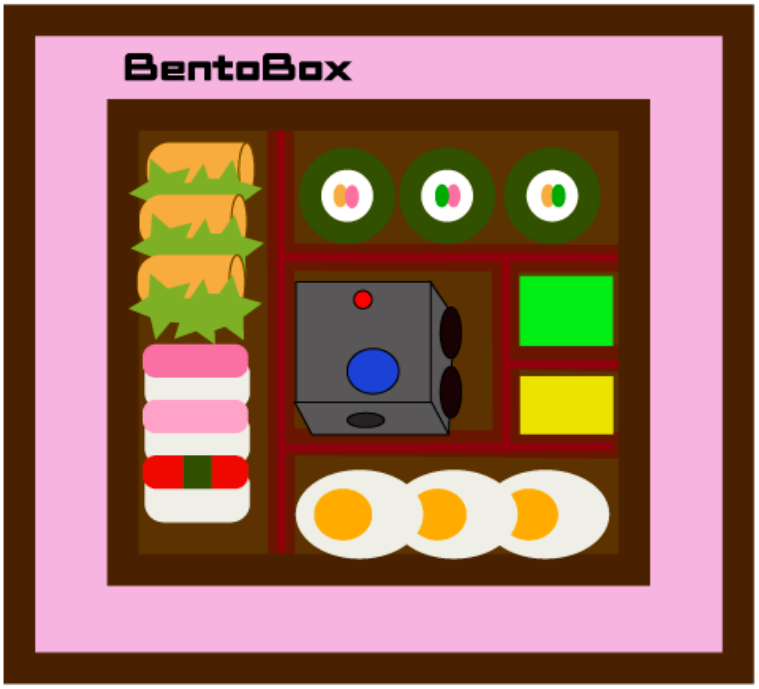
Description Paper of Team BENTO



Building & **E**ngineering **N**uremberg **T**echnical **O**rganisation

Application for participation in the RMRC league at the RoboCup 2023 in Bordeaux

1. Summary

We are BENTO, a group of interested, highly motivated students from Germany of different ages, genders and ethnicities who have experience in competitions with self-built, designed and programmed robots.

We unite students with many different skills and interests who all work together to achieve a futuristic goal.

Our group consists of about 20 people between the ages of 14 and 18.

We started four years ago as a small group of volunteers who worked mainly with Arduino.

A short time after this we expanded our knowledge towards many programming languages and tools, such as Python, C++ and ROS.

With our project we inspired many other people who then joined our team.

The name “BENTO” was chosen, because a BENTO is a meal made of many different ingredients that together create a well-rounded meal. It also lets us call the new robot “BENTO Box” so there's that.

We are very grateful to all the companies and organisations, such as SIEMENS and the Nuremberg Institute of Technology, that have supported us along the way and continue to do so.

With the combined knowledge of students, teachers and professionals, we have been able to build not only pre-designed smaller models, but also a fully customised robot with 4 wheels and more to come - because there are still so many ideas to realise and so much to do.

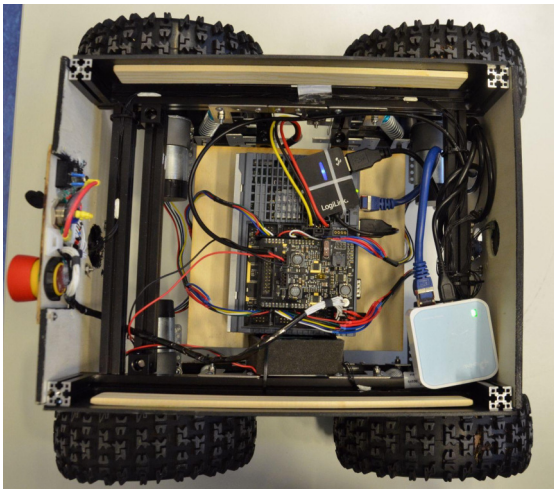
2. General information

- **Team Name:** BENTO
- **Robot Name:** BENTO BOX
- **Organisation:** Wilhelm-Löhe-Schule
- **Country:** Germany
- **Team Website:** https://baulusdev.github.io/robotic-website
- **Contact person:** Dr. Markus Stammler (mail: markus.stammler@loehe-schule.de)
    - **Second contact:** Jakob Halbig (mail: jakob.halbig@gmail.com)
      or Samuel Pelz (mail: samuelpelz007@gmail.com)

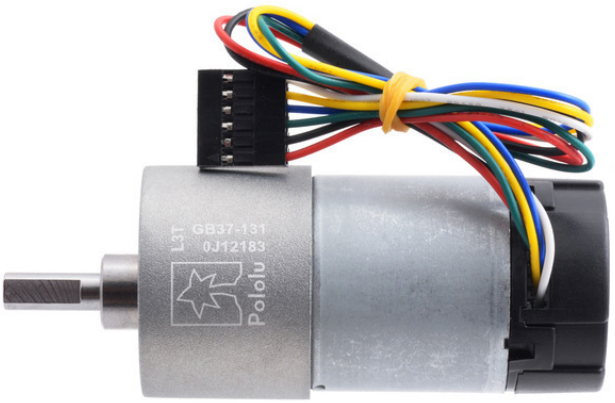
3. About our robots

a) Hardware Description

This is Zyklop, our first fully self-built robot.
(a first video of it: https://files.pipeman.org/robot/Roboter-Film-2.mp4)
We named it Zyklop after the one-eyed mythical creature in the Odyssey saga. Our robot's eye is the single camera on the front side.



It is built out of parts we acquired at a competition, bits and pieces that were lying about at school and components we bought. The frame is made of 15x15mm makerbeam aluminium extrusion, and the side panels are laser cut plywood.
In addition the robot has a suspension system with rc car shock absorbers to handle small bumps and prevent unnecessary damaging of the parts.

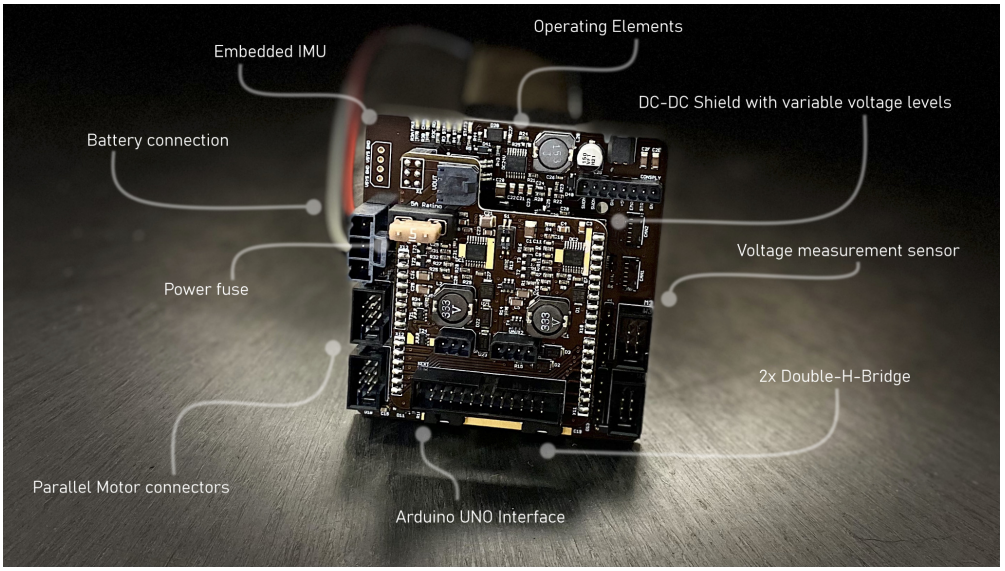


The motors used are Pololu 24V 37Dx73L mm 70:1 Metal Gearmotors which each have 3 Nm of torque.

The camera is placed in the front and the middle of the robot. With that design we have an optimal view to control the robot, because we see the environment in front of the robot clearly and also a part of the front tires so that the robot can be controlled with an accurate estimation of its position.
Also we placed heavy parts, meaning the SBC (see below) and the battery, at the lowest position, so that the centre of gravity is also at its lowest possible point. This ensures a safe and controlled movement of the robot.
The tires are big so the robot has the ability to deal with difficult terrain better: not only does it prevent small obstacles from colliding with the chassis, it also makes it easier to surpass small elevations like slabs.

b) Electronics

Our 4 geared motors are powered by EduArt-Robotik's iotbot shield sitting on an Siemens SIMATIC IOT 2050 micro computer(depicted below).
This electronic assembly is a complete drive system with integrated charge management and inertial sensors.

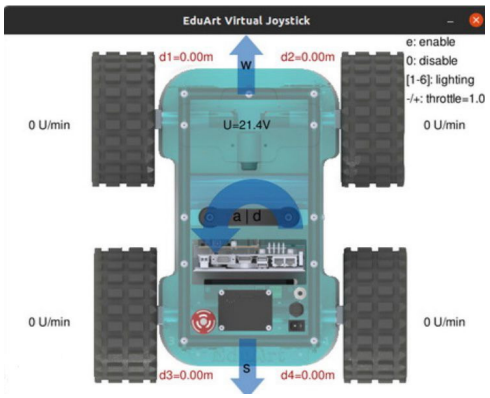


For power, we use a safe 19,2V NiMH battery with a capacity of 4.5 Ah.

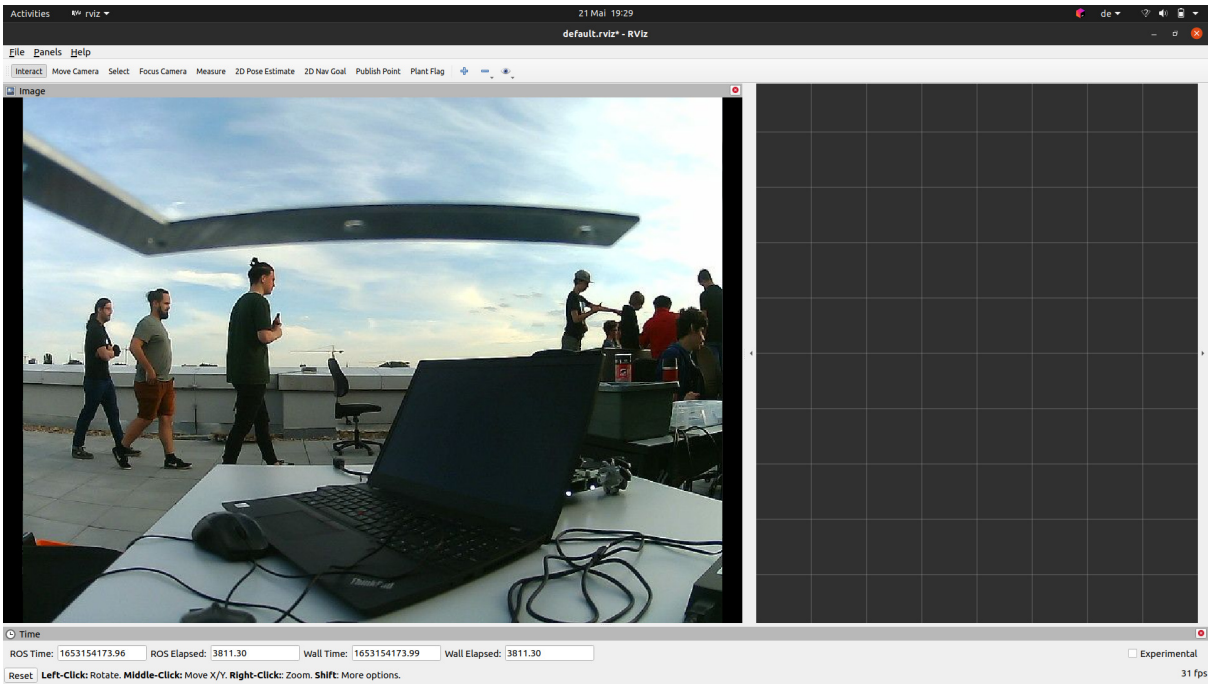
c) Software Architecture

We use the ROS to communicate between computers. This allows us to focus more on collecting and processing data and less on actually transferring it.
Repositories with our software:

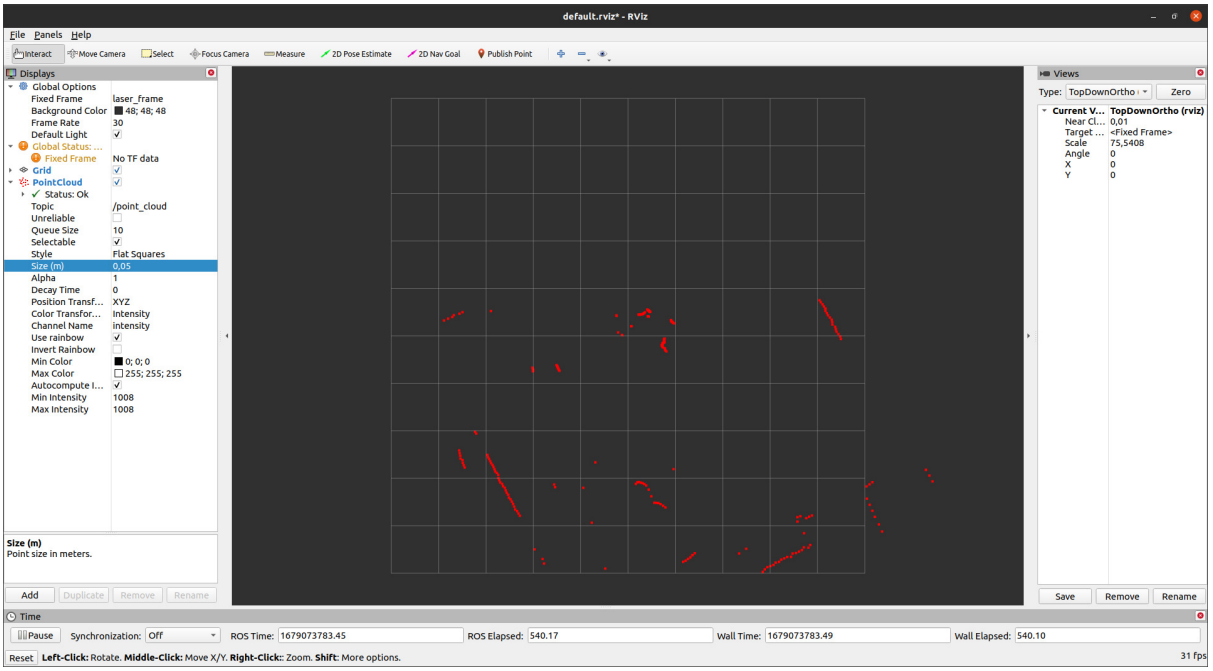
- https://github.com/The-Pipeman-Organisation/rosbot
- https://github.com/The-Pipeman-Organisation/iotbot-TUI



Here you can see the interface while controlling the robot via Joystick



Our Robot at a meetup with TH nürnberg



Visualising LiDAR, a remote sensing method that uses light in form of pulsed laser to measure ranges, data with rviz

d) Costs

Siemens has sponsored us on our robotic adventure

Zyklop:

Siemens IoT 2050 Advanced	~400€
TP-Link 300Mbps Wireless N Nano Router	25€
60mm Fan	*recycled from old printer* (~5€)
cables	*mostly recycled* (~10€)
Metal Shock Absorber	187€
wheels	69€
makerbeam	139€
camera	33€
LiDAR (ydlidar X4)	(~100€)

In total: ~ 798€

4. Details about our team

a) Team Description

Our team consists of a total of six members. Together the team is well-rounded and is able to efficiently work together as one.
By participating in the international competition, we also want to strengthen our teamwork and receive more experience.

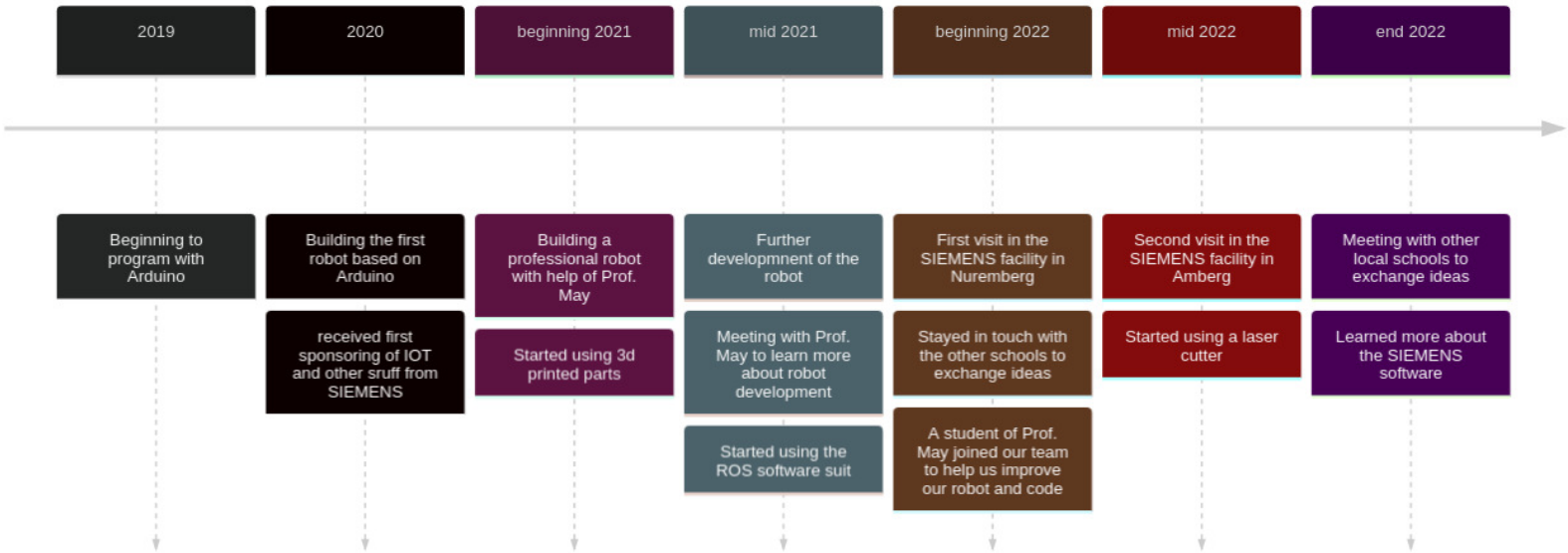
Our team members (from left to right on image)

- Luis Herzog
    - Luis is a programmer who works mostly on front-ends in software. Sam and him together make a great duo and benefit from each other.
- Samuel Pelz
    - Sam started programming with arduino in 2015 and maintains our communication and hardware software. He is very proficient at soldering, and built the electrical system of Zyklop.
- Lena Steinmetz Siu
    - Lena is the team's leader and organises the schedule. She helps the team keep track of time. She also helps build test tracks for the robot.
- Alina Reithmeier
    - Alina has participated in Arduino programming courses since 2018. She is our spokeswoman and represents our team. She also constructs and helps with the design of our robot and designed the unique logo for our team.
- Jakob Halbig
    - Jakob has participated in Arduino programming courses since 2017. After that he also started building and programming robots. In our team he helped design and build our first robot Zyklop.
- Noah Schuller
    - Noah started building robots in 2019, which has been a passion of his since his childhood. He has helped to design parts of the robot Zyklop via CAD.
- Markus Stammler
    - Our teacher and consultant who looks after us and helps us organise.

b) A brief history

Our team at the siemens Amberg competition

We had our first experience in a competition in July 2022 with our robot Zyklop. There we took part in the **F**ind **L**ive **O**n **M**ars (short FLOM) project which was sponsored by SIEMENS. Previous to that we took part in a couple of workshops that were held on SIEMENS company grounds in which we learned a lot of our current skills.

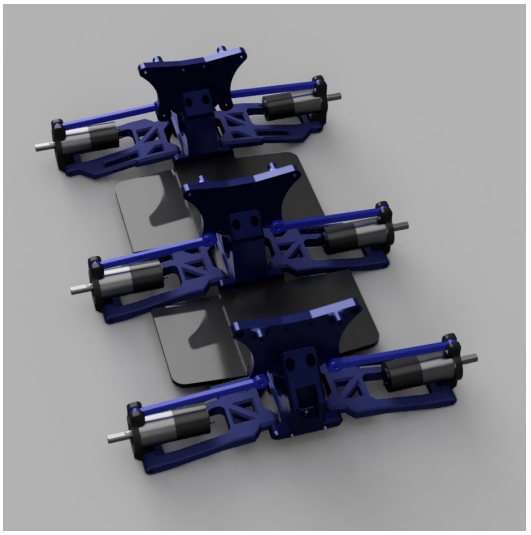


5. Future Ambitions

In the near future we want to update our systems to ROS2, since ROS1 is becoming a bit of a hindrance. When we first built Zyklop there was no pre-made ROS2 code for the drive shield, so we had to use ROS1. Since then our team has become much better at producing software, and efforts to port our
programs to ROS2 are ongoing.

For the software our goal is to transfer the bird pattern recognition concept as mentioned earlier to warning signage and other images as well as colours used in the competition by combining AI and ROS. We also planned on using an infrared camera to be able to find “life” and sort out IR rays, which would not only benefit us in a competition but could be beneficial in actual rescue missions.

As for hardware, we are planning a complete restructure, especially with the suspension, to make Zyklop easier to build, less prone to jamming and cheaper overall. To optimise it for actual rescue missions. The parts that we will use are easy to assemble and easy to get.



In the future we plan to call the new robot *Bento Box*. It will have a 6-wheel chassis with motors sponsored by Faulhaber (type 2224U018S R IEH2-512 22GPT 44:1). Our calculations show that this setup should give us a maximum torque of 0.77 Nm at the wheel and a nominal speed of about 109 rpm. With a wheel diameter of 100mm, forces of over 15N per wheel can be transmitted to the ground. The nominal speed is approximately 0.57 m/s.