Team Description Paper of Team BENTO

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

Summary

We are Bento, a group of interested, highly motivated students of different ages, gender and ethnicity 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 little group of volunteers who mainly worked with arduino.

A short time after this we expanded our knowledge towards many programming languages and tools, for example 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 were able to build not only pre-designed smaller models but also a completely custom robot with 4 wheels and more is yet to come - because there are still so many ideas to bring into reality and so many things still to be done.

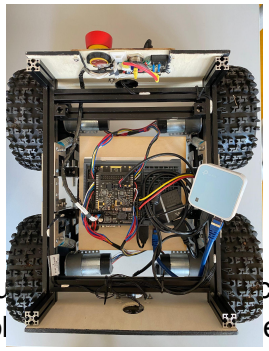
General information

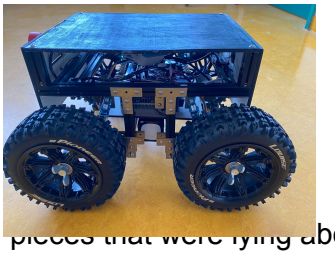
- **Team Name:** BENTO
- **Robot Name:** BENTO BOX
- **Organisation:** Wilhelm-Löhe-Schule
- **Country:** Germany

- **Team Website:** https://baulusdev.github.io/robotic-website
- **Contact person:** Dr. Markus Stammler (Mail: markus.stammler@loehe-schule.de)

Hardware Description

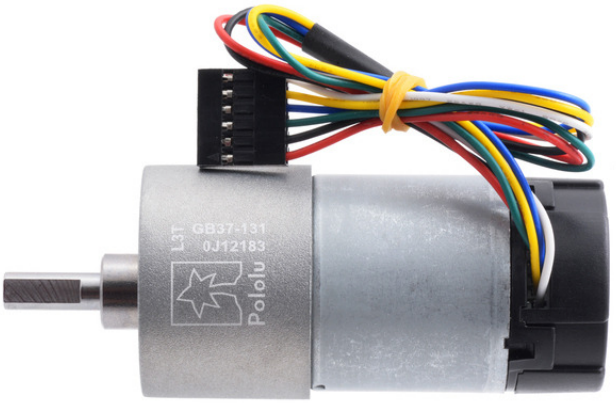
This is Zyklop, our first fully self-built robot. We named it Zyklop after the one-eyed mythical creature in the Odyssey saga. Our robot's eye is the single front camera which can be seen in the middle picture.





It is bu cquired at a competition, bits and pieces that were lying about at schoo e 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.

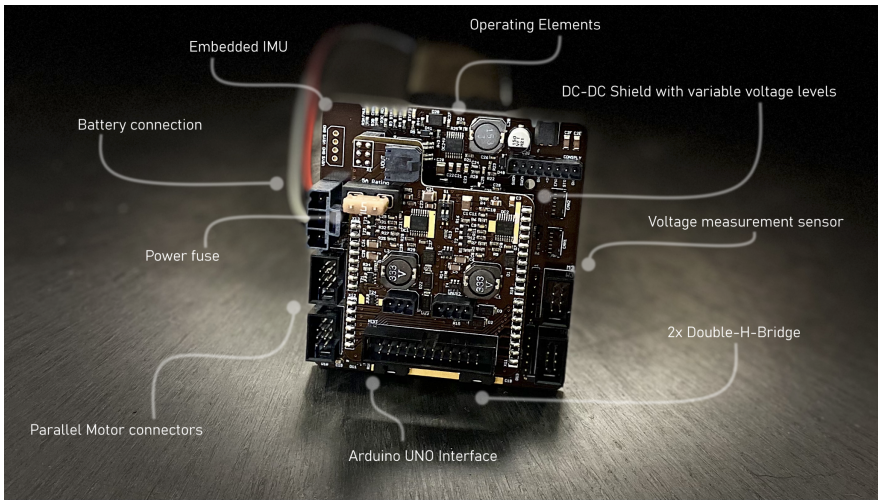
The motors used are Pololu 24V 37Dx73L mm 70:1 Metal Gearmotors which each have 3 Nm of torque.



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 IOT and the battery, at the lowest position, so that the center of gravity is also at its lowest possible point. This ensures a safe and controlled movement of the robot and prevents the worst-case-scenario of the robot falling over.
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.

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 safer 19,2V NiMH battery with a capacity of 4.5 Ah.



For wireless connectivity we use an Intel AX200NGW Wifi and Bluetooth radio, the same as most modern laptops. We attached the module to the IOT2050s mini-PCIe slot using an M.2 to mini-PCIe adapter. The antennae used (not in picture) are recycled from an old PC.
With this setup we can use Wifi 6 and Bluetooth 5.2 to achieve blazingly fast speeds with high range, making sure the person driving the robot can see where they are headed.

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

<RVIZ>
<Provide informations about the software packages that you are going to use, Ubuntu, ROS, packages, own algorithms>

<Tell also which challenges you aim to overcome>

In a workshop, organized by SIEMENS and the TH Nürnberg, we learned the basics of pattern recognition using AI. We applied the program on the recognition of different types of birds. Our goal is to transfer this concept from birds to warn signals and other images 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.

Costs

<Summarize the costs of your robot in a table>

Zyklop:

Siemens IoT 2050 Advanced	*sponsored by siemens* (~400€)
Intel AX200NGW M.2 wireless adapter	20,75€
miniPCIe to M.2 adapter	8,67€
cables	10€
Metal Shock Absorber	17€
wheels	69€
makerbeam	139€
camera	33,40€
LiDAR (ydlidar X4)	<sponsored at competition?> (~100€)
Co2 sensor	59€
Temp & pressure sensor	7,90€

In total: ~ 865€

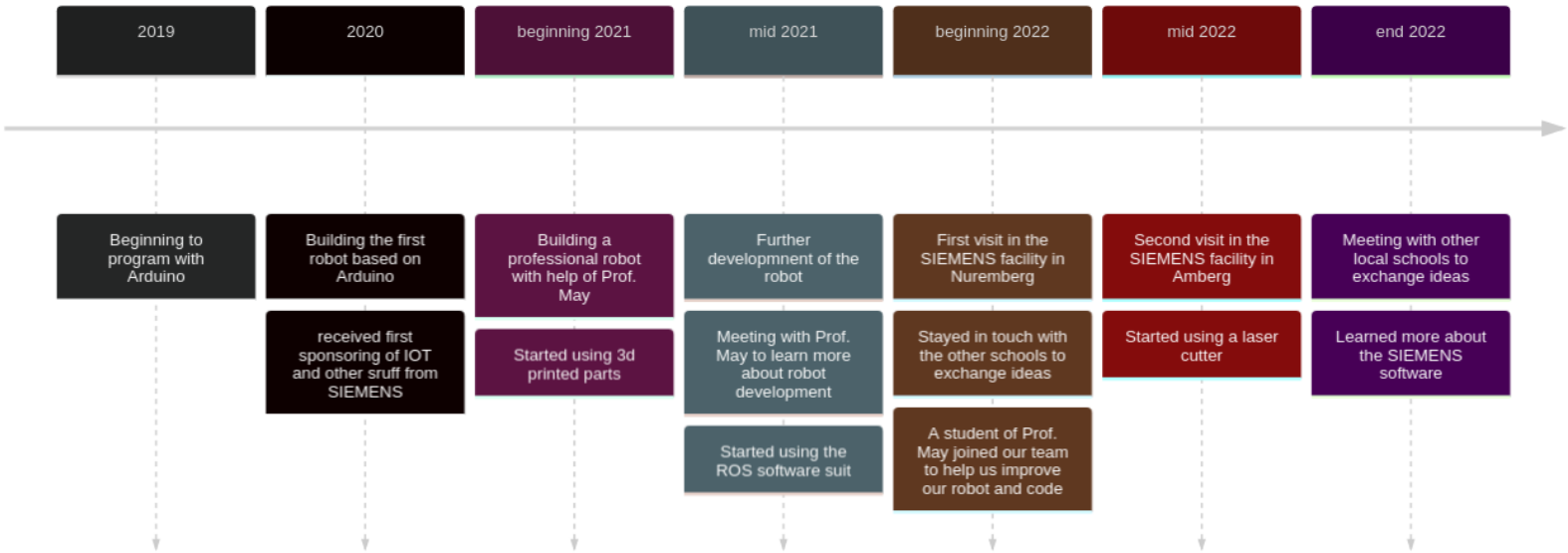
Team Description

<describe the roles of the team members>
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.

- 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.
- 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.
- 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.
- 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.
- 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.
- 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.

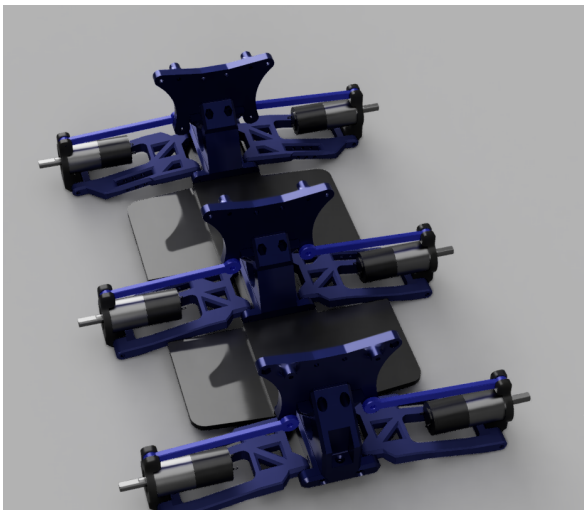
A brief history

https://files.pipeman.org/robot/Roboter-Film-2.mp4



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.

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.

We will call version 2 the *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 about 0.57 m/s.