House of Rookies was a bootcamp organized in two rounds; each of them included a teaching and a testing stage, through which we discovered the potential of every participant, in order to see who is a truly good fit for our team, whilst also helping them discover their passions by preparing interactive activities in the fields covered by STEAM. We held courses for PR, fundraising, graphic design, and principles such as color theory or how to work in Illustrator, CAD, programming and popular mechanisms in FTC and the physics behind each one. The event was successful, with a total number of 300 participants. 18 of them were recruited.

STARTER EVENTS (PEPPWEEN)

We use the principle of learning by doing, even when it comes to the training of the members. The new members are guided by the alumni and the team leaders into organizing their own smaller events in order to practice promoting activities both through social media and by starting partnerships with companies. The new members came up with this idea during a brainstorming session in which we were deciding what to do in this edition of PeppWeen to achieve tangible impact through this initiative.

BOBOT

No matter the department they wanted to apply to, the new members had to pass through specialized technical training. This was realized by building a robot for the PowerPlay season, with which the members participated in matches and competitions during the summer. This was also a chance for them to see the flow of the competition, making stickers, rollups and building a robot. They managed to interact with other teams before the starting of the current season, preparing for the future competitions. This process continued at Kickathon, where the people involved were also mainly the new members in our team.

EXONIA MENTORSHIP

Before the start of the season we were invited to the opening of Mercedes Showroom Iasi, where we got in touch with a local company called Exonia, which specializes in the fabrication of paper bags. On the 20th of September 2023, we visited them, learning about optimal methods of designing our robot in an industrial manner and how we can use our abilities developed through FIRST Tech Challenge in the professional world. During this visit they came to us with an interesting challenge in order to test our aptitudes: a robot that can test certain particularities of the paper bags designed by them. Throughout the season we maintained contact with them, constantly constantly presenting our ideas to them.

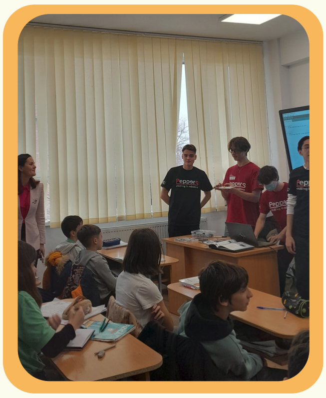
MATTI HÄMÄLÄINEN

Matti Hämäläinen is senior advisor at Heaven Solutions, our main sponsor and a physics professor at Aalto University, and together with the company's CEO, Cristian Micliuc, he visited us on the 14th of September, being interested in getting to know us. We held a presentation in which we explained what FTC means and what we do as a team participating in this competition. Because of his expertise in engineering and programming, he wanted to learn as much as he could about our robot and our building process. We spent about an hour talking about all the mechanisms that we built throughout the season and the algorithms behind them.

TEAM VALUES Hands-On learning lays the foundation for the improvement of every team member **EXPLORATION**

ORGANIZED EVENTS

GIFT A ROBOT



MOTIVATION

Therateofschooldrop-outinthelast10years>15%
Source: PISA - Programme for International Student Assesment

These statistics highlight the importance of our initiative of promoting education in rural areas, which represent the main cause of the problem listed above. We want to make learning more attractive, hoping this will encourage the students to remain in schools, trying to guide them to as many fields in STEAM. This project had a tangible impact in the community, resulting in the formation of 5 robotics clubs amongst middle school classes. The sponsorship contract is valid until June 2024, hoping that through it we will get to at least 13 schools.

THE CONCEPT BEHIND

Gift a Robot is a project through which we visit students from schools placed in disadvantaged areas in our county. We created an Arduino UNO guide, explaining 5 starter projects, later teaching the students the basics of Arduino and C++ programming. The organizational, travel and expenses matters were taken care of by the COTE organization.

5 SCHOOLS
400 STUDENTS

OCTOBER 2023

PEPPERS CHRISTMAS SPECIAL

CONCEPT

This event was organized with the intention of promoting STEAM education amongst primary and middle school students during the holiday season. We taught classes from multiple schools from our county, preparing experiments and interactive games in order to highlight basic notions regarding chemistry, programming and various branches of engineering, captivating the future generation with a practical approach on the STEAM domains. The majority of the students we interacted with were really receptive and keen on learning, contacting us later on about advice on how to continue their activity in the robotics field.

WHY?

The educational system in Romania focuses on theoretical learning, missing out importance of practical experience and learning by doing, an important aspect for the optimal development of the younger generations. Our event is oriented on awakening an interest for the development of practical abilities, by promoting the idea of putting in effort in every lesson and preparing challenging games and projects. We consider that this type of activity is an important step to a more hands-on oriented education in schools.

8 SCHOOLS
800 STUDENTS

10-15 DECEMBER 2023

22-31 OCTOBER 2023

PEPPWEEN

MOTIVATION

The rate of functional illiteracy amongst students under 15 is between 45-50%
PISA- Program for International Student Assessment

This is one more of the problems of the Romanian educational system that we want to combat.

CONCEPT

This event was organized in order to help everyone acknowledge the importance of helping others expand their horizon in a variety of domains and to promote lectures and arts that published authors create. To make this possible we collected books covering. various topics, such as classic literature, engineering and science, by making contact with a national foundation that works with students from disadvantaged areas from Romania. With their help we managed to reach 100 students. Because of the positive feedback received, we will definitely keep this event as a team tradition.

TEAM VALUES We encourage active listening and assertive communication to promote a positive work environment **RESPECT**

ORGANIZED EVENTS

KITCAT

ROBOREACH

We searched for methods to use our knowledge developed through FIRST programs for the benefit of the local community. Until now, two ideas were implemented.

THE CONCEPT BEHIND

Through this project, we are helping kittens with paralyzed or amputated legs by creating prosthetic kits to be offered pro bono by veterinary clinics and adoption associations, giving cats the chance to walk again. For information, we collaborated with the University of Life Sciences Iasi and with Dr. Şerban Moroşan from Sorbonne University of Medicine. We have received courses in orthopedics, comparative anatomy, and physiotherapy, and we have discussed with veterinary surgeons to establish the most suitable materials, namely TPU and PETG for prototyping and PEI ULTEM for the final versions.

4 CLINICS

THE CONCEPT BEHIND

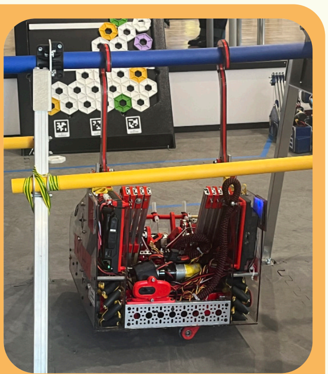
Alongside "Dăruieşte un Robot" (Gift a Robot), the RoboReach event is part of our new campaign, Robotics for Everyone, aiming to transform robotics from a luxury to a right for all enthusiasts. Through this initiative, we have taught children with disabilities basic programming concepts using Python and Lego Mindstorms. We visited two special schools in Iaşi County, interacting with blind or children with autism, as well as those with Down syndrome. Additionally, we have initiated a long-term partnership with " Asociatia Zbor de Fluturi", which has provided us with training on how to work with children with special needs. We are planning to work with autistic children from these schools for a period of two months.

3 INSTITUTES
200 CHILDREN

OUR LEAGUE MEETS

SUCEAVA

"League Meet of Penguins" was very significant, being the first in person FTC event that we've organized since the pandemic. We collaborated with the team Volta Circuits 20972, CyLiis19043 and the university of Suceava for the location of the League Meet. We had a total of 14 teams participating, making this event a great way of practicing for the biggest League Meet from our country; in the end we placed second in our region.



14 PARTICIPATING TEAMS

20 JANUARY 2024

IASI

Together with RoSophia and CyLiis we organized the last League Meet from our region. This was also the biggest one in the whole country, with 32 teams participating. We needed 4 playing fields and 30 volunteers for the event. Every team received sweets and vouchers for Noir Coffee for their participation.

32 PARTICIPATING TEAMS

3 FEBRUARY 2024

SEPTEMBER 2023- APRIL 2024

PEPPTALKS

WHY?

Every season many teams join FTC, starting their rookie period. Through the experiences we share, we create an optimal space in order for them to analyze the steps they need to take in order to achieve their goals. The information we present is posted on our YouTube channel in order for it to be easy to access. Since the beginning of the season we have connected with international teams from all over the world.

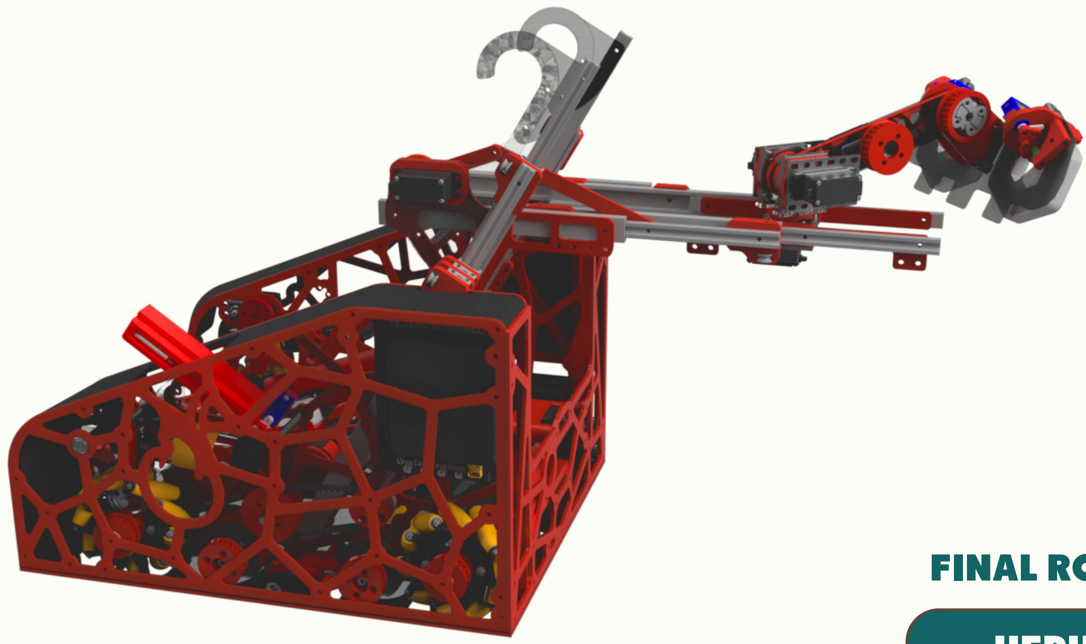
THE CONCEPT BEHIND

The purpose of this event is to start captivating conversations with STEAM enthusiasts, exploring new ways of managing a large team and sharing success stories. PeppTalks is a podcast organized by our team in order to share knowledge helpful for teams new to FTC and for learning useful principles from others. We met with a total of 9 teams from 5 different countries, and 4 of them had their interview posted, the rest remaining private.

EVENTS WE PARTICIPATED IN - 20+

TEAM VALUES All our work is done as a group, constantly helping each other **SOLIDARITY**

DESIGN PROCESS



FINAL ROBOT

HEPHY

BRAINSTORMING & ANALYSIS

This season was kicked off with an extensive brainstorming session to discover ways to streamline our workflow, opting make use of materials such as polycarbonate for prototyping, due to its lower cost and quick accessibility. We utilized concepts from theoretical physics to enhance the robot's performance, which proved valuable in situations such as measuring material limits for mechanisms like our chassis, climber, or launcher design. Employing Computer-Aided Design (CAD), we drafted various prototypes to ensure we could visualize and plan our ideas and how they come together in the end, dividing ourselves into mini-teams organized through Trello for each mechanism. This allowed us to work harmoniously and efficiently even with a large team.

This season the tasks were split among the members into different categories, each person focusing on a different mechanism. In order to achieve the best outcome possible, we always go through a series of fast prototyping, which can also be described as the process in which a member prints and works on a mechanism, whilst another person analyzes its flaws, already designing and working on the next prototype.

Technical drawing

Printing & Testing

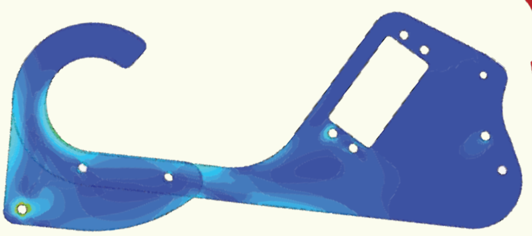
FAST PROTOTYPING

Fusion CAD

MATERIAL ANALYSIS

We used finite element analysis on SimScale to detect the structural flaws and the specific forces applied on the pieces. With this technique we can determine if the part would break under normal operation.

CLIMBER



You can see that the material displacement is minimal under the load of the robot, so our hook has very low chances of breaking.

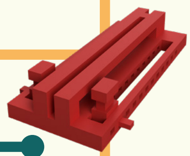
GAME STRATEGY

1. A small and quick robot that is easy to maneuver and slip under the trusses
2. A mechanism dedicating to easily collecting pixels from all spaces or levels of the stack
3. The automatization of most mechanisms on the robot in order to minimize the driver's role and have faster cycles.
4. The outtake is projected in order to facilitate the pixels scoring on any level on the backboard, making a mosaic with ease.
5. A consistent autonomous program, compatible with the ones of our teammates.

TEAM VALUES We take our work seriously; however, we also recognize the importance of maintaining a healthy work-life balance **FUN**

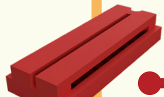
LAUNCHER

EVOLUTION



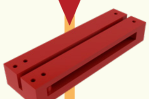
MK1

This was our first launcher design. The drone was supposed to go in the channel in the middle of the launcher and a rubber band which would have been tensioned to propel the drone was supposed to be attached to the two pillars, which were going to be fixed in the lateral channels by the thin "sticks" going through them. However, this design had many problems, such as the fragility of the "sticks" and the clunkiness of the launcher as a whole, that we didn't even print it.



MK2

This is the second design we came up with. It was taller than the first, but thinner and way less fragile. This is the first design we actually printed and tested. And it worked. It was successfully launching planes and it was doing so with surprising accuracy for a first prototype. It still had its problems however: despite it being slimmer than the first design, it was still too big to fit our robot (which at the time was very packed). Also, it still used rubber bands, which we have found to de-tension quite quickly, and to easily snap. So for our next design, we switched to springs.

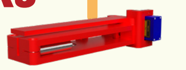


MK3

This design was thinner (and shorter) than the second design, being able to actually fit on the robot. As mentioned earlier, it used two springs (specifically extension springs) tied together with a piece of string which propelled the plane, instead of rubber bands, making it considerably more reliable, and we managed to calibrate it to consistently score zone 1.

MK4

While the last design already produced very good results, we wanted to keep experimenting. So this time we tried using compression springs instead. The prototype we made was very troublesome to use and quite inefficient but we decided to move on because we were unable to find springs with the proper elasticity.



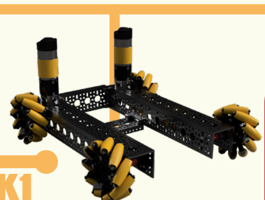
MK5

Our current launcher design is largely based on the MK3 design, but with great improvements. We've made it even more compact and switched to a more resistant type of string. We have also added a "roof" to keep the plane from falling out of the launcher during the match and guide it more accurately, increasing its consistency. We designed a mount in the machined aluminium, allowing for easy adjustment of the angle and we figured out that by placing the servo with its centre aligned with the force vector of the strings makes the servo use no power throughout the match.

THE NEXT STEP

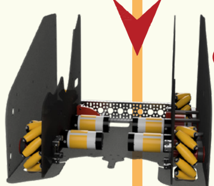
The springs can suffer from changes in elasticity because the string that ties them together needs to be regularly replaced due to friction, whilst also damaging the back of the drone greatly. Problems like these led us to look for a more precise method of propelling the drone and the idea is a magnet-powered launcher. This will keep the main body of the launcher but will replace the springs with a set of 6 magnets, with similar poles facing each other.

CHASSIS



MK1

Our first Chassis design was similar to the one we used last year on our robot. It consisted of GoBilda channels with motors that actuated at 90 degrees with gear drives and four mecanum wheels, similar to the GoBilda Strafer. This helped greatly because of the ease of assembly and the modularity that the standard pattern gave us. The downside of this design is that we were limited by the standard shape and length of the U-Channels, which forced us to make the robot bigger.

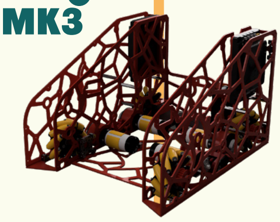


MK2

For the second version of our chassis we decided to change to a four parallel plate belt drive. This was done with a few key considerations in mind. Firstly we had easy access to a laser cutter from one of our sponsors, this meant that we could rapidly prototype with materials such as polycarbonate which has strong impact strength but also a low cost.

Secondly, the belt drive allowed us to more easily experiment with different gear ratios during our design process to help us get the fastest robot possible.

Lastly, this type of design allowed us simpler and more compact ways to package all the components on our robot. In this version we experimented with gear ratios ranging from 26:19 to 22:22. In the end we chose a 1:1 gear ratio with 435 RPM motors because of the combination of high speed but also high acceleration.



MK3

For the final version of our chassis, after we decided our design was final, through multiple sponsors we CNC cut our chassis out of high-quality aluminum. To keep the reduced weight of our chassis, through finite element analysis in SimScale we created a skeletonized version of our lateral plates, optimized for the smallest weight-to-strength ratio.

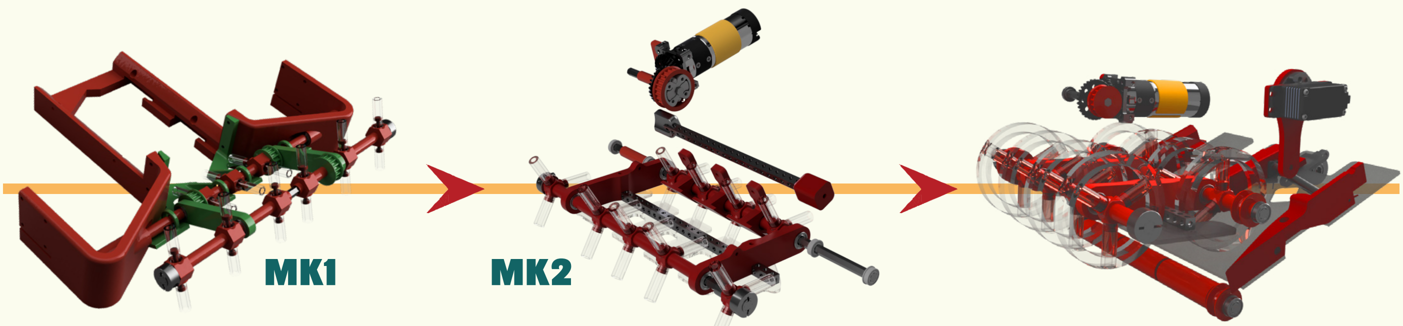
INTAKE

KICKATHON - The Kickoff was an important learning experience for our rookies, where they developed their quick-thinking skills by prototyping in a time-constrained environment. The intake was created by repurposing the claw from last season. By connecting it to a servo-powered arm, we could raise the claw to a 60-degree angle after grabbing two pixels stacked on top of one another. This way, it would work as both an intake and an outtake.

Our goal for the first intake design was to prototype and improve the system as much as possible, our focus being on reliability and automation. To bring the pixels into the robot, we designed an active intake using tubing set up on a pair of metal shafts, using custom 3D-printed mounts. One of the shafts was fixed and the other mobile, able to drop down as needed. This allowed us to bring pixels directly into the robot, from the ground or the stacks, without needing a ramp. However, this created another issue, due to the friction between the pixels and the ground which led to difficulties in the process of bringing them to the claw.

For our second version of the intake, we made multiple changes to improve performance. The previously used color sensors proved to be inconsistent, which led to us switching to infrared ones. Aside from the improvement in reliability, the new sensors allowed us to read their state in bulk, along with the positions and speed of the odometry encoders, thus greatly lowering our loop time, and consequently increasing our localization accuracy. Additionally, we changed the orientation of our claw to create more space in the robot and switched up our linkages. We also added another tube to each set on the dropdown to improve the reliability and speed of the mechanism.

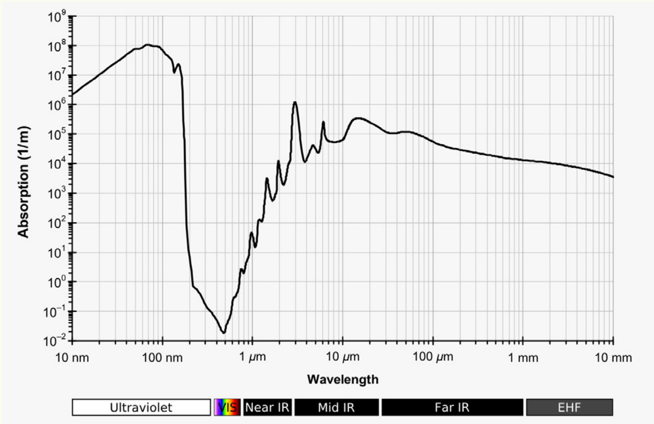
EVOLUTION



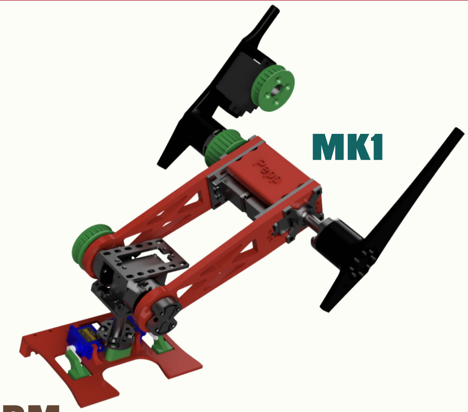
To more easily bring the pixels into the robot, we added a ramp and a counter-rotating roller to the dropdown mechanism. They stop the pixels from getting stuck under the tubes, the roller spinning in the opposite direction to guide them in properly. Because the pixels were getting stuck in the intake, we decided to induce rotation in them by removing two tubes from the lateral spinners, which proved effective.

An issue that arose during the regionals was that during the matches, our color sensors would give wrong readings, detecting everything to be closer. This didn't happen on the practice fields, and we couldn't figure out what was happening. After the competition, we researched the APDS-9151 sensors that we used in search of a solution. The room in which the matches took place was incredibly humid, due to the large number of people that were constantly there to watch the matches, and the organizers couldn't open the windows to let air in since it could interfere with the drones.

At the time, the sensors were placed very close to the pixels, which meant that the margin of error was minimal and the humidity could interfere with the reading since water absorbs many wavelengths of light, including some used by our sensors. To fix this, we changed their placement to be further away from the pixels and raised the threshold such that there would be a bigger margin of error and we could use the readings regardless of the humidity.



The spectrum of atmospheric water absorbtion



ARM

To enhance pixel placement and mosaic creation throughout the game, we incorporated a servo pivot into our storage system. While initially promising, this concept introduced significant complexity and required multiple degrees of freedom to maintain reliability. Moreover, our drivers found that a non-automated pivot was slower compared to an outtake mechanism without one.

Our outtake was designed to be as versatile and simple as possible to integrate with our intake. We used this design to test multiple ideas for our future designs and the game strategy we would implement.

STORAGE AND LINKAGES

The outtake storage consisted of 3d printed plates with small walls that would constrain the sides of the pixels. It presented two micro servos with linkages that would over-center when the claws closed which gave them immense holding power compared to the small amount of torque the micro servos gave us.

SENSORS

For pixel detection, we used Rev V3 Color Sensors that we would use to detect the pixel proximity in our storage using the infrared light coming off of the pixels. Because of the storage orientation, when we picked up only one pixel, it moved back and forth too much and was too hard to grasp, even when detected automatically. The sensors were also unoptimized and used slow I2C communication, which significantly slowed the update speed of our code.

THE NEW STORAGE

The new polycarbonate design of our MK2 robot allowed us to create a better orientation for the outtake storage that would be able to pick up one pixel alone instead of relying on two pixels to be in the storage. This was done by picking pixels side by side. We also tried a new kind of sensor, beam breaks, because of its higher read speed. They seemed to have consistent reliability and speed but were too fragile mechanically to resist during FTC matches.

REMOVED PIVOT

For this version, we decided to completely remove the pivot because of the increased complexity and simplify the controls for our drivers, letting them focus only on the driving.

The new pixel storage is angled similarly to our ramp, so it could pick up pixels in a smoother motion, without having too much friction with the floor. In this design, we decided to choose a new sensor combination, to give us better reliability in time. For this reason, we returned to the Rev Color Sensors used in the first version of our robot, but with our sensor drivers, so they have the same speed as the beam breaks. This proved way more reliable and because of the positioning of the sensors, we also removed all chances of false positives.

LINKAGE CHANGE

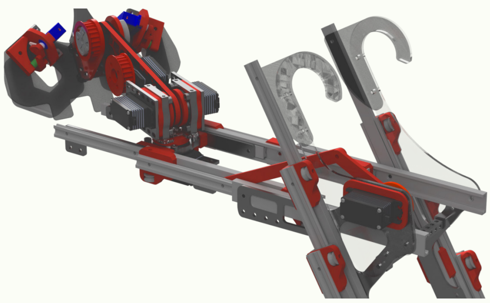
For this new design, we created a stronger and faster linkage, that would take all the load from the servo but also hold the pixels from the bottom. This gives us the ability to hold the pixels in our storage without any strain on the servo, while also making it very hard to drop a pixel unintentionally

ARM CHANGE

The new arm is much shorter than our last iteration and presents faster Axon Mini servos, than the Axon Max servos we used before. This was also possible because of our custom mini servo blocks with bearings that take up the axial load on the servo head and transfer it to the base of the turret. This uses the same pivot as the MK2, which easily extends and aligns with the backboard

TURRET

A new addition to our outtake is our turret, This stands at the base of our arm, and with the help of our IMU and odometry, automatically aligns with the backboard, letting us place pixels even if we are perpendicular to it

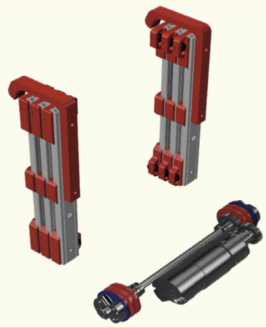


EXTENSION

The outtake extension gives us more flexibility when placing pixels from multiple angles, even when the backboard is blocked by a robot or other pixels. For the extension, we experimented with automating it using a distance sensor, but in the end, we found it easier for our drivers to just extend it fully. To move the extension we have a linkage that transforms the rotational movement of a servo to linear extension. To keep the linkage compact we used cascading slides, so our linkage only needs to extend one of the slides.

CLIMBER

MK 1



Our first prototype of the hanging mechanism consisted of 3 SAR220 Misumi sliders with a hook attached to the end on both sides. This mechanism was placed in the center of gravity to avoid tipping the robot. This was powered by a 223 RPM motor. To move the 2 sets of sliders simultaneously both of the hanging pulleys were placed on a single hex shaft. Because of the 33mm diameter pulley, we could lift up to 22.3 kg (0.65m/s). This ended up not working because of the friction from the chassis and the climber strings but it was a good starting point for our next version.

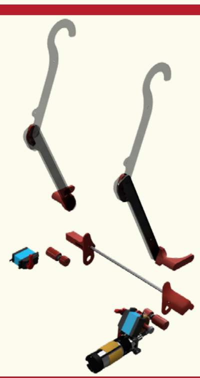
MK 2

The second prototype of hanging featured two Misumi SAR220 sliders on each side of the robot, equipped with a mobile grappling latch at their ends. This hook rises simultaneously with the sliders through a cascade mechanism and a passive extending hook. Actuated by a 1620 RPM motor connected to a 28:1 worm gear, each slider can lift 30.4kg. The non-back-drivable nature of the worm gear helps in endgame scenarios where the motor doesn't bear any weight.

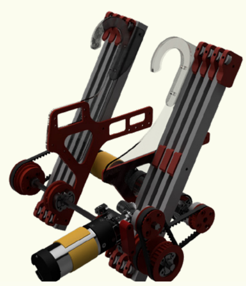
Special rubber bands pre-tension the hooks, allowing for release when the pulley system is activated, with a stretching capacity of up to 700% of their length. Initially, two hook designs were tested: hook form and T form. While the hook form was reliable, it limited climbing to the front. Switching to the T form allowed hanging from both sides without chassis rotation, but posed issues with instant release, prompting reconsideration of the design.

MK 3

For the third design, we kept the same power unit as the MK2 but used a different release mechanism for our hooks. This design was our first try at an instant-release rigging mechanism. This was done by pre-tensioning with elastic bands a hook arm split in two that extended instantly. This was held down during the match by two servos, with the vector force of the elastic bands aligned with the head of the servo. This way we didn't need the robot to be powered on to hold down the hooks. This proved to be too unreliable during regionals so we scraped this idea for the MK3.5



MK 3.5



Because we wanted our rigging mechanism to be as fast and reliable as possible we decided to use the lift for both scoring and rigging. To be able to have enough torque to lift the whole robot, but also enough speed to not sacrifice scoring speed, we connected the motor that was meant for rigging to the outtake axle and also geared down all of our elevator motors 29:20. This gave us a theoretical pulling power of our elevator of 20.2 kg at 28.8 Amps at 12V. Because the battery fuse on our robot limits our current consumption at 20 Amps it means that our elevator can lift 14kg at 12V without blowing its fuse. Because our robot is only 12.6kg, at 12V we use 18 Amps from our battery, which would normally be the maximum we could use safely during short periods in a match. This way we have exactly as much power as needed for the rigging, but also have a theoretical 0.5 second extension to the highest level on the backdrop.

MOTION PROFILING

Although PID is a very reliable controlling algorithm it takes usage of the motor encoders to get the error, which don't exist on a actuator; to solve this problem for servos we use motion profiling to generate a set of positions that the motor will follow at a desired velocity and acceleration, thus making the servo much more controllable and also finding the position that the servo is in any given time. We also use motion profiling combined with the elevator's PID in order to achieve 100% control over the elevator movement.

The simplest starting point for the motion profile is to start by defining the acceleration function. To define the function, we must first define the timestamps where the profile accelerates, has constant velocity. Let T0 be the time duration that the profile accelerates, T1 the time duration that the profile has constant max velocity T2 the time duration that the profile decelerates, and A both the acceleration and deceleration, and VM the maximum velocity that the profile can have.

$$T_0 = \frac{V_M}{A}$$

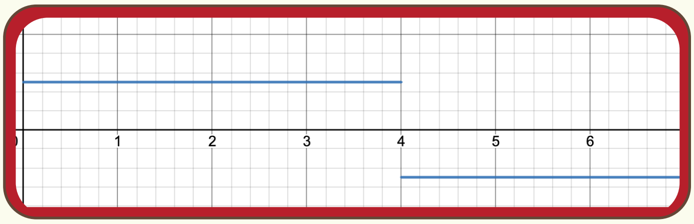
$$T_1 = \max\left(\frac{|\text{initialPosition} - \text{finalPosition}|}{V_M} - \frac{V_M}{A}, 0\right)$$

$$T_2 = T_0 = \frac{V_M}{A}$$

ACCELERATION

We can define the acceleration function based on these timestamps:

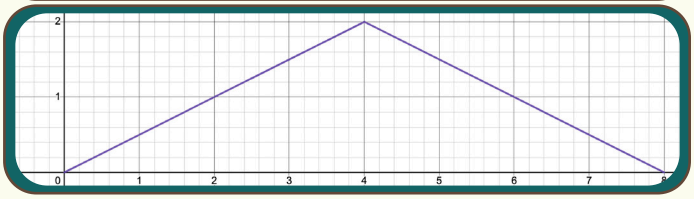
$$a(t) = \begin{cases} A & \text{, if } \; 0 \le t < T_0 \\ 0 & \text{, if } \; T_0 \le t < T_0 + T_1 \\ -A & \text{, if } \; T_0 + T_1 \le t \le T_0 + T_1 + T_2 \end{cases}$$



VELOCITY

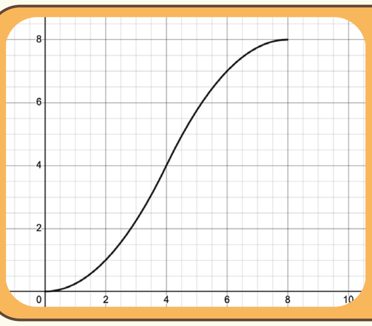
In order to define the velocity that the profile has we can just integrate the acceleration function with respect to t:

$$v(t) = \begin{cases} A \cdot t & \text{, if } \; 0 \le t < T_0 \\ V_M & \text{, if } \; T_0 \le t < T_0 + T_1 \\ V_M - A \cdot t & \text{, if } \; T_0 + T_1 \le t \le T_0 + T_1 + T_2 \end{cases}$$

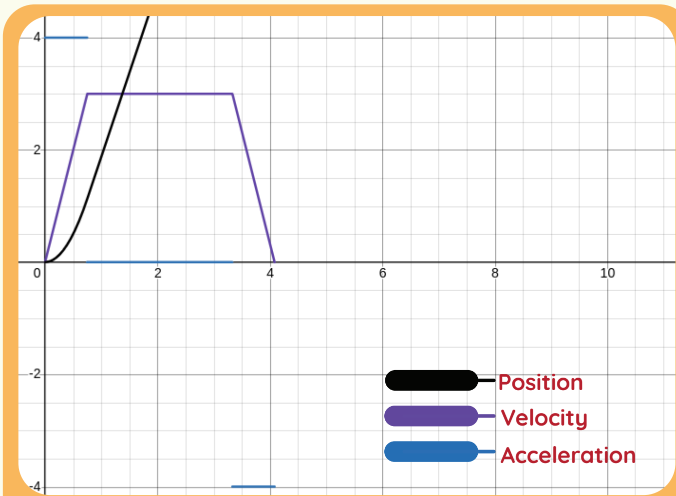


POSITION

$$p(t) = \begin{cases} \frac{A^2}{2} t & \text{, if } \; 0 \le t < T_0 \\ \frac{A^2}{2} T_0 + V_M (t - T_0) & \text{, if } \; T_0 \le t < T_0 + T_1 \\ \frac{A^2}{2} T_0 + V_M \cdot (t - T_0) - \frac{A}{2} (t - T_0 - T_1)^2 & \text{, if } \; T_0 + T_1 \le t \le T_0 + T_1 + T_2 \end{cases}$$



Same as we calculated the velocity we can calculate the position on the model by integrating the velocity with respect to t.



MOTION PROFILING GRAPH

CONTROLLER PID

Using the PID controller for the elevator raised a problem - when the robot's battery suffers a voltage drop, the elevator does not rise for a period of time, and when the voltage returns, the integral in the PID will exceed the desired position of the elevator. In order to solve the problem we use the limitation of the integral. Limiting the integral works by analyzing whether the position is moving quickly towards the desired position and if the error causes the elevator to accelerate even faster, then the integral is removed.

$$P(t) = kP \cdot E_t + kI \cdot \int_0^t E_x dx + kD \cdot \frac{d}{dx} E_t$$

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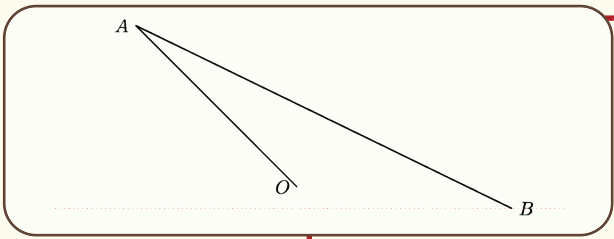
TEAM VALUES

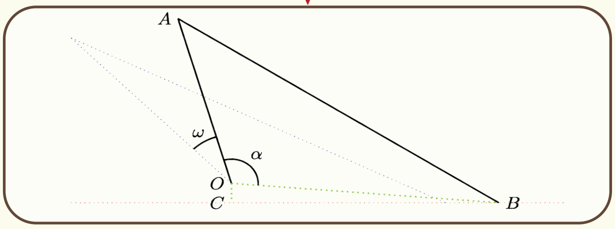
Our team is divided in small departments that work together to make sure every task is verified by multiple people to insure the best results

EFFICIENCY

PROGRAMMING

ALGORITHMS USED





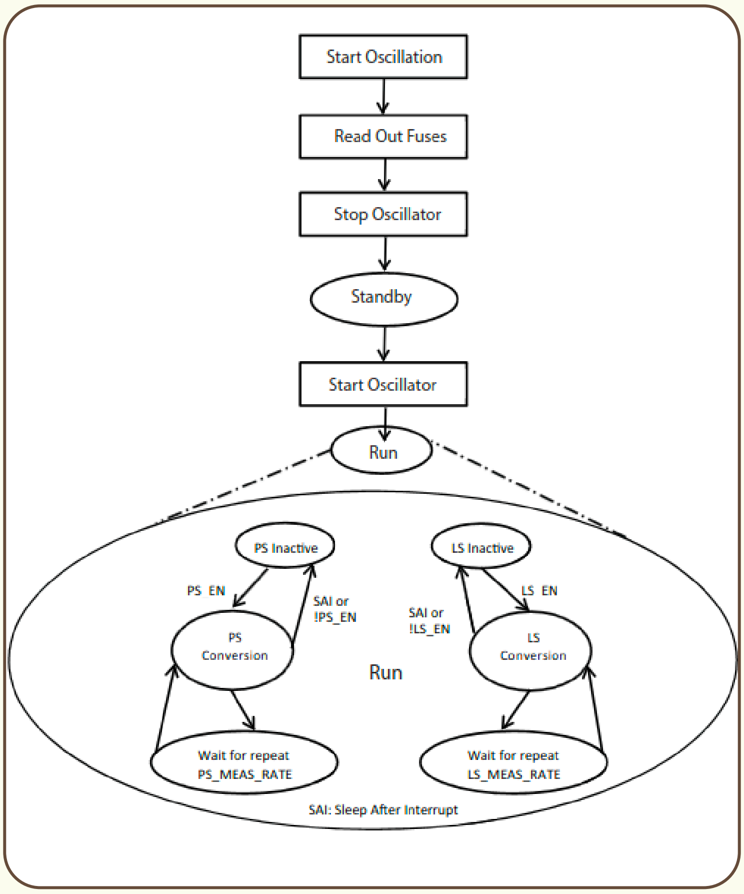
INVERSE KINEMATICS

Inverse Kinematics is an algorithm that dictates the desired position of a component based on the position of another component. We chose to use this algorithm because when we finished the robot we realized that if we raised the elevator first, the storage would get stuck in the lift's shaft; if we moved the arm with the storage first, it would have got stuck in the intake, so the only option was to do both things at the same time.

We know OA and OB are constant and known values
Let CB be the length we want to extend, $CB = \tau$ and $CO \perp$ ground and constant $\Rightarrow OB = \sqrt{CO^2 + CB^2} = D_\tau$
$\alpha = \arccos(-\frac{AB^2 - OA^2 - D_\tau^2}{2AB \cdot D_\tau})$
$\omega = 2\pi -$ initial $\angle COA - \angle COB - \alpha$ where initial $\angle COA = a$ is known.
$\angle COB = \arctan(\frac{CB}{CO})$
$\omega = 2\pi - a - \arctan(\frac{CB}{CO}) - \alpha$

SENSORS

In our TeleOP we noticed that the loop frequency was really small, around 15-30 hz, and it started to cause problems with the PIDs and motion profiles and made the robot movement jerky. We identified the problem and we came to the conclusion that the i2C reading was really slow. We had to make 3 readings/loops: one for IMU and two for each color range sensor. The first attempt was to make the reading in parallel with the rest of the code. This worked as it raised the loop frequency to ~60hz which was good but the sensor readings were really off due to the delay in reading the sensor.



Next, we opted for less frequent reads, increasing the frequency to around 100 Hz and optimizing the read operation for faster performance. By disabling the sensors we don't use from the REV Color Sensor V3 and implementing a read window in repeat mode, we achieved high and accurate proximity sensor readings, reducing the read data from 10 bytes to 2. Comparing our driver implementation - default sensor in the FTC robot controller, our approach was 30000% faster with an average of 130k readings/s compared to the default driver's 400.

Address	Type	Name
00HEX	RW	MAIN_CTRL
01HEX	RW	PS_LED
02HEX	RW	PS_PULSES
03HEX	RW	PS_MEAS_RATE
04HEX	RW	LS_MEAS_RATE
05HEX	RW	LS_Gain
06HEX	R	PART_ID
07HEX	R	MAIN_STATUS
08HEX	R	PS_DATA_0
09HEX	R	PS_DATA_1
0AHEX	R	LS_DATA_IR_0
0BHEX	R	LS_DATA_IR_1
0CHEX	R	LS_DATA_IR_2
0DHEX	R	LS_DATA_GREEN_0
0EHEX	R	LS_DATA_GREEN_1
0FHEX	R	LS_DATA_GREEN_2
10HEX	R	LS_DATA_BLUE_0
11HEX	R	LS_DATA_BLUE_1
12HEX	R	LS_DATA_BLUE_2
13HEX	R	LS_DATA_RED_0
14HEX	R	LS_DATA_RED_1
15HEX	R	LS_DATA_RED_2
19HEX	RW	INT_CFG
1AHEX	RW	INT_PST
1BHEX	RW	PS_THRES_UP_0
1CHEX	RW	PS_THRES_UP_1
1DHEX	RW	PS_THRES_LOW_0
1EHEX	RW	PS_THRES_LOW_1
1FHEX	RW	PS_CAN_0
20HEX	RW	PS_CAN_1, PS_CAN_ANA

Our robot uses the three-wheel odometry setup. By placing two of the dead wheels parallel we detect the robot position in the X axis and the heading of the robot relative to the field and using one perpendicular wheel determine its movement on the Y axis.

$$\Delta x_c = \frac{\Delta x_l + \Delta x_r}{2} \qquad \varphi = \frac{\Delta x_l - \Delta x_r}{L} \qquad \Delta x_\perp = \Delta x_h - (F \cdot \varphi)$$

The encoders placed on the odometry wheel measure the number of rotations of the wheel with a precision of 1/8000 in combination with the known initial position of the robot we are able to determine very accurately the current location in the field enabling precise movement and navigation on the playing field.

$$\begin{pmatrix} \Delta x \\ \Delta y \\ \varphi \end{pmatrix} = \begin{pmatrix} \cos(\theta_0) & -\sin(\theta_0) & 0 \\ \sin(\theta_0) & \cos(\theta_0) & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \frac{\sin(\varphi)}{\varphi} & \frac{\cos(\varphi)-1}{\varphi} & 0 \\ \frac{1-\cos(\varphi)}{\varphi} & \frac{\sin(\varphi)}{\varphi} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \Delta x_c \\ \Delta x_\perp \\ \varphi \end{pmatrix}$$

Due to the fact that the odometry wheels weren't finely tuned, the robot position caught drift overtime. In order to solve this problem we are using the AprilTags to relocalize the robot in the field and thus removing the drift that every time the robot finds an AprilTag.

The AprilTag relocalisation works quite well but it raises another problem If the robot is in motion the image that the camera captures is blurry and impossible to process. So if we want to detect an AprilTag we are forced to stop the robot motion and then capture the AprilTag and consume a lot of time during the autonomous period. To solve this blurry image problem we decided to use two different cameras: one better and faster monochrome, a global shutter camera, so we can capture the image in motion and we don't waste time anymore and the usual camera that we use in team element detection.

Assume that tagx and tagx are the position of the AprilTag relative to the global shutter and robotHeading the current rotation of the robot relative to its starting position.

Because the camera rotates with the robot we need to normalise the positions we got from the apriltag to the starting position:

$$x_{\text{displacement}} = \cos(\text{robotHeading}) \cdot \text{tag}_x - \sin(\text{robotHeading}) \cdot \text{tag}_y$$

$$y_{\text{displacement}} = \cos(\text{robotHeading}) \cdot \text{tag}_y - \sin(\text{robotHeading}) \cdot \text{tag}_x$$

Our global shutter camera is located on the edge of the robot so we have to add an offset to the position in order to get the relocalization relative to the center of the robot insetead to the camera:

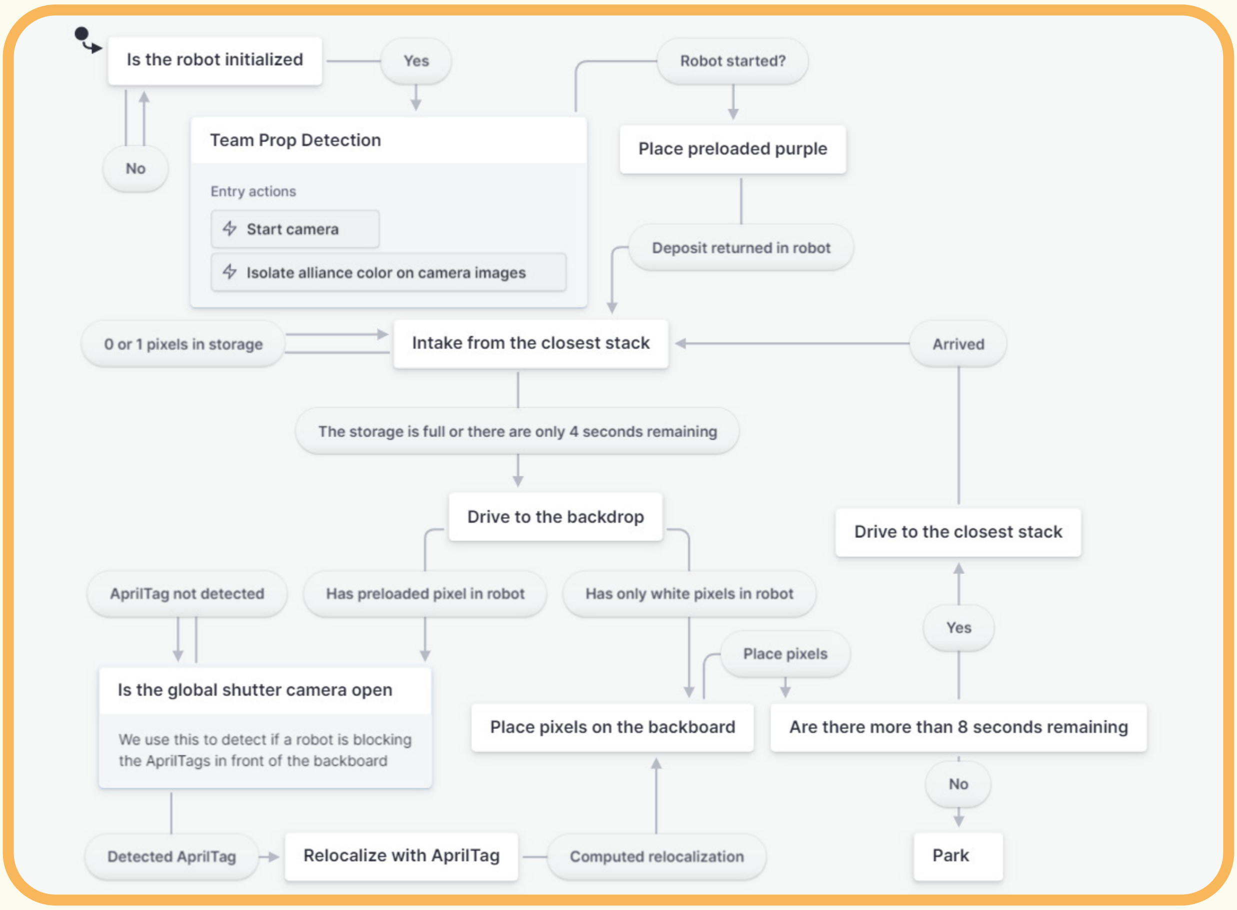
$$x_{\text{center}} = \cos(\text{robotHeading}) \cdot \text{distanceFromCameraToCenter}$$

$$y_{\text{center}} = \sin(\text{robotHeading}) \cdot \text{distanceFromCameraToCenter}$$

Finally, our position on the field is:

$$\begin{pmatrix} -(x_{\text{displacement}} + x_{\text{center}}) + \text{AprilTag}_x \\ -(y_{\text{displacement}} + y_{\text{center}}) + \text{AprilTag}_y \end{pmatrix}$$

AUTONOMOUS LOGIC



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