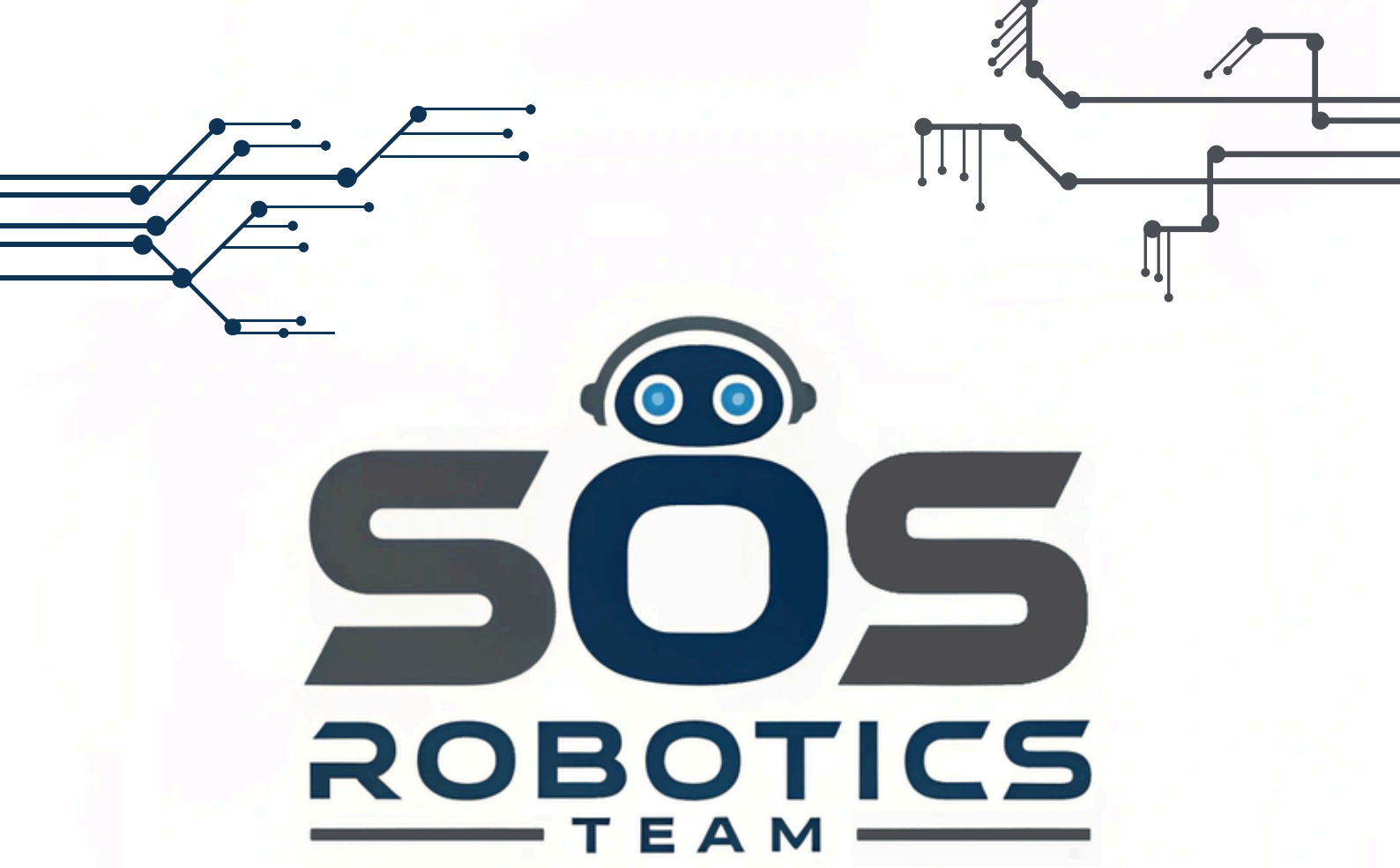
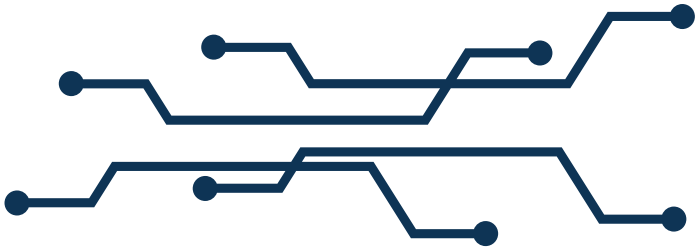


SOS Robotics Team

Team members:
Ákos Szánthó, Zsombor Kukucska, Kristóf Gere

Mentors:
András Tamás Bakti, Norbert Medve



Summary

We are three software developer and tester students from Hungary who are passionate about programming, robotics, 3D modeling, and challenges.

As part of the RMRC project, we are working on the development of a robot capable of reading QR codes, lifting and moving objects using a robotic arm, and performing multidirectional movement on the competition track. The design of the robot prioritizes a compact structure, energy efficiency, and precision. The central control unit of the system is a Raspberry Pi, which operates with Python-based software. Throughout the development process, we have gained a significant amount of knowledge, and robotics has grown even more close to our hearts.

The goal of the project is to create a reliable robot that effectively meets the challenges of the RMRC and adapts flexibly to changing environments.

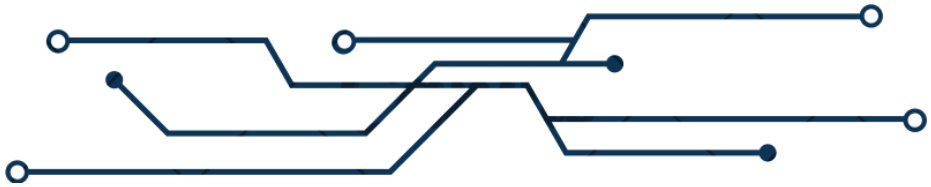


Table of Contents

SOS Robotics Team

Logistic information

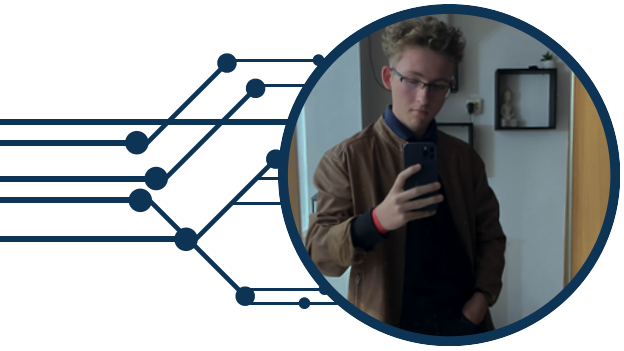
Team name:	SOS Robotics Team
Organisation:	NYSZC Széchenyi István Technikum és Kollégium
Country:	Hungary
Mentors:	András Tamás Bakti, Norbert Medve
Contact Person:	András Tamás Bakti

Introduction

We are a team of three students from NYSZC Széchenyi István Technikum és Kollégium in Hungary, united by our enthusiasm for technology and innovation. While this is our first experience in a competition like the RMRC, our passion for programming, robotics, and 3D modeling has brought us together to tackle this exciting challenge.

Team members:

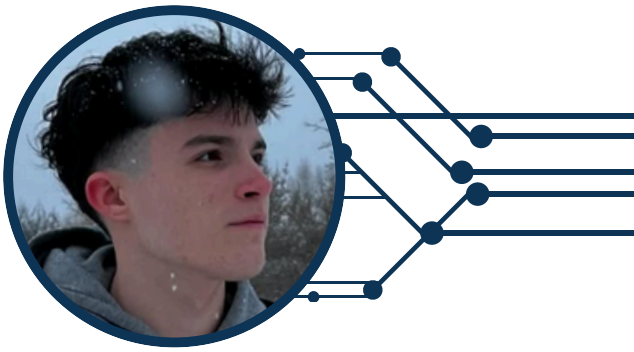
Ákos Szánthó



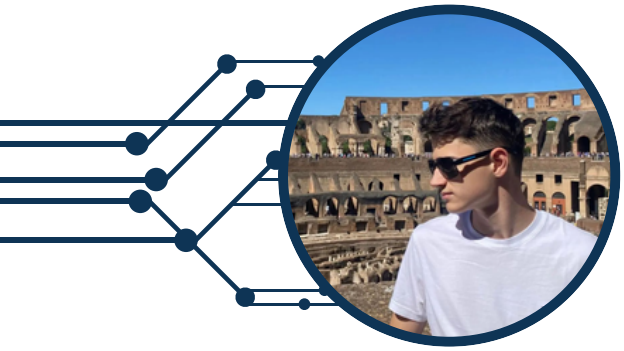
Ákos is the team leader, responsible for organizing the project and overseeing the hardware development. With a strong focus on hardware design and integration, he ensures all physical components are properly assembled. Additionally, Ákos contributes to the software side, helping to ensure smooth communication between the hardware and the overall system.

Zsombor Kukucska

Zsombor is mainly responsible for programming and graphic design. He developed the project logo and other visual designs, while also contributing to the software development. Although he assists with hardware setup when needed, his primary focus is on ensuring the robot's functionality through programming and creating the project's graphic elements.



Kristóf Gere



Kristóf has been a versatile contributor to the project, assisting in all aspects of development, including programming, hardware, and design. His contributions have been essential to the success of the team. Additionally, Kristóf will be responsible for operating the robot on the competition track, ensuring smooth navigation and task completion.

Robot Introduction

Our robot is designed to autonomously navigate the competition field, identify and scan QR codes, and manipulate objects using a robotic arm. This part of the document provides a detailed overview of the robot's key functionalities, hardware, and software architecture, as well as the challenges faced during development and the optimizations implemented to enhance performance.

Hardware components:

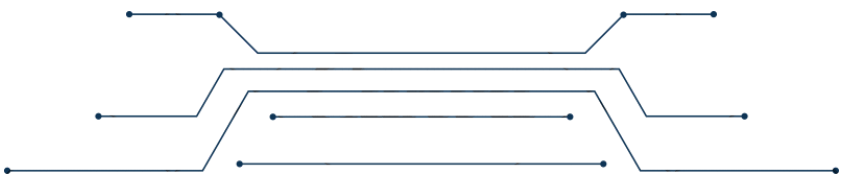
Name:	Quantity:	Price:
12V Cooling Fan	2	3,21 €
12V DC Motor	6	39,89 €
Servo driver	2	6,39 €
Servo bracket	3	9,24 €
Servo MG996R 2 pack	2	15,71 €
H-bridge motor controller	2	8,02 €
12 CM diameter wheel	4	19,18 €
Heatsink	8	5,60 €
20A buck converter	2	8,16 €
5A buck converter	6	14,98 €
Threadlock	1	3,57 €

Name:	Quantity:	Price:
20 Kg servo	2	19,14 €
Brass tinned crimp	50	2,88 €
2x20 port GPIO	1	1,83 €
Raspberry PI 4 Model B 4GB	1	69,32 €
ProXtend X701 4K Cam	1	27,58 €

Total price: **254,7 €**

The robot is composed of several key components that work in tandem to achieve optimal performance during the RMRC competition. Each part plays a crucial role in ensuring smooth operation and task execution:

- **Chassis (Body):**
  The robot's frame is constructed from **plexiglass**, chosen for its lightweight yet durable properties. The custom-cut chassis ensures stability and compactness, making it ideal for maneuvering through the competition area while providing clear visibility of the internal components.
- **Motors & Drive System:**
  Equipped with **12V DC motor**s, the robot utilizes omnidirectional wheels for seamless movement in all directions. This setup ensures smooth, agile navigation, allowing the robot to swiftly move forward, backward, and rotate in any direction with precision.



Microcontroller & Processing Unit:

At the core of the robot is a **Raspberry Pi** microcomputer. It handles high-level processing tasks such as managing inputs from the sensors and controlling the robot's movement. The Pi interfaces with additional microcontrollers that control lower-level functions like motor actions and sensor readings, ensuring real-time responsiveness.

Camera & Vision System:

The **ProXtend X701 4K Cam** serves as the primary vision system, capable of recognizing QR codes. This is essential for navigating the field and recognizing QR codes on the track.

Robotic Arm:

The robot's robotic arm is designed for manipulation tasks, such as lifting and moving objects. The arm, powered by **servo motors**, is built with **metal brackets**, ensuring durability and precision in its movements.

Power System:

The robot is powered by a **rechargeable ParkSide battery**, providing a reliable energy source throughout the competition. The voltage regulator ensures a stable power supply to all components, preventing voltage fluctuations that could affect performance.

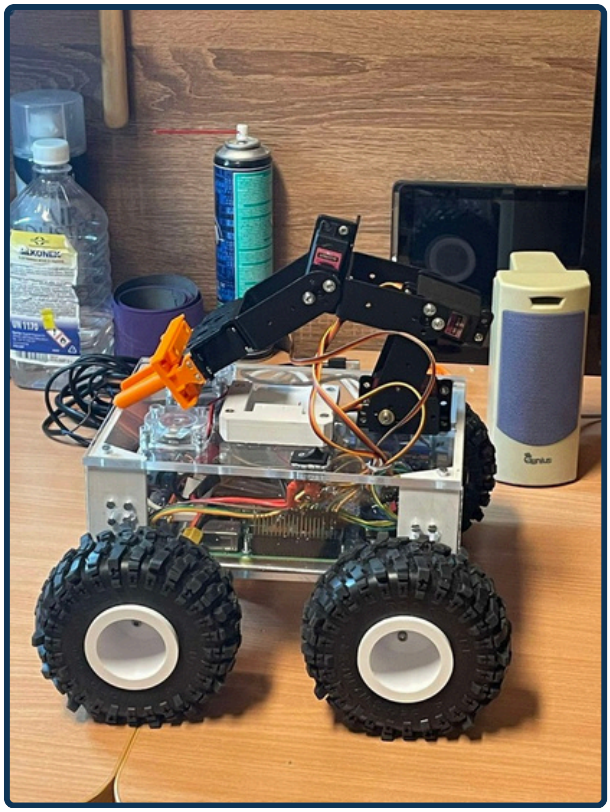
Motor Mounting & Battery Connector:

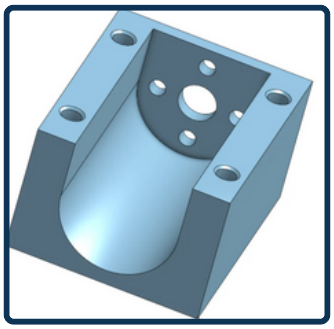
The motor mounts and battery connectors are **3D printed**, ensuring a secure and precise fit. This custom approach enhances the overall stability of the robot by keeping components firmly in place during operation.

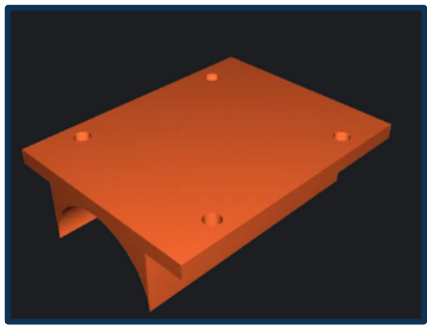
Communication System:

The robot is operated via a **wired connection** to a laptop. This wired setup ensures continuous communication between the robot and the operator, reducing the risk of interference or signal loss compared to wireless options.

Hardware Pictures







Programming

Our RMRC robot is designed to navigate and complete tasks autonomously by integrating computer vision and precise motor control. The codebase is developed to ensure smooth communication between hardware components while maintaining high efficiency in executing competition-specific tasks.

Software & Libraries:

- Python (Primary Programming Language for Control and Logic)
- OpenCV (Advanced Image Processing – if Required for Further Enhancements)
- SMBus2 (I2C Communication Library for Efficient Sensor Management)
- Adafruit PCA9685 Library (Motor PWM Control Library)
- Custom Algorithms for Task-Specific Enhancements

Challenges, Optimizations and Github:

I2C Communication Stability:

To mitigate occasional data transmission failures, we implemented robust error-handling mechanisms and periodic device resets to maintain a stable connection.

Processing Latency Reduction:

By optimizing frame capture and processing times, we improved the robot's response speed, ensuring near-instantaneous reactions to visual inputs.

Motor Control Refinements:

Adjustments to the PID control parameters allowed for smoother acceleration, deceleration, and directional changes, enhancing navigation precision.

Github:

https://github.com/SOSRoboticsTeamHU

The robot's code has been designed to be highly modular, adaptable, and efficient, ensuring a seamless integration of vision processing, motor control and decision-making. The structured communication system between components, along with carefully optimized control algorithms, allows the robot to perform competition tasks reliably and efficiently. With its robust design and intelligent automation, our RMRC robot is capable of handling diverse scenarios, maintaining accuracy, and successfully executing complex tasks in real-world conditions.

Conclusion

This project has been an exciting challenge for our team. Despite the difficulties we encountered, we have gained valuable experience in **hardware integration**, **software development**, and **teamwork**. Our goal was to create a reliable and adaptable robot, and we take great pride in what we have accomplished. This competition is not just a test of our technical skills but also an opportunity to grow, innovate, and take a step forward in the world of robotics. For those interested in our work, we have made all resources available on **GitHub**, allowing others to explore, learn from, and build upon our project.

SOS ROBOTICS TEAM

Github link: https://github.com/SOSRoboticsTeamHU