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LNX ROBOTS

Bratislava, Slovakia

RoboCup Junior Soccer Open 2024

Abstract

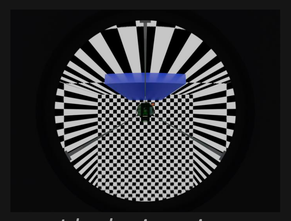
We are LNX Robots, a team of 3 high school students from *Gymnázium Grösslingová 18* and *Gymnázium Bilíkova* high schools in Bratislava, Slovakia. We are participating in Robocup Junior Soccer Open category.
This paper shows a quick overview of our robots and the biggest improvements since last year. We mainly focused on adding a dribbler, kicker and a 360° camera vision to our robots. For the software, we implemented a more complex behavior based on the position of the robot on the field. If you have any questions about our poster, feel free to reach out to us and ask us directly or contact us through Instagram.

Mechanical Design

We designed all our mechanical parts in Autodesk Fusion 360 and 3D printed them for the prototype version. Later we swapped the main parts for aluminum, for better structural integrity. Components were chosen based on our past experiences with them and internet research.

Vision

Our mirror's shape is calculated using a differential equation to ensure that objects on the field plane appear equidistant in its virtual image. To test the mirror and find an optimal positions for cameras, we simulated our robot and the playing field in Blender. The mirror was then made by vacuum forming of laminated polystyrene.



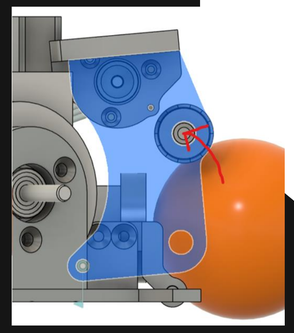
Ideal mirror image

Real mirror image

3D model of our robot

Dribbler

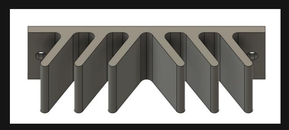
The dribbler on our robot is **bottom-mounted,** meaning its rotating around an axle which is mounted below the top of the ball. This offers better ball capturing performance and overall dribbling, since the dribbler is moving with the ball. Our dribbling bar has 2 **screw patterns** on both ends for ball centering and hence more precise kicks.



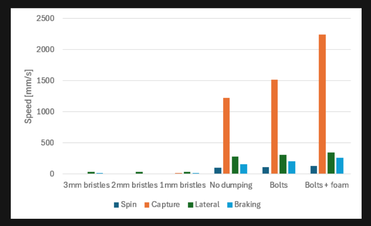
Dribbler from the side

Dribbler dumper tests

We added a dumper which would be always pushing dribbler back down and when it loses the ball it would fall back faster and raise the chance to capture the ball again. We tested our dumpers with four different movement tests with the ball and marking highest consistently achieved speed (you can find more information on our GitHub, file `movement_test.py`). Based on the results of our test we implemented the *bolts + foam* dumping. However, we are confident that there is still room for further improvement.



One of the tested dumpers



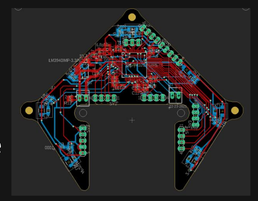
Results of dumper tests

Electrical Design

Our robots consist of 6 PCBs each, all made by us in Autodesk Eagle and later produced by JLCPCB. As our main processing unit, we use Raspberry Pi 5, which reads from cameras and communicates with 2 other STM32 microcontrollers:

- STM32F427 – handles user interface, gyroscope and lidar data
- STM32G474 – handles motor control and reads values of line sensors

All our **drive motors** are direct drive, brushless and have an encoder.
Paired with Escon 24/2, they give a fast and precise motor control. For **kicker** we use Tremba HMF-2620 running at 48V from a booster circuit.



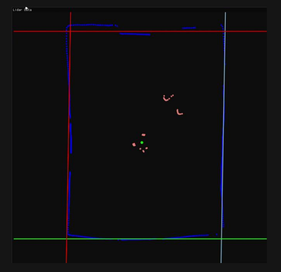
PCB design for bottom STM

Software

The code for RPi is written in Python – we used Visual Studio Code as an editor. For programming STM32 microcontrollers, we used STM32CubeIDE with FreeRTOS and wrote our code in C. We use multithreading to optimize our code and to be able to process image from both of our cameras simultaneously.

Positioning

Robot uses a 360° lidar to measure the distances from the walls. It then finds the points that represent the walls in the point cloud and calculates its position from the distance of the walls. We can estimate robot's position on the field with sub 5cm accuracy.



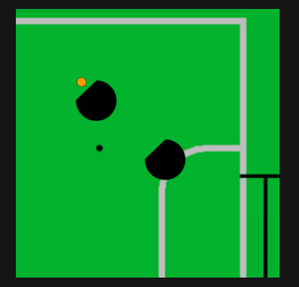
Point cloud of the lidar

Strategy

By always knowing our position on the field we can make different decisions depending where we are on the field.

Goalie

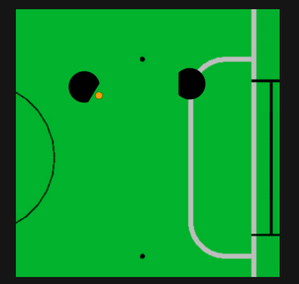
Goalie moves along the penalty area line and defends the goal from incoming balls. When it captures the ball, it does a kickoff. If an opponent's robot proceeds to hide the ball, we can track the position of our opponent's robot with lidar and defend it regardless.



Goalie's robot defense

Striker

Striker normally plays "north" oriented playstyle for its defensive benefits, but switches to rotating to the ball and capturing it near the sides of the field. After capturing the ball, it shoots the ball inside the biggest unguarded space visible in the goal.



Striker's best place to shoot

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