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LNX ROBOTS

Bratislava, Slovakia

RoboCup Junior Soccer Open 2025

Abstract

We are LNX Robots, a team of four high school students from Gymnázium Grösslingová 18 in Bratislava, Slovakia, participating in the RoboCup Junior Soccer Open category. Last year, we were grateful to achieve second place in World Championship and first place in European Championship, which motivated us to keep improving.

This poster offers a quick look at our robots and the main upgrades we've made since then – especially a **wider dribbler with better grip**, a **more precise, powerful kicker** and an **AI for ball recognition**.

If you have any questions, feel free to ask us in person or contact us on Instagram.

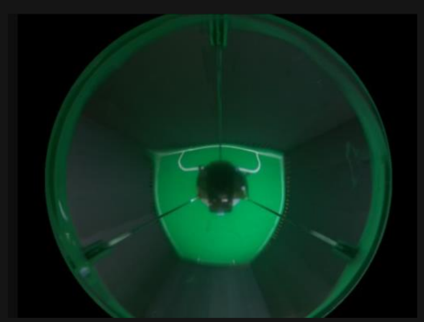
Mechanical Design

All mechanical parts were designed in Autodesk Fusion 360 and initially 3D printed for prototyping. Key components were later replaced with aluminum to improve structural integrity. We selected parts based on our previous experience and online research.

Vision

The robot uses two cameras: a front-facing wide-angle camera and one aimed at a 360° mirror. We simulated the setup in Blender and built the mirror by vacuum-forming laminated polystyrene.

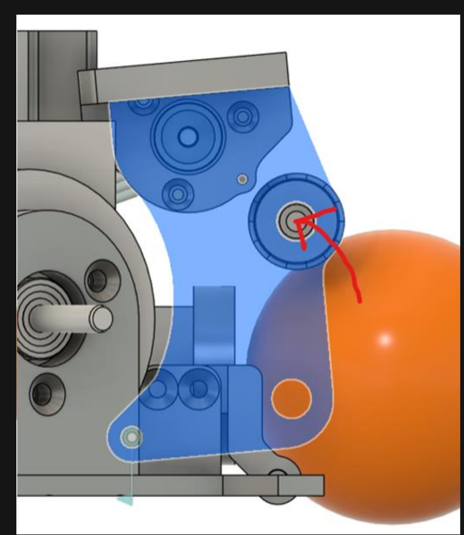
Ideal mirror image



Real mirror image

Dribbler

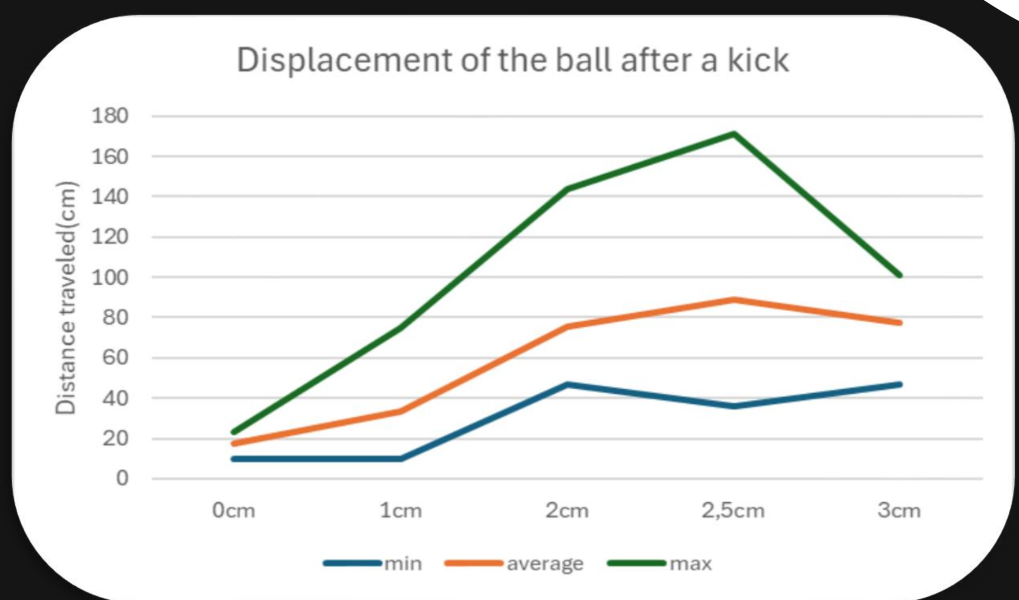
The dribbler is bottom-mounted: rotating around an axle positioned below the ball's top. This improves ball capture and control, as it allows the dribbler to move more naturally with the ball.



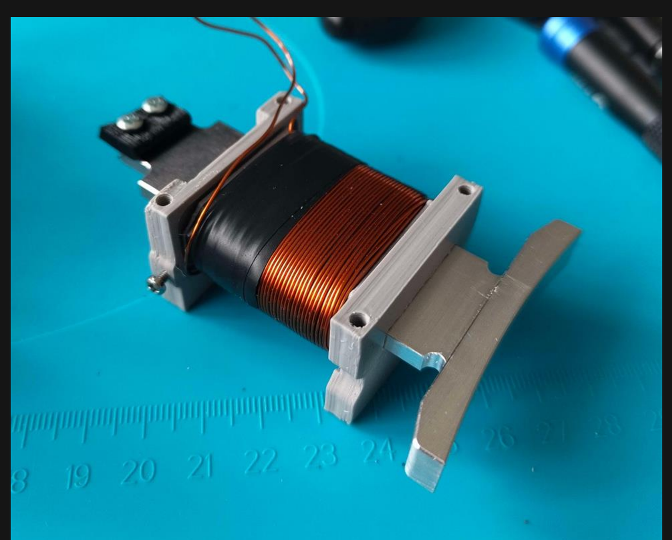
Dribbler from the side

Kicker

To save space, we designed a custom flat solenoid. Its core has a similar mass to the ball to reduce energy loss on impact. We prioritized higher current over more windings for a compact, powerful design. Each 10 ms kick draws around 20 A from 4.4 mF capacitors.



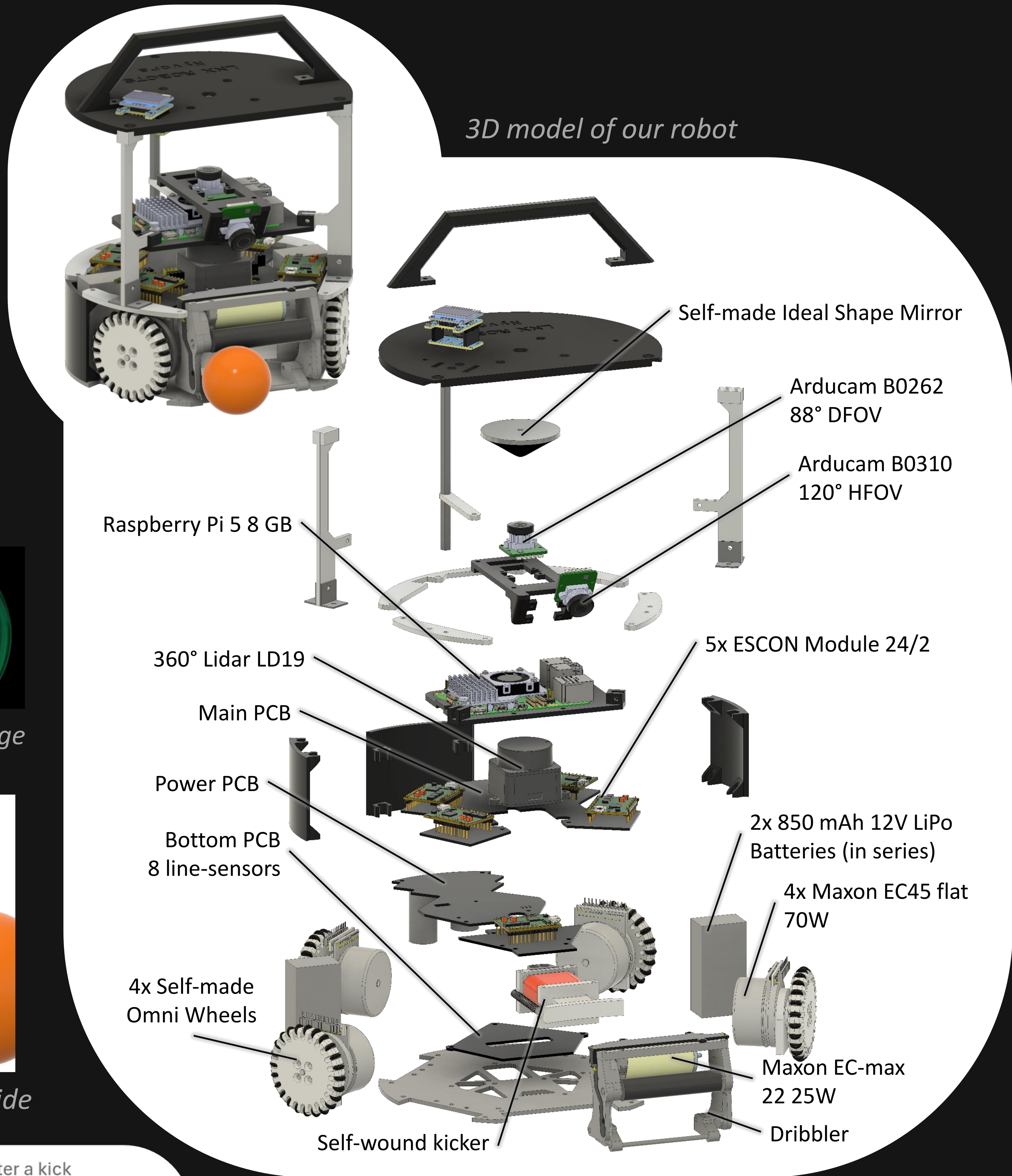
Results of the solenoid test



Self-wound solenoid

Solenoid Test

To optimize our solenoid's performance, we tested various distances between the ball and the solenoid plunger. For each setup, we measured how far the ball traveled after being kicked. The strongest kicks occurred when the ball was 2-3 cm from the plunger. Based on this, we moved the solenoid further into the robot.



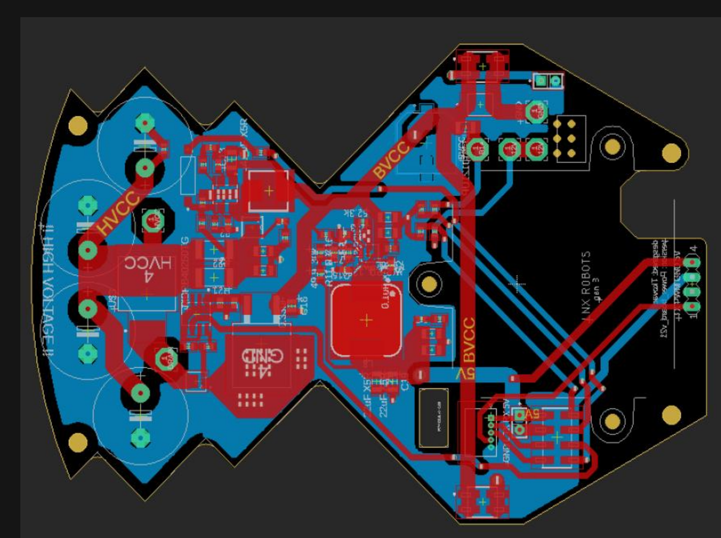
3D model of our robot

Electrical Design

Each robot contains four custom PCBs, designed in Autodesk Eagle. The main processor is a Raspberry Pi 5, which handles camera input and communicates with two STM32 microcontrollers:

- STM32F767: manages UI, gyroscope, motor, and kicker control
- STM32G474: handles line sensors and LiDAR data

All drive motors are direct-drive brushless with encoders, controlled via Escon 24/2 units for fast and precise movement.



PCB design for power STM

Software

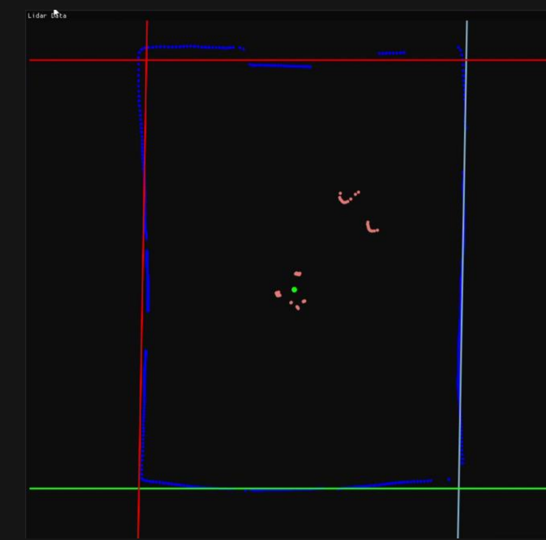
The Raspberry Pi code is written in Python. The STM32 microcontrollers run FreeRTOS and are programmed in C using STM32CubeIDE. We use multiprocessing to optimize performance, enabling the system to handle image processing from both cameras in parallel.

AI ball detection

The front camera detects the ball using a custom YOLOv8 model running on a Hailo-8L (13 TOPS) via the Raspberry Pi AI Kit. It was trained on ~7,000 manually labeled frames selected from 2 million collected during matches and tests.

Positioning

The robot uses a 360° LiDAR to detect straight segments in the point cloud via Hough transform, identifying field walls and estimating its position based on their distances and orientations, with sub-5 cm accuracy.



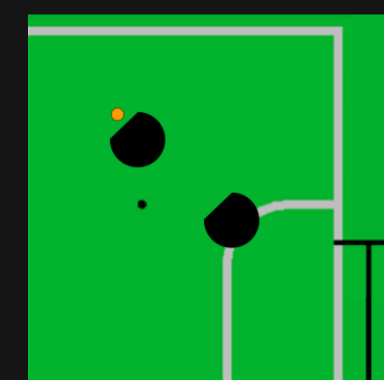
Point cloud of the lidar

Strategy

Knowing our position on the field at all times allows us to adapt our behavior based on where we are.

Goalie

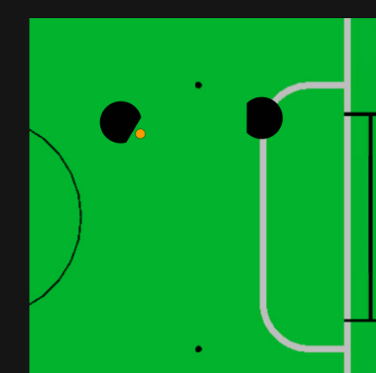
The goalie moves along the penalty area line to block incoming shots. When it gains control of the ball, it performs a kickoff. If an opponent hides the ball, we track their robot's position with LiDAR and defend that position instead.



Goalie's robot defense

Striker

The striker uses a "north-oriented" strategy for defense but turns toward the ball near the sidelines.



Striker's best place to shoot

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*This project was made possible with the support of **Siemens s.r.o.***

*This project was financed with the support of the **TNE Programme***

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