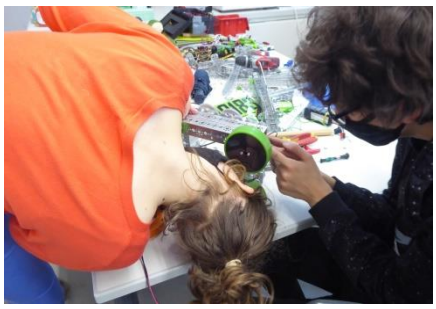
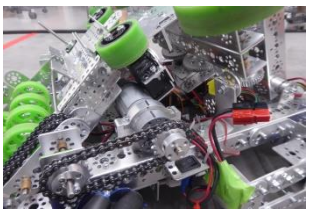
Engineering Notebook #10183

F.R.O.G.

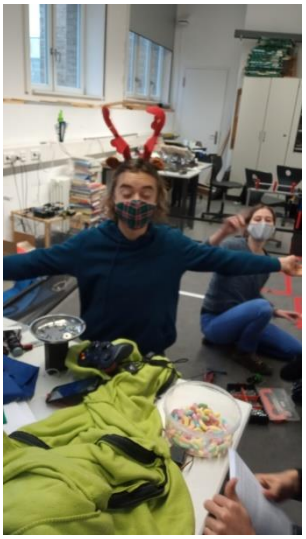
Frog Robots of Germany











Contents

Introduction

This is the notebook of the team F.R.O.G.: Frog Robots of Germany. It is the work of the whole FTC season by five inspired students of different ages and grades. We wrote everything down we did since last September. Our Notebook grew a lot during this time in order to give you, the readers, a little insight in our everyday live regarding FTC. You can see how our team grew together and how our robot became able to solve this seasons' tasks. We did also as much outreach as possible to stay a part of the huge FIRST community although it was a bit difficult due to Covid19. Because of this contact and our work, the FIRST core values became a part of all of our lives. They inspired us and brought us forward.
This Notebook might not be perfect and it is one of many you will see today, but it was hard work with a big goal: participating successfully and graciously in FTC. We hope that this insight in our season we spent together will convince you of our work. To make sure that we are not just a team of many others but a very special one.
Have fun reading it through,
F.R.O.G.
Frog Robots of Germany

Our Team

Team Name

Our school has a history of more than 200 years. It began as an elite girls' school in 1818 founded by Queen Catherine Pavlowa of Russia. Their school uniform was a green dress. Every morning, when the girls dressed in green went through the park to school, the citizens gave them the nickname « green frogs » or just « frogs ». Later the frog became the mascot of our school and also for our team. After the previous team « What the frog » reached to the top of their career winning the Aviano Invitational and going to the world finals in St. Louis we founded a new rookie team: F.R.O.G. is an abbreviation for Frog Robots Of Germany and refers on the one hand to our school and on the other hand also to our way of thinking. We are a green, economic team but also young students lively and animated like young frogs. Due to the word Germans, it's easy to identify us as a German team, which is at international competitions very helpful. During two competitions in the Netherlands, we learned a bit of Dutch language while giving frogs to other teams and visitors. The Dutch word for « frogs » is kikkers and now we are calling ourselves all the time the kikkers.

Leontine

Name: Leontine, Lemontine, Leo, often seen as Quewak
Age: 18
Grade: 12
season number: 3rd FTC season
responsible for: As it's my third season, I'm very familiar with almost all kinds of tasks (except the new online competitions). I helped allot with the hardware, especially with solving problems and at the beginning of the season while planning the robot. But my main task area is the software, together with Tobias. In else, I organize some Outreach events and stay in touch with teams I know from the last seasons so that we can exchange ideas. Of course, I am also responsible for the Engineering Notebook like everybody in our team.

What I like about FTC: I love FTC for lots of reasons: At the beginning of a season, we have lots of ideas. With the time, we build our robot together as a team. It's just so much fun, when things finally work out as we planned them! I also like working in a team and the international community: we have friends all over the world and it's normal that you get up at four o'clock am on Sunday mornings because you want to talk to somebody on the other side of the world.

How I came to FTC: Three years ago, I came in the Legoroom because of an art project of our school. I had lots of fun building something together with two former members. I immediately liked the atmosphere in our working room. This is why I decided to start FTC.

Other interests: I like several areas of STEM, not only robotics. I also like to do math's, physics and also astronomy. My second passion is music, I play the clarinet in an orchestra and I do chamber music. I'm also a climate and social justice activist with Fridays For Future.

Tobias

Name: Tobias
Age: 16
Grade: 10
Season number: second FTC season

Responsible for: My main responsibility is programming the robot. I really like programming and am able to influence the program with my own ideas and thoughts. In addition, I also help to build the robot.

What I like about FTC: I love robots and programming. In FTC I can do both of it with great team members and not only for my own. I too like the community.

Felicitas

Name: Felicitas, usually called Feli
Age: 15
Grade: 10
Season number: second FTC season
Responsible for: My main task is to build, design and repair the robot. I am very glad that I can bring in my own ideas into the building process since I have a lot more knowledge than the last season. I also help writing the notebook, outreach and preparing for competitions. I am the second B-Driver too.

What I like about FTC: I like doing practical things and try out stuff by myself. At school you have to solve theoretical problems, the way it was taught. In FTC you can collect your knowledge and learn things and how to solve problems together with your friends. I also like the worldwide, science- loving, inspiring, gracious FIRST community.

How I came to FTC: As Lemontine asked me whether I would like to join the FROG Team, I was very happy since I like science and technical stuff a lot and searched for an enriching project. So, I joined the team.

Other interests: I really like solving rubiks cubes and playing the French horn. I also play soccer.

Mahir

Name: Mahir
Age: 16
Grade: 10
Season number: 3rd FTC season

responsible for: In the last FTC season my main task was to build the robot, but I also helped out in other areas as well. In this season I am still primarily working on the robot but also for the drawings in our Notebook. With two seasons already under the belt I believe that I can offer interesting suggestions to our robot and lend a helping hand in mechanism related problems. In my previous seasons I also took part on certain outreach events like the Nokia Innovation. In accordance with my team, I work on this Notebook.

What I like about FTC: I like that FTC has more to offer than robotics. It is much more. I enjoy working in a team with dedicated people on a common goal and to strike conversation with other teams all over the world and while there are ambitions to strive for, such as Gracious Professionalism, one thing will always be the same when participating in FTC:

Having Fun! :)

Juri

Name: Juri, Dozy, Erklärbär, Dulli
Age: 15
Grade: 10
season number: Rookie
Responsible for: As it's my first season, I first have to get used to FTC. Still, I`m responsible for the outreach and take care of our Instagram account. I am also a mechanic, especially since we took all our stuff to my home where I often build on my own until midnight. I'm glad that I´ve got so many kind team members who get never tired of explaining me every simple step. As everybody else I am responsible for the Engineering Notebook and, too, created the Portfolio. Furthermore, I am the main A-Driver.

What I like about FTC: I love the combination of building a robot, programming it, spending time with good friends and meeting new teams. It always is such a nice experience to learn from your own faults and discover the ideas of FTC teams from all over the world. The FTC community is just unique!

How I came to FTC: Three classmates of me participated in the FTC competition last year. They always were amazingly thrilled about it and couldn't stop talking about their robot. Therefore, I also got interested in participating.

Other interests: I play several instruments, for example piano, clarinet and guitar and am the member of a jazz band and an orchestra. I play field hockey in our local club and compose songs. In the remaining free time I meet friends, read or just play the piano.

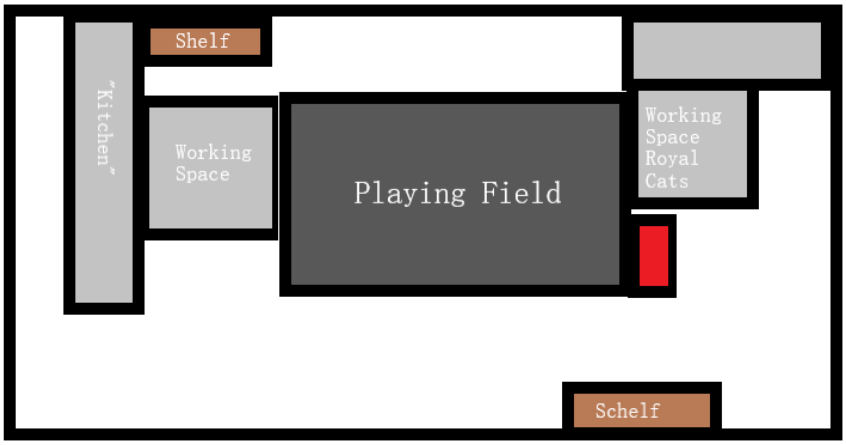
Sylvia

Name: Sylvia Wetzel
Age: 24
Season number: since 2013
Responsible: As a coach I support the team with inspiration or experience from my own FTC years.
What I like about FTC: For me FTC became a big part of my life also after I finished school. It helped me also with my curriculum vitae. It's a very special way to get in contact with robots not only doing robotic stuff but also working as a team together. This is a very important soft skill.
How I came to FTC: 2011 I supported the FLL-Teams of our school. After I wanted also to participate at a similar competition. 2012/13 we participated the first time at the FIRST Tech Challenge. I participated at FTC till my graduation. During my study of electrical engineering, I supported the teams of our school as a mentor. Now I am the coach.

Werner

Name: Werner Fick
Age: 51
Season number: >= 8
Responsible: Coach, Mentor, adult, (usually bus driver), journey organization, booking hotels and renting Cars, searching for museums/cultural events around the FTC-events.
What I like about FTC: FTC is just more than robotics. The students learn to work together, to organize themselves in the team, they learn to be responsible for each other, they learn cooking, cleaning the kitchen, organizing lunch and dinner. The students find more and more connections to teams and students all over the world. They don't hesitate to talk with people from other cultures.
The next important thing they learn is to present their selves, the team, the robot and their ideas to people from companies who work with technique, electronics and robots (local companies in Stuttgart and big companies in Germany and Europe)
They also learn to calculate the costs for the robot, for the journeys, for the playing field and find sponsors to cover the costs.

Our Working Space



This is the room where we spend the most of our time. The room has the number 212 since we had to change our room because the FLL-Teams at our school needed more space to build and program their robots. So, we got this room and needed to carry all our tools, materials and our playing field to the second floor. Somehow, we miss the character of the “Lego room” which we shared with the FLL-Teams the last years. But somehow, we managed to create a room with a great atmosphere and a lot of inspiring stuff inside where we can do our work.

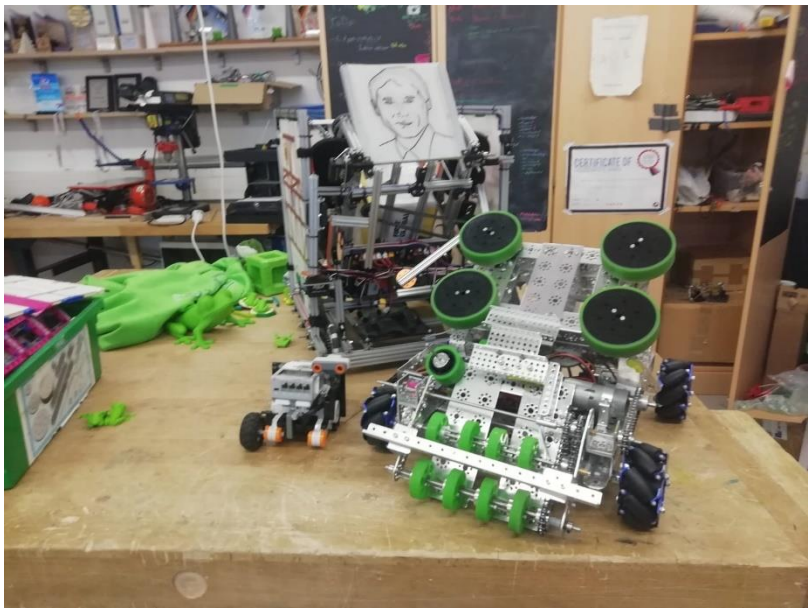
The royal Cats

We share our room with the second team of our school, the Royal Cats. They rose from the union of two former school teams, the Royal Frogs and the Robo Cats. Therefore, The Royal Cats have more members but also more Rookies in their team than we have. As we see them almost every day and use the same stuff, we are quite connected to each other. As I already mentioned, there are a few Rookies in their team who need to be taught a lot, especially in programming. We are always eager and exited to explain mechanisms, introduce them into the world of programming or just have fun with them strolling around in the room and creating a huge mess. We can often help them by bringing up new ideas and vice versa. They, too, often have good ideas. By sharing ideas and strategies to improve our robots we have almost become one single team. In addition, we often split up work and distribute tasks to increase the efficiency of the work and the possible result.

The Robot

Gorfi- Our robot and friend

Gorfi is a robot and our respected team member, who we became attached to and therefore deserves his personal page



Here you can see Gorfi socializing with another robot. He really lives up to the spirit of FIRST!

This text will explain how the smallest, wittiest and best-looking member of our team came to his name.
One day we tried to think of a name for our robot, since this is quite common and didn't had one yet. Because we lacked the creativity for an original name we came up with the name "Gorf", so frog but it's read backwards. We liked the name because it sounded powerful and also a bit quirky and dangerous, so we stuck with the name for a while. One of our team members then suggested a name that would fit his personality better: "Gorfi". The small change with the i lets his name sound more cute than dangerous. In the end we chose "Gorfi" over "Gorf". Gorfi shouldn't really represent something dangerous and due to his small stature, we thought that a cute name would be better.

So, this is the origin story to the name of Gorfi. Even now he supports us greatly by succeeding at matches and shooting rings accurately. Although he has some moody days and doesn't always work as intended, he really makes us proud.

He reminds us constantly what we're doing in FTC and why we are doing it: Having fun and working together on a common goal!

After an elaborate surgery Gorfi now even looks prettier

Wheels

One of the first things to decide are the wheels. We thought of the advantages and disadvantages of different wheels and figured out which will work the best.
We had three different types to choose from:

- **Mechanum wheels:**
  The disadvantages are that the robot shakes and vibrates. Due to the vibrating, we risk causing technical problems like loose cables. This is easy to fix with 3D printed cable mounters next to the modules, so it isn't a big problem for us. But the omni wheels allow us to drive sideways, which can be a big advantage, especially if we want to grip minerals. And we are able to turn without an extra on one place, which is also very helpful to collect the rings.

- **Small omni wheels:**
  The small omni wheels are almost the same as the big omni wheels. One difference is that they are smaller, so they are not as high as the big ones. That provides a low center of gravity, and we minimize the risk of falling down. The other difference in comparison to the big omni wheels is that the small omni wheels are smaller, so the number of revolutions is bigger. Due to that, the error rate is bigger. But the biggest disadvantage is that you can drive by encoder using these wheels.

- **Monster wheels:**
  Vibrations and shakes almost don't exist, so the driving is soft and balanced. But if we use monster wheels, we need servos to turn the robot without moving it. The biggest disadvantage is that the gravity center is very high, we risk to fall down, especially when we accidentally drive against the skybridge with the arm. Additionally, the wheels have lots of grip to the ground, so it is difficult for other robots to move ours, which isn't necessary this year with just one robot on the playing field. We decided on the mechanum wheels, because we think that they have the most advantages and we have already made good experiences with them last year. Then, we had to choose the motors. That for, we calculated the speed and the force of the AndyMark gear motors 20, 40 and 60.

We also have to decide on the motors. We can choose between the 20er, 40er and 60er. The 60er are very slow! It takes about half a minute to drive 240 inches, which is far too low. The 20er motors on the other hand are so fast that it's very difficult to control them and the robot. So, we decided to use the AndyMark gear motors 40:1 as they are a good compromise between velocity, control and force.

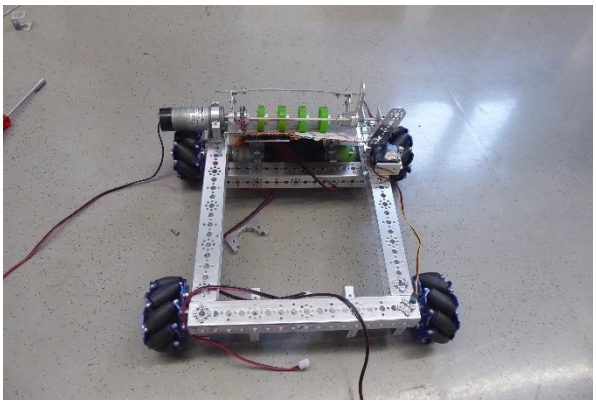
	rpm	*rpm (in inch)*	*Stall current (in AMPs)*	*AMP/rotation*
20er	340	340*4.2= 1428	11.500	11 500/340 = 33.8
40er	160	160 * 4.2 = 672	11.500	11 500/160 = 71.9
60er	105	105* 4.2 = 441	11.500	11 500/105 = 109.5

length of the playing field: 144 inch
distance between foundation: 240 inch

Base frame

The base frame is one of the most important parts of our robot since every other mechanism needs to fit on and be attached to it.
We wanted the base frame:

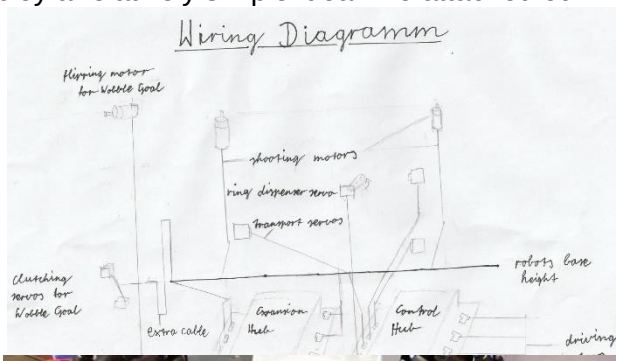
- stable
- simple
- with easy mounting possibility for the wheels without transmission because me made bad experiences with that the last season.
- with a possibility to mount the ramp for the intake mechanism



We decided to connect thee Tetrix profiles to an U. This was the easiest part.
We had to decide where we mount the last Tetrix profile to stabilize the base frame. Because of the ramp we wanted to mount later we chose the place to attach the profile under the U a bit closer to the middle. So, we could mount the motor mounts to this profile and had enough space left for the ramp.

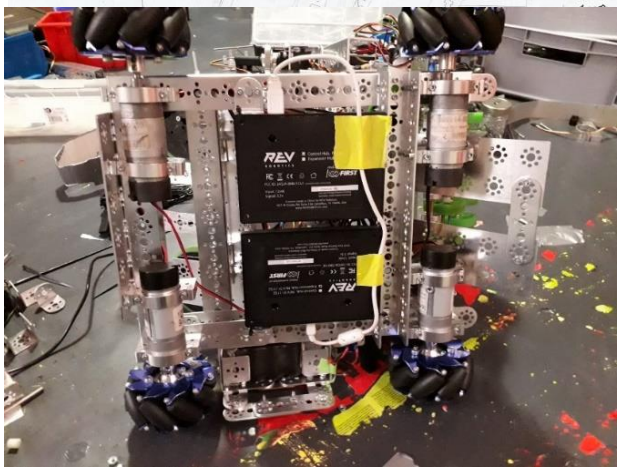
Cable Management

For the cable management we decided to employ a relatively simple idea. We attached our Control Hub and our Expansion Hub underneath the robot, which gives us some nice reach to all the vital areas of the robot.



It was at the beginning a bit troublesome to properly use the Hubs because we lacked the necessary adapters and as a result had to solder fitting attachments in place of the old ones, but eventually we got those and we don't have to solder further cables.

When all of our DC motors and servo motors were set, we thought of how they could be placed in such a way that the distances to the Hubs are as small as possible. It proved to be quite convenient and functional at the same time.

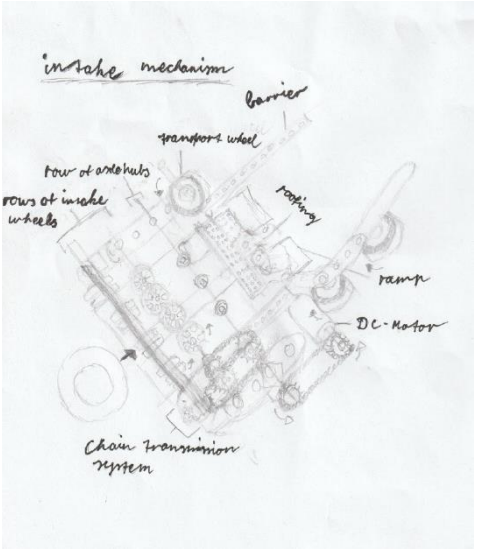


There were of course certain cables that had to be elongated and were only fixed on few points since they needed to be movable for mechanisms with motors which can distance themselves from their initial location. One example would be our Wobble Goal clutcher.

To keep the cables safe and secure we chose to mount them to either the main framework of our robot or to other fixed parts.

Intake mechanism

Compared to most other parts of our robot which underwent several changes over time, our intake mechanism stayed relatively the same in its functionality.



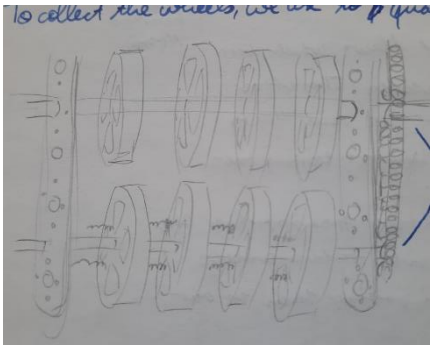
It utilizes twelve low-firmness intake wheels, eight on the bottom, four above those, which are powered by one 60 DC motor and a set of chains via multiple axes. It also includes an elevated and angled ramp, a roofing, two barriers and three Continuous Rotation servos for transporting at later sections.

The wheels in addition to the slow, but strong motor allow us a confident grip on the rings, while they are guided to our shooting mechanism.

The ramp together with the roofing and the barriers keeps the ring at a steady transport route.

The ramp itself experienced some changes in regards to its attachment. Before they were hold by two old L-brackets, which made the ramp a bit wobbly, but now we opted for a safer attachment on different places on the ramp.

The chains and the axes simply work as the means of transmitting the power of the motor to the intake wheels.

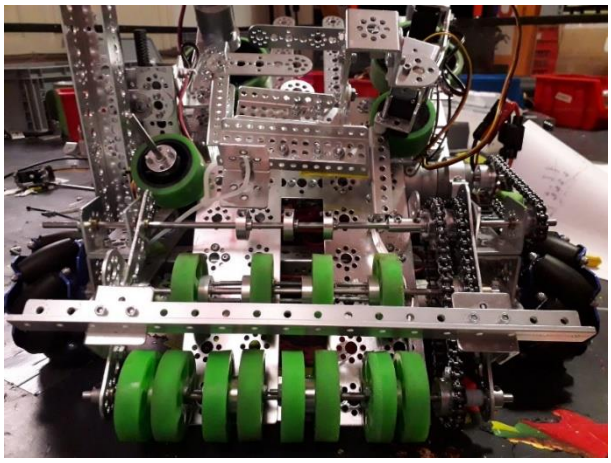


The three servos are crucial to overcome the final bit of distance. They are attached sideways to be able to transport the rings, but only lightly to not impose too much resistance on the ring and to make more room if necessary.

Admittedly it was quite bothersome to find just the right construction, but when we finally did find it, all the efforts we put in there were worthwhile.

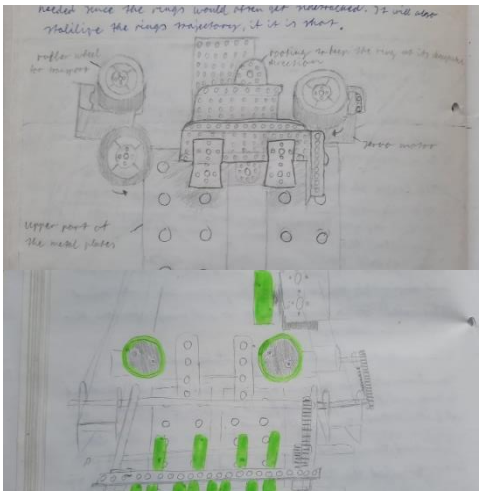
Transporting Mechanism

When we started to build Gorfi we planned a lot of details and special mechanisms including the transport mechanism who was supposed to transport the rings from the collecting mechanism to the shooting mechanism. We planed the mechanism as an even plate with an elongated chain on each side which would rotate upwards, squeeze the ring and thus transport the ring the required distance. But as we were building the two other main mechanism, they got bigger and wider than we had expected them to get. In the end there was only a small gap left between the two mechanisms which unfortunately still had to be bridged.



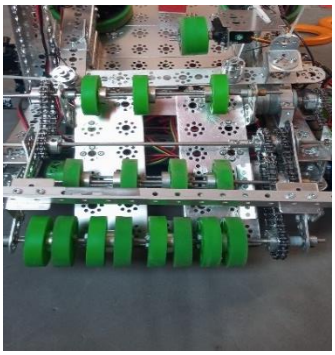
Our first collecting and shooting mechanism

We only had one week left until our first competition but no idea how to redesign the transport mechanism that it would fit. For this reason, we brainstormed for a while and finally decided to use single wheels sticked on top of servos. That way it was possible to customize a unique and adaptable mechanism with any number of wheels in any angle. Furthermore, we could save up a motor for the planned Wobble Goal mechanism (We already used 4 motors to drive, one for the collecting mechanism and two for the shooting mechanism). We immediately started to build the mechanism by screwing servo bracket beneath and next to the rear end of the shooting mechanism and sticking small rubber wheels on top of the servos. After a while Gorfi was *theoretically* able to transport rings. But as always, there were technical issues. Firstly, the brackets were screwed too loose. Instead of squeezing the ring between two wheels the rings simply pushed the wheels to the side. We fixed the problem by screwing the brackets tighter or attaching them at different spots. Secondly, the rings simply jumped above the mechanism when being squeezed instead of moving upwards. We weren`t able to fix this problem until one team member had the glorious idea to install a second plate above the servos and wheels which prevented the rings to jump up. By using bendable metal this plate was even adjustable. After all we managed it to create a stable functioning mechanism who was



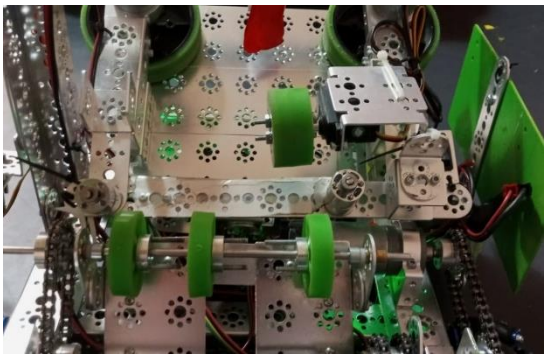
The first and second transporting mechanism

able to transport and, by stopping the wheels, even store rings. We finished it before the competition and thus it was possible to enjoy the contest without huge technical issues. Unfortunately, we couldn`t keep this well-loved mechanism as conditions to



Our final transporting and collecting mechansim

transport rings changed when we rebuild our shooting mechanism in February. As a consequence, we were forced to replace the servos which we had installed with such an effort by two servos in different positions and a third one above the ring storage to get the rings in their final spot. Of course, there were problems again. The servos transported the rings slower than the collecting mechanism did. Thereby, the second ring collected often overtook the first one and got stuck beneath it. As a result, we had to overthink the mechanism again and finally came to the solution to simply adjust a third a third row of spinning wheels above the ring. We put multiple wheels on an axis and connected the axis to the collection mechanism with a chain. To put it in a nutshell, we fused the collecting and transport mechanism into a single mechanism of three spinning axis, studded with small rubber wheels.



Transport and intake with antennae

For quite a long time we **had issues with our intake and transport mechanisms**, that were not a total hindrance, but nonetheless impeded an accurate performance. Those issues include the ring getting stuck for a little while and then being transported again, the ring not being flung far enough into our shooting mechanism, or even a rather funny scenario, where the ring gets atop of the transport mechanism as it is transported in reverse direction.

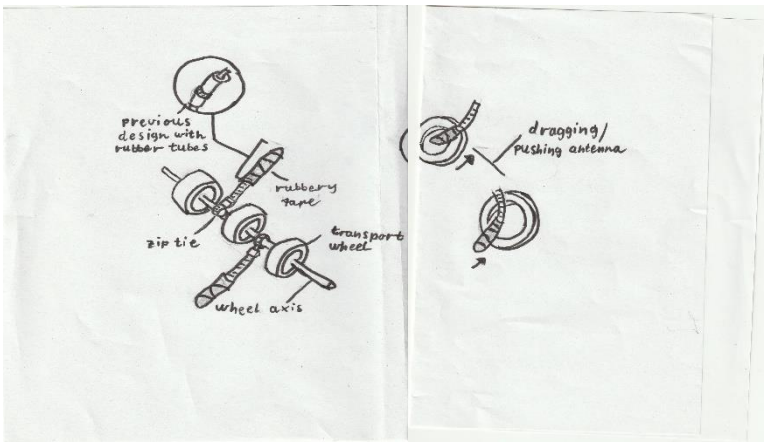
Since we already had our hands full with basically building the robot from scratch after the first shooting and transport mechanism didn't work as intended and programming an Autonomous, we didn't spend much time thinking about how to improve the transport.

But as you can probably deduce from the title, we finally found a solution for those problems:

Antennae

One might ask how antennae are suited for transporting flat, circular objects. We admit that we had the same doubts at the beginning, but tried it out anyway and to our surprise it ironed out most of the flaws of the transport and intake mechanism.

The following drawing will show how they work and what they consist of:



As you can see we have utilized zip ties as our ,,antennae" because they provide the necessary flexibility to drag themselves over the ramp/ground. **They are reinforced with rubbery tape for gripping the rings and attached in opposite direction to each other**. They are attached this way so that one zip tie **drags** a ring along with it while the other one **pushes** the ring forward. The antennae are installed on every axis for the intake/transport in the gaps between each pair of wheels, except for the second one.

Prior to that we used rubber tubes and an additional zip tie as our gripping reinforcement, but noticed after some tests that the tubes will eventually be stripped off after too many rotations, rendering the antennae ineffective for transportation. With the rubbery tape we were able to solve these problems.

In short, Gorfi became an insect!

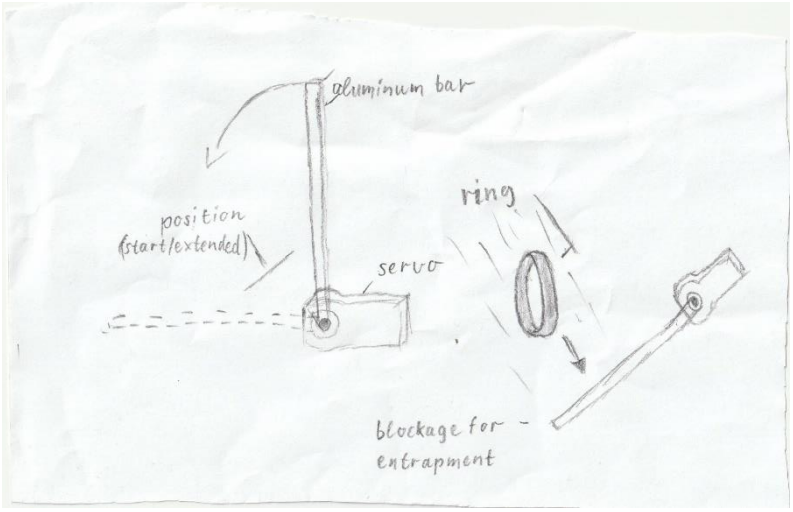
Barriers

Earlier we talked about how we utilized zip ties as means of transport and improving the overall flow and speed of the ring transportation. Here we will show our secondary measure for upping the pace and reliability **outside of the robot** even further.

We already have taken many measures to improve Gorfis potential and while he performed well when it came down to collecting, shooting and grabbing it took a while until he manages to reach the rings that are dispensed as they will be rolling to the field barrier on the opposite end of the playing field. For that we created a really simple but nonetheless effective mechanism for stopping the rings as they are rolling.

It consists of **two Servos with two light and thin bars of aluminum attached on each Servo**. When both swing out, they roughly **double the length** of the robot giving us a wide range for trapping the rings. It proved to be useful in the middle game since we **don't have to waste time on chasing the rings allowing us to collect and shoot rings at a fast pace**. Ultimately, we could claim a personal best of 18 rings landing in the High Goal.

Here is a drawing for comparison:



As an added bonus, Gorfi can also extend and draw in alternately **making him wave at any lucky person standing before him**. Gorfi is quite the courteous robot, isn't he?

Shooting Mechanism

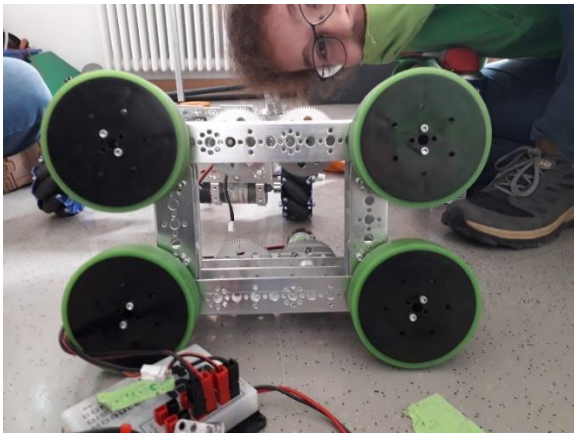
The shooting mechanism is one of the most crucial parts of our robot. That's why we built two versions of it since it influences the flow and the success in a match a lot.

First Version:

Mentioned aspects:

- shooting strength
- straight trajectory
- flight range

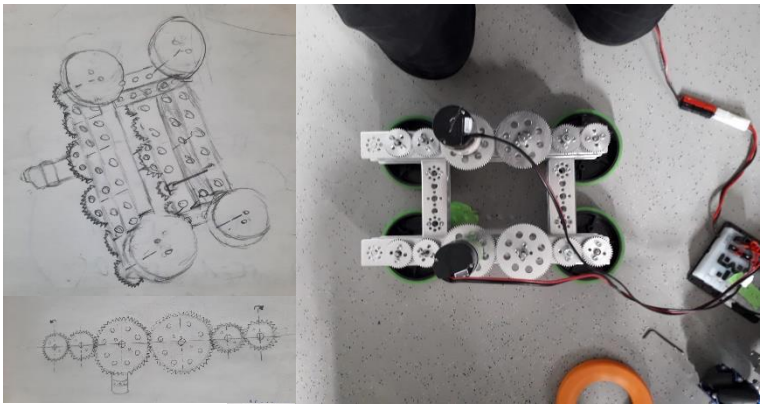
As we wanted our rings to fly very fast and straight, we thought that 4 wheels to speed up the rings for a long period would be a good idea. We wanted the wheels to turn very fast so we decided to use two 3.7 Motors with some transmission to make those wheels even faster. In results the wheels had to be very stable to stay in form when the force submitted to them is very high. That's the reason for using wheels with a plastic internal instead of full-silicone wheels.



Our first shooting mechanism

Resulting mechanism aspects:

- 3.7 Motors with transmission
- 4 Wheels with plastic internals



For the transmission we had to use a lot of gears since we needed to bridge over a log distance between the two wheels, so that the ring can fit between them. Chains weren't possible since the speed would have been too fast and they would have ripped. We built the same row of gears and wheels twice and put them after each other. In this way the two wheels touching the ring at the same time, have the same speed and so the rings fly very even and straight. First, we had some trouble attaching the mechanism to our robot as we wanted the angle as. But then we found a very nice solution: We put an axis on the base frame and take the attachment of the shooting mechanism through this axis. This turned out as a very stable but also changeable attachment.

positive aspects	negative aspects
straight trajectory	flight range was way too far and flight trajectory was way to high
easy changeable angle of the mechanism	problems to shoot the ring after each other because of no loading mechanism
	loud (the gears)
	rub off of the gears was bad for electronics
	needed long to go on and off since the wheels needed to run out

Our expectations weren't satisfied. We overestimated the distance and the force we have to apply to the ring to score a goal. We tried to fix the problems the following:

- turn the power of the motors down in the program
- practice driving to compensate our nonexistent loading mechanism
- change the angle of the mechanism
- use WD-40 to minimize the rub off

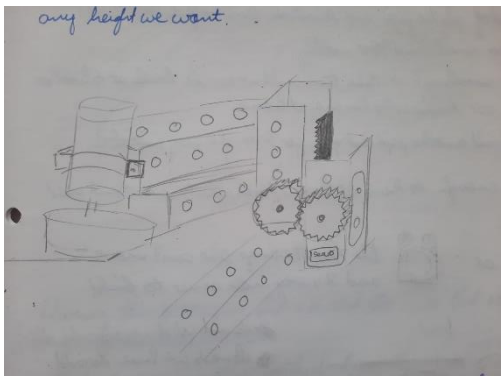
We tried a lot to improve this mechanism until we realized that this is not worth it and we need to change the idea and rethink our priorities.

So, we decided to do a team meeting to rethink this mechanism and exchange ideas.

This were the results:

Important aspects and improvements:

-**loading mechanism** to shoot the rings faster after each other --> more space for this mechanism→ **only 2 wheels**



- the wheels have not to turn that fast as expected: **no transmission**

- the speed of the motor is not that different --> each wheel can be powered separately

-**the wheels itself are grea**t→ use them again

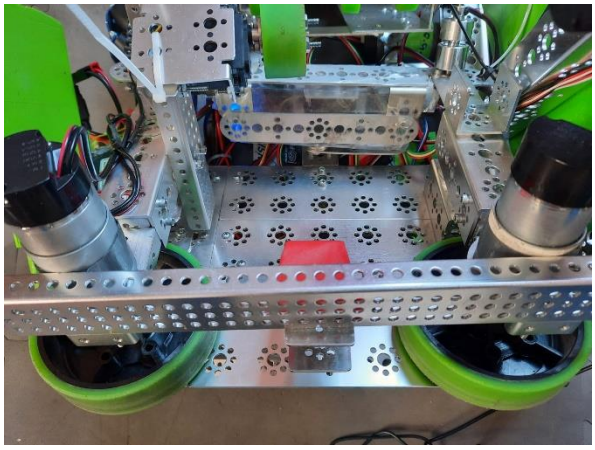
- keep the mechanism as simple and effective as possible

Based on this realization we built our second version of the mechanism:

This mechanism is far better than the old one. The construction of the bare shooting mechanism was pretty straight forward. We used two motor mounts and attached them to the prototype depot and attached this to the base frame as before. This shooting mechanism was better than expected. The rings fly very even and with the right strength.

But there was a big challenge left,

The loading mechanism:



The second mechanism including the loading mechanism

We wanted the mechanism to fulfill the following criteria:

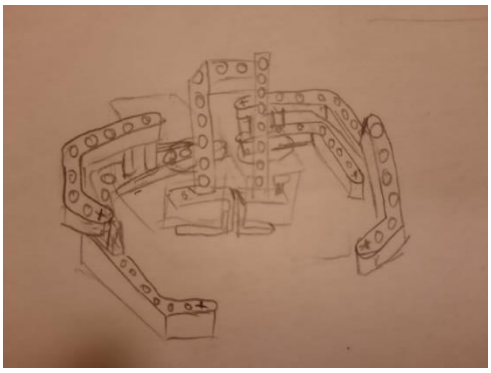
- easy to load the rings in
- fast, short and simple delivery to the turning shooting wheels
- capacity of 3 rings for maximum efficiency
- must be the missing piece between the intake and the shooting mechanism

We decided to stack the rings onto each other to use the minimum of space. This method is also nice for easy delivery from the intake to the loading mechanism. We tried round forms to fit in the rings perfectly. But these were really difficult to build and put the rings in. We realized that a simple quadratic form out of Tetrix with a bit tolerance for the rings is the best solution. As we wanted to keep things as easy as possible, we used a 180-degree servo with a Tetrix profile attached to it to push the rings to the shooting wheels. This mechanism works perfectly and fits nice into our game strategy.

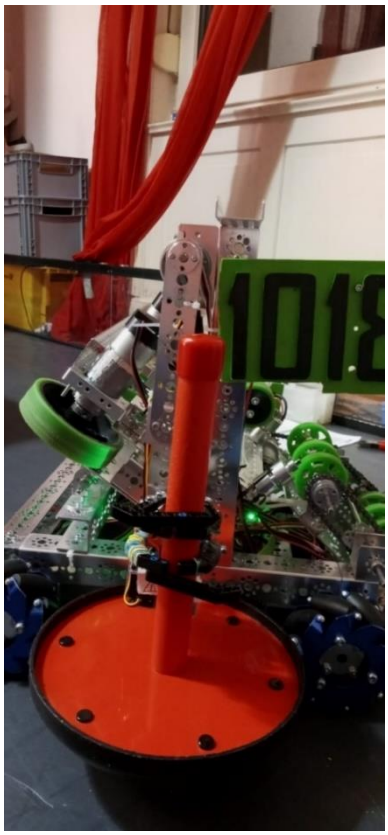
This mechanism taught us that the first idea isn't always the best. You need to accept downsides and problems and work on them and learn from then for an improvement. This mechanism proves that we were open minded enough for new ideas, and settings of priorities. We are glad to create a second version of which we can be very proud of.

Wobble Goal Mechanism

The Wobble Goal mechanism was the last mechanism we planned to build as it wasn't necessary in the beginning. We first needed to have a robot who could collect and launch rings. But in February all the other mechanisms were finished and we already drove quite good matches. So, we decided to design and build our fourth and last mechanism. But there were only a few weeks left until the first competitions. For this reason, we didn't want to design the mechanism too complex. The simplest design we figured out was a long matrix profile at the side of the robot with a 60-dc motor on top. We chose this type of motor as the Wobble Goal didn't have to be lifted up quickly, but was quite heavy. A second Tetrix profile was directly attached to this motor. On the end of this Tetrix profile, we attached a special construction which included three different building systems:



- two servos were put into their servo brackets and tied to each other
- on top of each servo, we installed a construction formed out of Lego, as Lego parts have just little weight. Both constructions were the same, just mirrored and could move independently.
- Each of these grippers contained two layers of oval Lego brackets. Like this the Wobble Goal couldn't free itself. (It always fell down when using only one layer)
- We wrapped rubber and tape around these two grippers to increase their grip.
- As the Wobble Goal would be pressed against the servo brackets, we formed a sheet metal which had the same shape as the Wobble Goal. Thereby the Wobble Goal wiggled less.

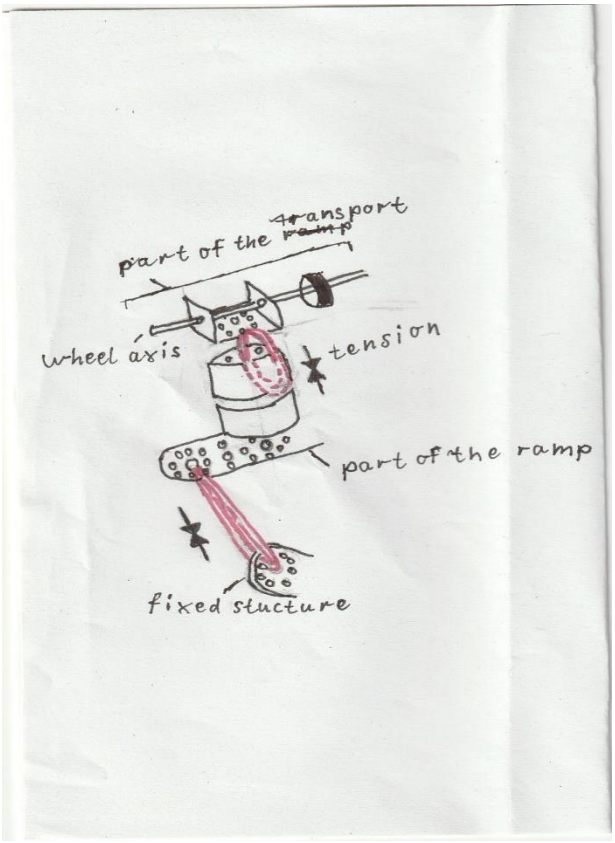


When turning on the motor the Tetrix profile and therefore too the mechanism on its end which gripped the Wobble Goal would move upwards in a semicircle. After reaching its highest point it would have fallen down again at the opposite side starting at zero again. To prevent this from happening we installed a matrix stopper on top of the main Tetrix profile. This stopper keeps the Wobble Goal at its highest position. More precisely the stopper keeps the Wobble Goal a little bit behind the highest point so that gravity pushes the mechanism against the stopper.

By inventing such an easy construction, we could build the whole mechanism in only a few days and already use it in our practice matches on week later. It increases the points we are scoring by about 70 points. Like the shooting mechanism this mechanism too taught us, that a mechanism doesn't need to be extremely complex to work decently. Often the simplest solution is the best. After a few months in use, we decided to elongate the grippers by adding further Lego profiles to increase the range of the mechanism and like this the possibility of gripping the second wobble goal in the autonomous. This proofed to be a very efficient reconstruction.

Zip ties for the win!

We apologize for the internet slang, but no other words can express for us how good and useful the zip ties were to us. Here we will explain in which ways the zip tied provided support on the important spots on our success and how they were sometimes even crucial to our mechanisms.



Providing tension

By tying one zip tie on two different, distant points and by virtue of adjusting their length, you can quite accurately regulate the amount of tension. For us this was especially helpful. Previously we mentioned in this notebook how our ramp was not static and instead was built upon an adjustable axis. With this design we were able to fixate the zip tie on one static point on the transport system and one movable point on the ramp. The more we would shorten the zip tie the more tension we would create and as a result the ramp goes up allowing us to adjust the high as we see fit. They were also useful for bringing the highest axis of our transport system closer to the ramp while still permitting the rings to push the axis higher up if more room would be necessary.

Cable Management

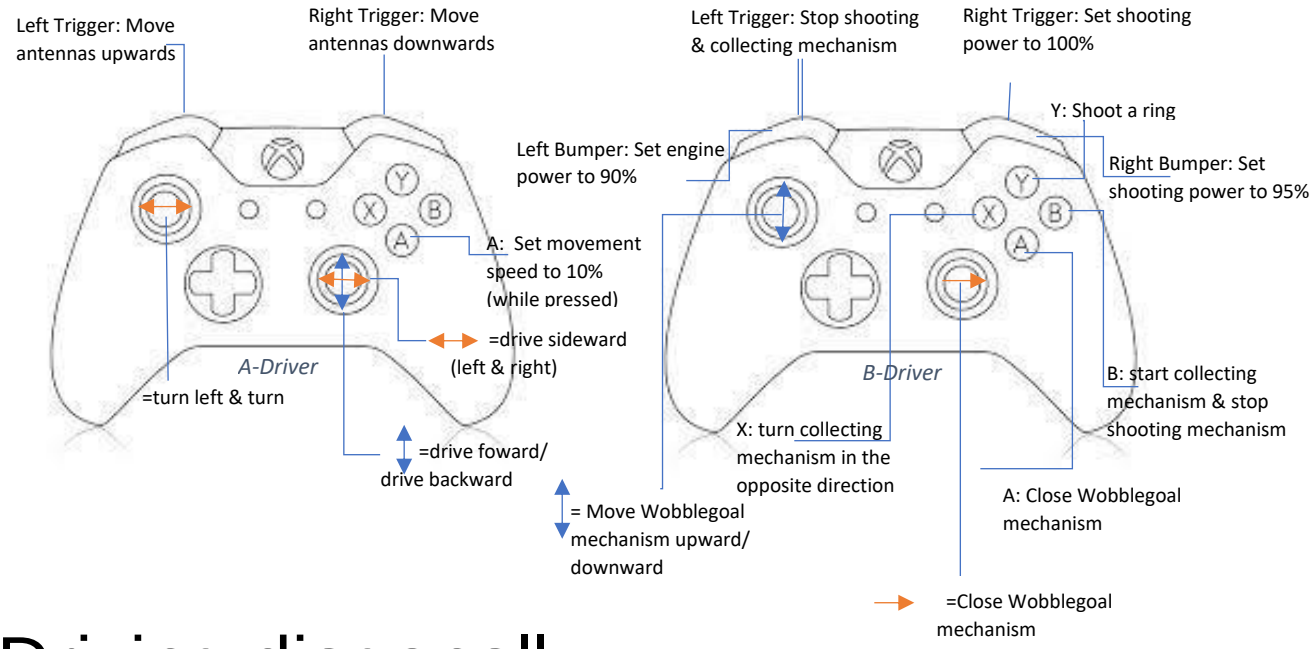
As you can imagine, the zip ties were used very frequently in our cable management. They came especially in handy for fixating our hubs onto our robot. Since the attachment holes of the hubs were designed for metrical screws, so not compatible with our Tetrix parts we couldn't use screws for that. The cables located in the robot aren't fixated that much because they can't intervene with any other mechanism and need to be a bit loose for easier reparations and examination purposes in case that we are running into problems. At the outer parts of the robot, they are placed in such a way to take the shortest way from one motor to a port. However, in case that cable was too long we would compress the cable into a kind of flat knot and tie it together with a zip tie.

We also used them for transport but their function there is already described in detail in our ,,transport and intake with antennae" entry.

After all that you simply must admit the awesomeness of zip ties if you have not already done so.

Programming

Driver Control



Driving diagonally

Our robot uses a method Tobias designed last year to drive diagonally. First, the robot calculates how much it has to drive forward, sideways, and how much it has to turn. Then, the robot calculates what each wheel has to do:
(The motors are configured that they all drive into the same direction)
Front right = forward - sideways + turn
Front left = forward + sideways - turn
Rear right = forward - sideways + turn
Rear left = forward + sideways - turn
All values are limited to 1.
Using this method, the robot can drive forward, sideways and turn at the same time.

Autonomous

The autonomous we had until now worked more or less but it was not very reliable. In else, we are not able to do the wobble goal. So, we had to work on the Autonomous again to make it better and also more complex. At first, we added encoders. Now we can drive more precisely. That for, we also programmed some methods.
The main structure is:

AutonomousUtils → initializing → driveForward → driveLeft → driveRight → driveBackward

Autonomous1/ Autonomous0.9/Autonomous0.95

In the class AutonomousUtils, we wrote all the methods so that the actual Autonomous OpModes are more structured, so the code is very clean and it's easy to find mistakes.

The other Autonomous OpModes are the actual OpModes for the Autonomous. We have three different and we choose the opModes depending on the voltage sensor. For a voltage sensor of more than 13V it's Autonomous1, for 12.5V it's Autonomous0.95 and for less it's Autonomous0.95. Now that we could drive precisely, we wanted to be able to put the wobble goal in the correct part of the field. That for, we used Vuforia.We used the sample OpMode of the FTC RePlay Repository.

We scan during the initialization routine. As a result, we have more time during the 30 second autonomous period to fulfill as many tasks as possible. We start with shooting the rings as it's very important for this task to know the exact position. Then we drop the first wobble goal and park on the line. In the future, we plan to expand the autonomous to also deliver the second wobble goal. The Vuforia camera detection wasn’t that reliable. That's why we asked some other teams how they are doing this task. Among these is the team #7247. They are using an easy open cv provided by wizard.exe and say that this works very well. So, we're going to try to do this too and to get a more reliable autonomous.

After the first league Meets, we completely reprogrammed the Autonomous. Our goal was to have a more reliable one. In the beginning we needed several Autonomous opModes for different voltage sensors and we wanted it all to be in one OpMode. Like this, we don't have to focus on this part.

We divided our classes in the packages Autonomous, AutonomousUtils and OpModes.

In the package Autonomous, there is our Autonomous Period, the camera calibration program and a backup Autonomous. That means that if due to light differences or other disturbing factors the recognition doesn't work, we still have an autonomous period.

In the package AutonomousUtils is everything we need for the different autonomous periods and in the package OpMode everything we need during the driver-controlled period. As these are just three classes, we decided to put them in one package to have a better overview.

Autonomous:

- AutonomousMain
- backupAutonomous
- AutonomousCalibration

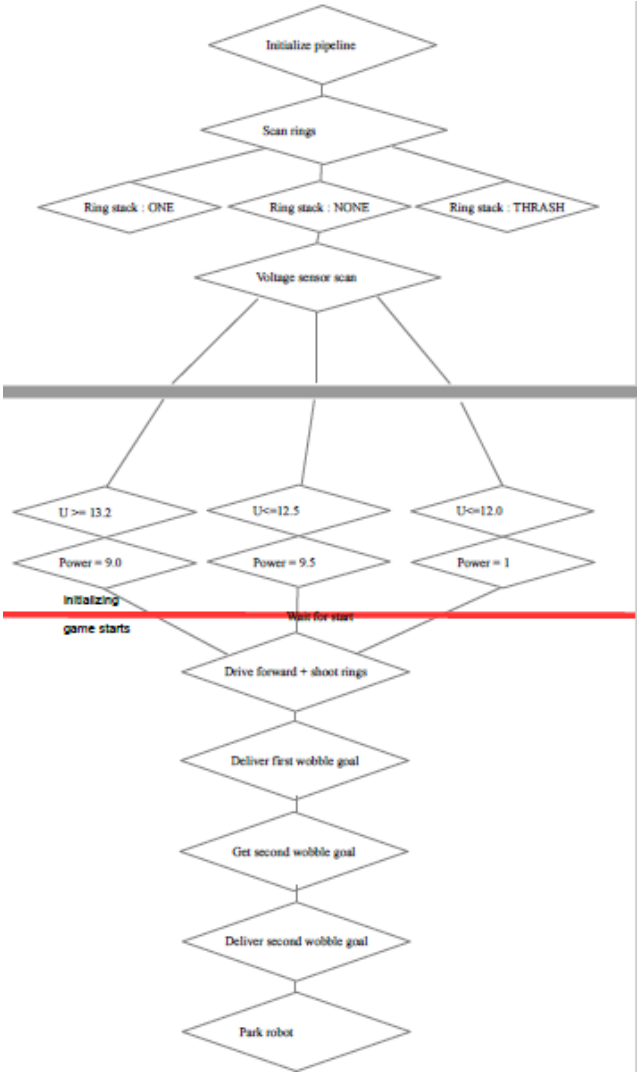
AutnomousUtils:

- pipeline

drivingUtils

OpModes:

- Directions
- DrivingStuff
- GorfiMainOpMode



As this year's season is a remote season and we won't compete with other robots on one playing field, we don't have to worry about other robots.

The autonomous program works through the following steps:

We wrote a program **that calculates the number of ticks** with the distance. And we also wanted to know the number of rotations needed:

distance	what we want to calculate
position	the distance the robot has to drive
radius	4.2 this is the radius of our wheels
ticks	1440 we use AndyMark motors, so this is the number of ticks of one rotation
circumference	radius*2*pi
rotations	position / circumference
distance	rotations * 1440

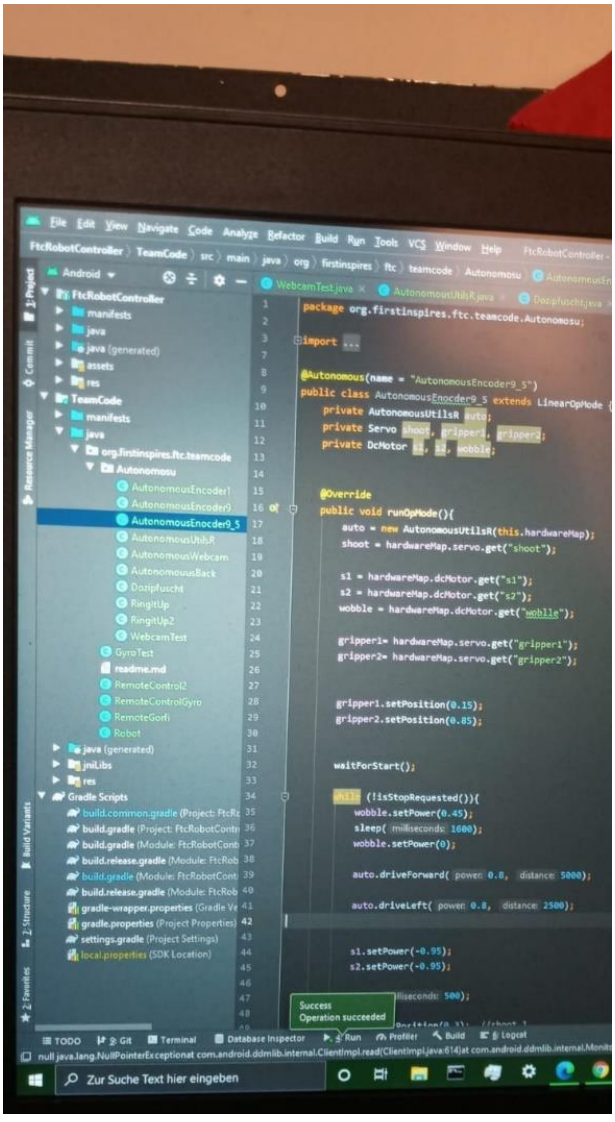
Example	
distance	**42 inches**
position	42
radius	4.2
ticks	1440
circumference	radius * 2 * pi = 26.4
rotations	position/circumference = 42/26.4 = 1.6
distance	rotations * 1440 = 1.6 * 1440 = 2293

This program allows us to calculate the needed ticks very fast, so that we don't have to test the values to find the right ones.

Another thing we did this year to be more precise during autonomous is that we use the wall to determine the exact angle of the robot.

For driving, we wrote methods for all driving directions (360 degrees). That way, we have to write less code and have a better overview over the code. The methods need two inputs: the power and the distance. The distance is the value we calculate like previous explain and the power is usually 0.8 because this turned out the most reliable.

To detect the number of rings, we use an easy open cv provided by wizard.exe. That for, we scan during the initialization routine. That's how we have more time during the 30 second autonomous period to fulfill as many tasks as possible. We start with shooting the rings as it's very important for this task to know the exact position.



At the beginning of a match day, or after extended break with different light conditions, we have to calibrate the robot. That for, we place it on the playing field. The first thing we check is the camera position. We open the camera stream and move the camera a bit, if needed. Then we check the different values and adapt them if needed.

Errors and how to fix them

1. **Received message: “cannot find device with name …”**

- wrong config-file
- wrong name when getting from hardware map/wrong name in config

2. **can't find device → look at voltage sensor**

- power
- dead battery
- check for loose cables
- restart robot

3. **disconnected with WIFI etc.**

- pair with none
    - → pair again
- check names
- WIFI: forget all groups (in settings)
- reconnect

4. **nothing is working**

- to question:
- what’s about the gamepads?
- Is the program started?
- plug in and out
- test new gamepad/ USB distribution hub

5. **motor continues rotating**

- forgot to set power to 0
- → put in an else and set power to 0

Gracious Professionalism

Gracious Professionalism is a very important aspect of FTC which makes it unique. We are inspired by the FIRST Core Values and live them not only in the LEGO Room, but also in our everyday life. Since pictures can show a lot more than thousands of words, we created a little collage to show what these values mean for us:

Discovery

Impact

Inovation

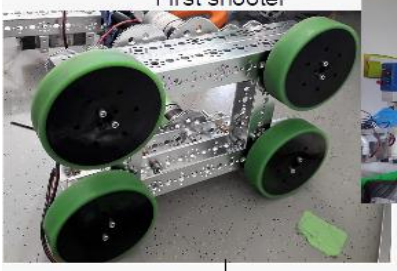
Inclusion

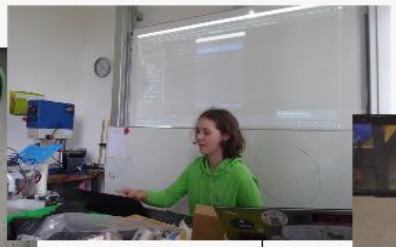
Teamwork

Fun

Milestones

First shooter





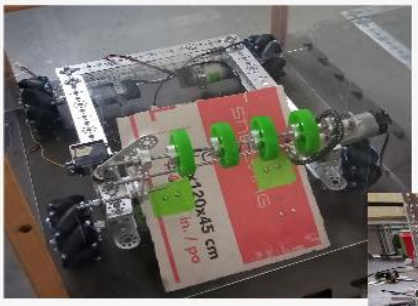
Start programming

Robot finished + school closes

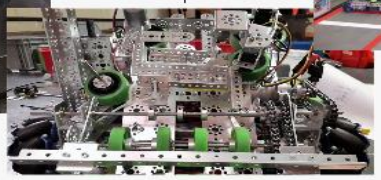
New shooter

Wobble goal

-koff



Early intake mechanism



Transport mechanism

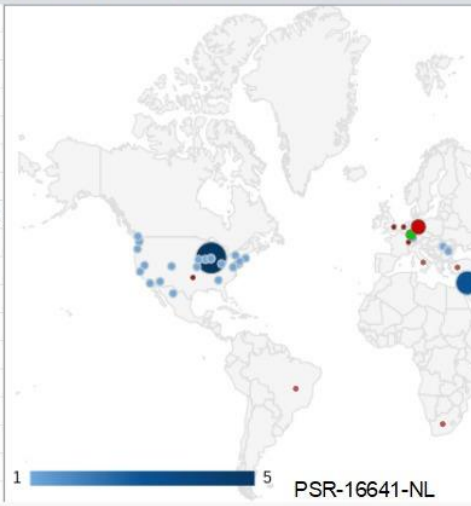
First League Meet

Team F.R.O.G.

Other teams

RobotICGS-11515-Germ

Location	Number of Members	Rookie Season	Join Date	Total Number of Teams
Woodinville, WA, USA				
Pune, IND				
McMinnville, OR, USA				
Highland Park, IL, USA				
NJ, USA				
Highland Park, IL, USA				
Central NY, USA				
Overland Park, KS, USA				
Eldridge, IA, USA				
Seattle, WA, USA				
Wilmington, DE, USA				
Foxboro, MA, USA				
Glen Rock, New Jersey				
Misgav, ISR				
Stuttgart, GER				
Waukee, IA, USA				
Fairfax, VA, USA				
Taiwan				



PSR-16641-NL

FTCAMP-16049-Brazil

Outreach

Compared to the last season our Outreach with others for this season is not that numerous for obvious reasons, but the ones that we had were all the more precious. Examples for this are the EAGles one of the few German FTC teams and a Norwegian rookie team.

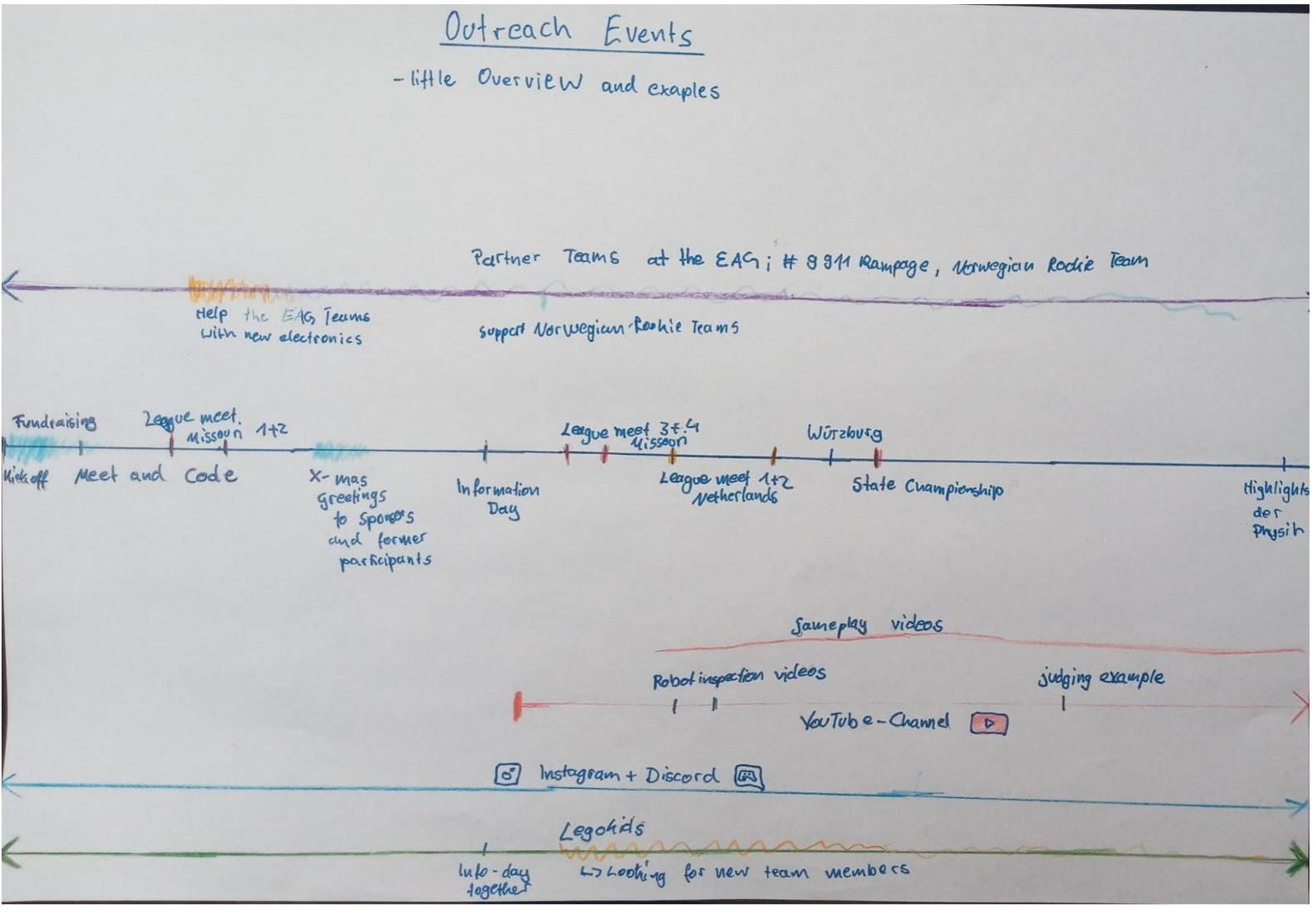
One of the outreach events in the last season

We know the EAGles for quite a long time now and experienced a lot with them, like the FTC competition in Spain of the season 2018/2019 where we traveled there together. In this year we still love to communicate with each other, share our thoughts on the matter that occupy as at the moment. The fact that the coach of the EAGles is a relative of ours certainly but not singlehandedly contributed to our relation.

In this year we still love to communicate with each other, share our thoughts on the matter that occupy as at the moment. We were able to help them with mechanical problems regarding their robot.

As for the Norwegian team we were able to make first contact with them via (you guessed it) the omnipotent medium of the Internet. There we were glad to help them with any kind of po problems. This was also an excellent opportunity to exchange thoughts and motivate each other.

One of our team members decided that it would be a great idea to get up at midnight and meet with another team to play a good game of Scribble.io...and it was! According to her the game was loads of fun and everyone had a blast. We as her team members and friends had no choice but to let out a little chuckle when hearing that, since the situation itself was not something we expected to hear for the day. So now we have met yet another ambitious team by rather unexpected means.


Outreach Events
- little Overview and exaples
Partner Teams at the EAC; #9911 Rampage, Norwegian Rookie Team
Help the EAC Teams with new electronics
support Norwegian Rookie Teams
Fundraising
Kickoff
League meet. Mission 1+2
Meet and Code
X-mas greetings to sponsors and former participants
Information Day
League meet 3+4 Mission
League meet 1+2 Netherlands
Würzburg
State Championship
Highlights der Physik
Gameplay videos
Robot inspection videos
judging example
YouTube-Channel
Instagram + Discord
Legokids
Info-day together
Looking for new team members

Würzburg

Großer Preis des Mittelstandes (award for best family-owned companies in Germany) in Würzburg

Last season, we went to an automotive fair. There we met Mr. Kalkenbrenner, who organizes every year a meeting of about 100 heads of companies of Germany. He invited us there to present our robot and also to collect money and seek for new sponsors.

Shortly before the lockdown, we went to this event in Würzburg. That for we prepared a presentation, updated and printed our flyer and prepared some sort of pit. We were supposed to be a surprise, but the presentations before ours have been a bit long so we arrived during the lunch break. This wasn't too bad at all, because like this we got tons of super delicious food!
Then we prepared ourselves and the robot for the presentation and 10 minutes later it started. We went in with the robot and our frog Quewak a presented FIRST, our work and FTC. This was a very great opportunity for us also to practice our presentation skills. I was very nervous because standing in front of 100 heads of companies isn't something you are doing every day. Most of the people were very interested in us and our work. We collected lots of money and even got an interview which you can now see on YoutTube: *gründerTalk Frog Robots Of Germany*.

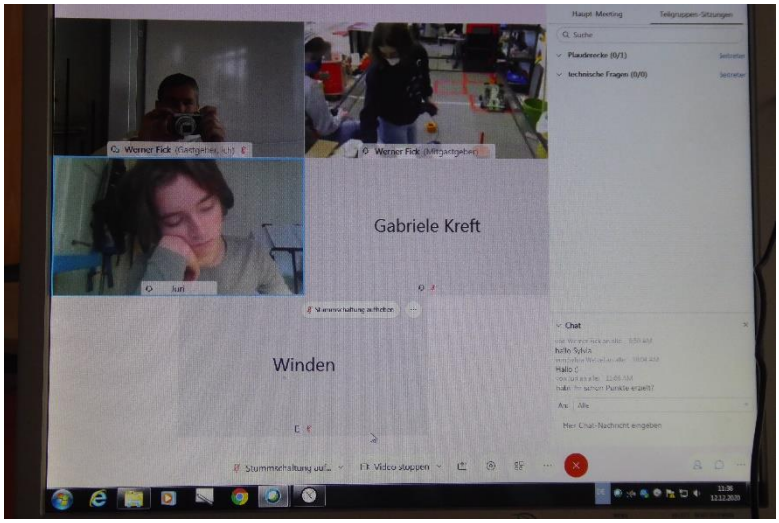
This year, we got invited again and we are already preparing our presentation for this year. We present them our team, work, FTC. They sponsor us, we had an interview which you can find now on Youtube and we also ask them to sponsor a competition in Germany. This was a very great opportunity for us also to practice our presentation skills. I have been very nervous because standing in front of 100 heads of companies isn't anything you are doing every day.

Legokids

At our school, there are FTC and several FLL teams. Almost everybody in our team has some FLL experiences and we are a lot more experienced than they are. Some of our materials are in their room. That's why we work together with them. Participants of the FLL are mostly age 10-14. We help the teams with programming or building the robot. Often FTC participants did FLL before. Helping the FLL teams means also looking for rookies to continue FTC at our school as they already have experiences in FIRST and robots and are interested in science. Having participated already at another FIRST competitions helps to get along with FTC.

Information Day

Every year at our school we have a so called “information day” where we as a team represent FIRST as a whole and FTC in a more accurate frame. In a short video we have already summarized what we do for FTC.



Such opportunities to popularize FTC in our countries had to be seized, or at least that’s what we think and so we did. We hope that this video will pique the interest for FTC of the person who is watching it.

There we presented ourselves as a team with an affinity for the color green and for frogs and this is in fact not just a coincidence. The female students that our school had in the past were often referred to as “frogs” since they are figuratively “hopping” from their homes on their way to school. Why we’re wearing green should be obvious now.

This year, we had a special role at this event at it was an online competition due to corona. We helped the teachers to join their screen and managed the questions as the teachers had been a bit overwhelmed by the technical aspects. This was a really great opportunity to us because we could once again make an impact in the real live with our skills.

With the inclusion of different pictures, the showcase of our robot Gorfi and the little end slide where we’re all jumping from an edge, we tried to incorporate the FIRST Core Values not only in the context of a robotics competition but also in also in a social and sometimes in a bizarre context. This is in our opinion necessary to make clear that FTC isn’t just a robotics competition and in fact an event that strives to create a fun environment for ambitious people to express themselves, inspire each other and to build a future together.

The Core Values will stay with us and remind us that we should always try to make the best out of us, others and our ambition to inspire each other, to have fun and to create a future together.

WRO – World Robot Olympiad

This competition isn't part of the FIRST organization and the tasks are easier than these of FLL. We want to spread the FIRST Core Values also at these competition in order to inspire the kids at doing more than just building a robot. Because the teams consist of only three people, it's difficult to feel a real team spirit, but difficult doesn’t means impossible! With us as role models it gets also easier for the girls in the teams to involve themselves.

Meet and Code

We don't just have to pass our knowledge on to other teams and programs. But also, to make sure that knowledge is as passed on within the FTC teams. That's why we participate every year in the Meet and Code event. All over Europe groups and individual people share their programming knowledge with others.
This year, Leontine held a workshop on the basics of programming and on the new control system. The REV control hub is new to use, some new members of the FTC didn't know yet how use the FTC app, configure the robot, ... In else it was great for everybody who didn't do any programming before to get an introduction and to learn the basics. As teams change every year, students graduate etc. it is very important to us to spread our knowledge!

FTC in Missouri

As this year only remote events take place, we had at the beginning of the season the idea of participating in another country. We immediately thought of Missouri, because St. Louis is the partner town of Stuttgart. That's why we already stay in contact with teams from there, especially team rampage #9911, which is our partner team.

By participating in the states, we can get lots of new impressions regarding FIRST but also strengthen the partnership between our cities and countries even during such a difficult time.

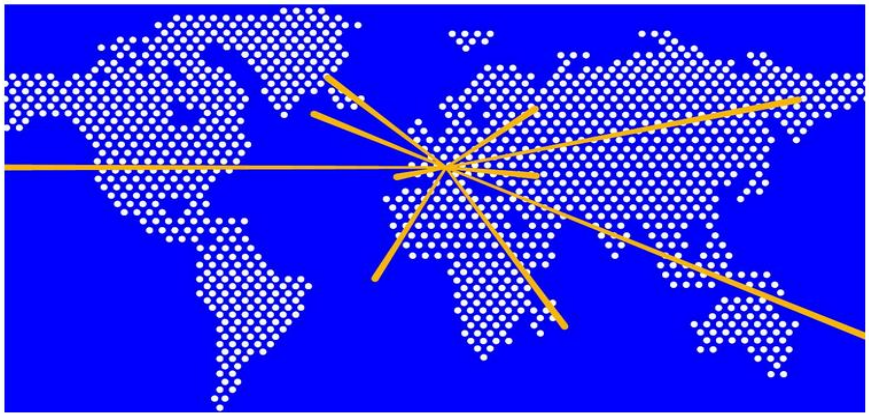
Das Königin Katharina Stift Stuttgart erfolgreich bei der FIRST Tech Challenge!
Im Rahmen des weltweiten Bildungsprogramms im Bereich Robotik (FIRST Tech Challenge) hat das Königin Katharina Stift erfolgreich teilgenommen.

Mit einem Remote-Wettbewerb qualifizierten sich Team Frog und Team Royal Cats für die Missouri-State-Championship in unserer Partnerstadt St. Louis – herzlichen Glückwunsch!

Film zur Preisverleihung

Landeshauptstadt Stuttgart
Abteilung Außenbeziehungen

STUTTGART



Highlights der Physik

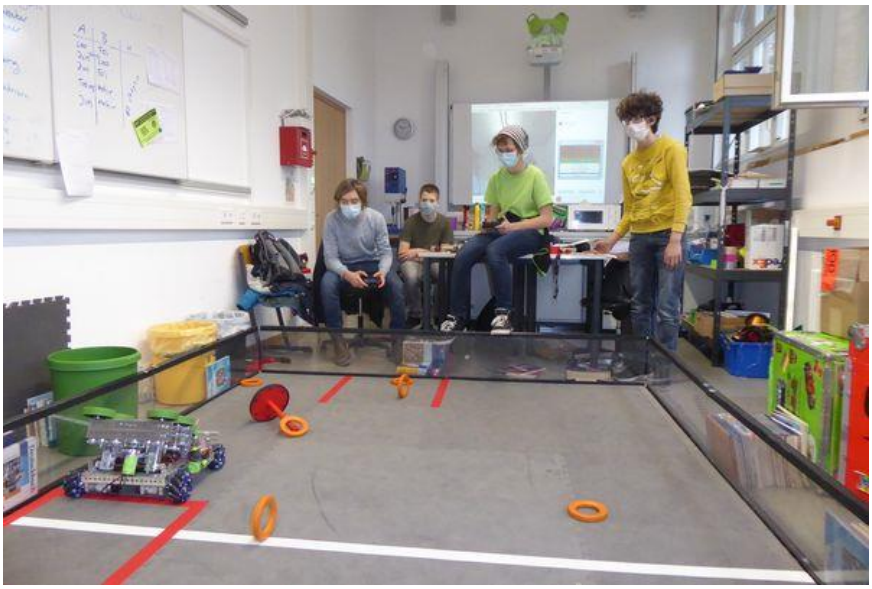
Also, from one of the contacts we got in Würzburg, we now got invited to the highlights of physics. There, we are going to present FTC to lots of students that are interested in Science and we really hope to inspire them to spend more time with STEM subjects.

FIRST community in Germany

Until now, there isn't a wide FIRST community in Germany. During the last years, we could get several school starting FTC teams. But the problem is, that there aren't annual competitions in Germany, just our scrimmages. Now, we met a teacher in Wetzlar, Hessen who lived in Virginia and therefor has been involved in FIRST for a while. Together, we are now trying to build up an FTC community here, which is very exciting!!!!!!

St Louis

After building on our robot for over three month we finally had our first contest in November. Unfortunately, contests couldn't take place in real life due to the rising corona infections, neither in Germany nor in Europe. But luckily, we got invited to participate in the remote event of St Louis in Missouri to practice our driving skills. We were extremely glad about this invitation and totally determined to create the perfect robot and make Gorfi invincible. But, as always, a lot of stuff went wrong. Suddenly the collect-mechanism didn't work anymore 4 days before the contest.



And as we fixed it, we realized that we still had to finish the transport-mechanism. By the time we "finished" this task (the rings were transported in a very strange way as we had to improve aka. repair the mechanism over and over again), we still had to program an autonomous and test it. Unhappily there wasn`t enough time anymore. On the day of the contest, we met each other at 9 am at school to begin the glorious day. Of course, the day didn't start "glorious". We had forgotten to charge the mobile phones and the battery packs! And when they were charged it took over 45 minutes to connect them to the robot as we had technical issues. Finally, we could start driving the matches. We wrote a table with every combination of A and B drivers we wanted to test. Feli and Leontine drove the first match and scored about 35 points. At this moment we were quite thrilled about the result but stopped driving because there were a few problems with Gorfi which needed to be solved. Afterwards we created a game strategy which included: building a solid autonomous in which we can score about 15 points and hitting as many powershot targets as possible in the endgame. We drove a few more matches and scored higher results every time. Meanwhile Tobias and Leontine programmed and improved the autonomous which was able to score 20 points itself. We discovered the best constellation of drivers: Leontine as the B-driver and Juri as the A-driver. In the fifth match they suddenly scored 80 points by hitting two powershot targets in the endgame. For this reason, we decided to take a break to celebrate the result. We didn't expect to score even higher results but already in the next match Leontine and Juri scored 99 points which was, at November, the European record. Even our principal Mrs. Vacano was amazed by this result and congratulated us.

In conclusion the contest was a nice experience and a great success for the whole team. We managed it to score way more points as we expected to score and surpassed our expectations. We are very happy to participate in the contest in Missouri as a German team. But we also missed to interact with other teams and the judging.

Obstacle Covid19

As one can imagine, the COVID-19 pandemic has given us a great share of inconveniences and unfavorable circumstances that we needed to overcome. We were especially sad that the travel to competitions all over the world had to be cancelled, which would have given us a multitude of opportunities to take like sharing and receiving ideas, reaching out to other teams and testing out the skills of our robot in an official competition.

Problems and complications that arose with the corona outbreak were certainly not easy to overcome. These problems include the interdiction to work on our robot in school in our designated room, the low amount of two people who are allowed to meet at once and the transfer of our complete robot in addition to tools, the playing field and building parts from our workplace to a teammate.

If we wanted to meet each other to work on our robot we obviously needed to wear masks for safety and watch out for any kind of physical contact, which is not the easiest task if the workspace is crammed up due to all the equipment. But nevertheless, it was still lots of fun to meet living humans and work for a common cause.

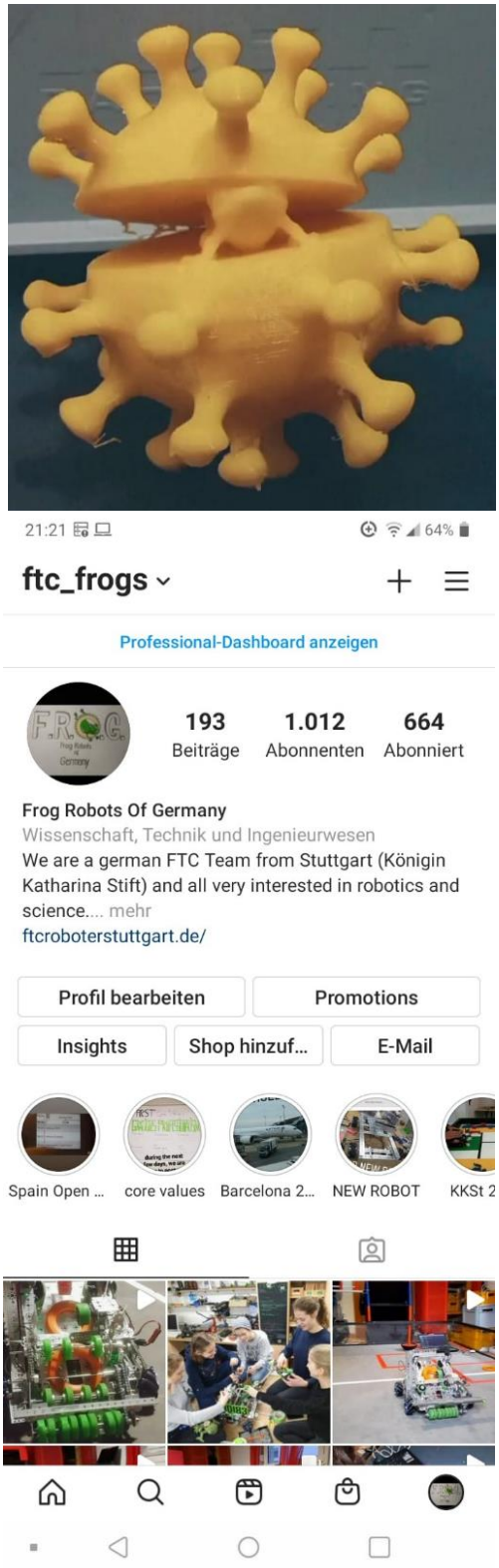
Although this occurrence has damped our spirits a bit, we were still determined to make the best of our situation and improve Gorfi even further. After our robot was transferred and the playing field set up, we now have the ability to work on it and drive some matches.

Firstly, we created a schedule to see on which days which person could come over to our teammates residence where we set up everything.

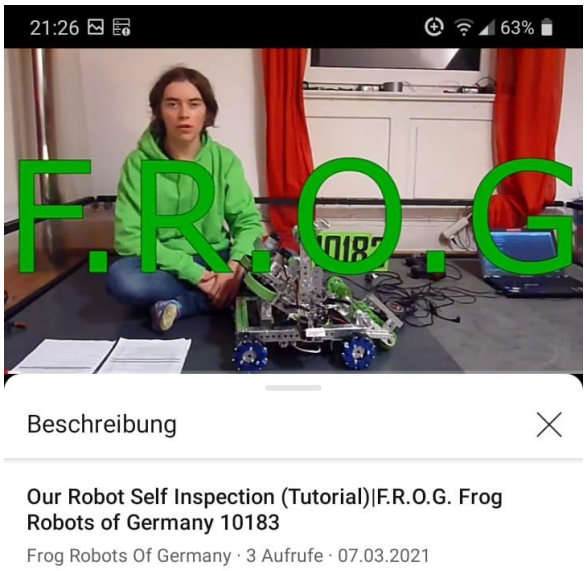
Then we have adapted our means of communication to social networks and conferences, so that we can still stay in touch with each other and coordinate our next steps.

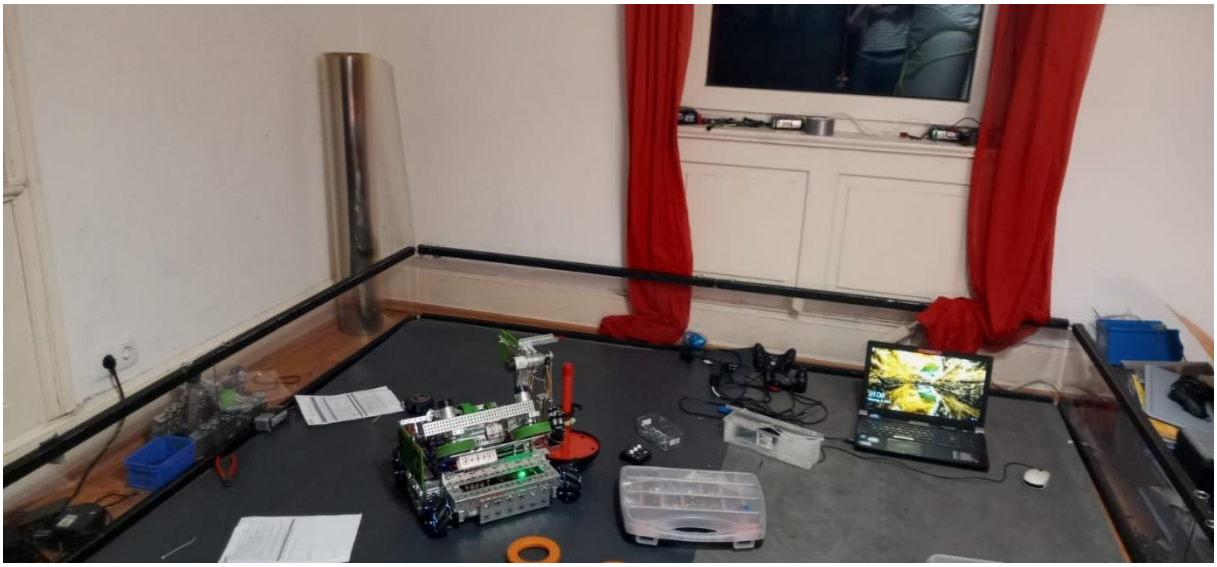
We think that most people have pursued similar ideas, but believe that that we should still stress them and simultaneously show that there are no challenges that can’t be beat.

We are convinced that it is even more important to stay in touch with the other team during Corona.



Therefore, we increased our effort of sharing our work progress and staying open minded via Instagram by publishing multiple videos and refreshing the contact to well-known teams. We too created an own YouTube channel called “Frog Robots of Germany” which we use to make tutorilals on how to do, for example, the robot self inspection. Since we already are a long-standing team with some experience, we accepted the offer directed at us to make a video about the robotself-inspection to live up to Gracious Professionalism and (hopefully) aid rookie teams all over the world when it comes to aspects where some teams might feel unsure about and to handle their first FTC season. For this reason we shot two videos: a short overview of the topic which is about 5 minutes long and a more detail explination, which takes over 15 minutes. Ofcourse we too hope to increase our general outreach like this.





The alternative FTC Room at a team members house

Costs & Sponsoring

Costs

playing field	1 500€
new building materials	ca. 1 500€
new tools	200€
additional costs like notebook etc.	100€
Earning	8500€

Note: this is the cost plan of our two teams at the Königin-Katharina Stift. We share all materials, tools and our room, so it's impossible to calculate the costs for just one team. Some of the sponsors are the same as last year, some found our coach and some are companies our team asked.
The size of the logos on our pullies depends on the donation of the different companies.

Sponsoring

up to 500€	16cm^2
up to 1 000€	24cm^2
up to 2 500€	30cm^2
up to 5 000€	36cm^2
more than 5 000€	42 cm^2

We chose these increments because they are psychological good. It's rare that companies choose the most expensive one, more often one in the middle. In else, the more they donate, the more the size increases.
With the different logo sizes, we want to express which companies donate more and we want to thank them for their support, because without them it wouldn't be possible for us to participate at the FIRST Tech Challenge as we are.

	2000€
	2000€
	2000€
	2000€
	500€
	Gifts (umbrellas, sticker, etc.)
In total	8500€

Team Plan

1. **robot goals**
   → fast and reliable shooter

   → good autonomous with camera input

2. **outreach goal**
   → new teams
   → new team members
   → connection with non - technicals
      → spread STEM
   → connection with technicals
      → spread exchange
   → this year it is more difficult than during the last years to exchange and meet other people due to corona. Nevertheless, we try to make the biggest impact possible.

3. **financial goals**
   → seek for sponsors
   → cover coasts of both teams
   → this year we don't need that much money because we can't travel.

4. **sustainability goals**
   → new team members
   → rookies
   → FLL/WRO → robotic competitions
   → technical workshops for example: meet and code
   → encourage other girls → FIRST like a girl
   → skill sharing so that we can pass our knowledge

5. **events**
   → participate in at least 3 events
   → go to the Netherlands championship
   → go to the Missouri state championship
   → op. qualify for the world championship
   → host an online scrimmage for more possibilities for other teams

6. **others**
   → stay in touch with former participants
   → signalize that we will help new teams throughout the next years, even when we left school.


F.R.O.G.
Frog Robots
of
Germany