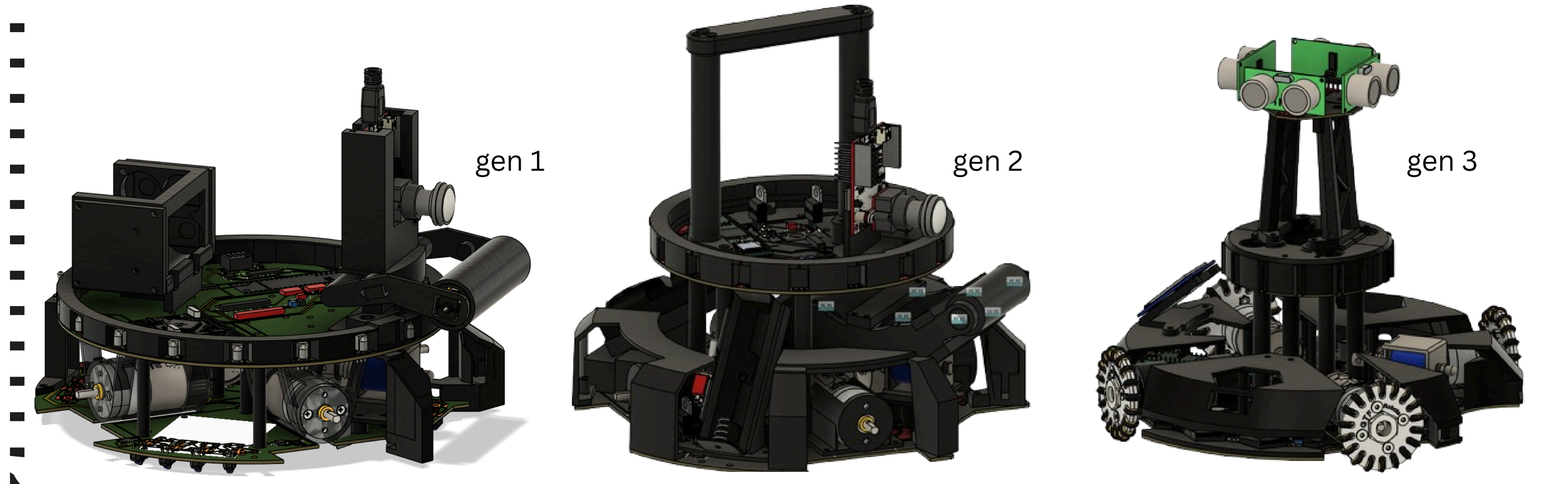

Martin Zayonc


Igor Višňovský


Ema Lujza Koháníová

MUSHROOMS

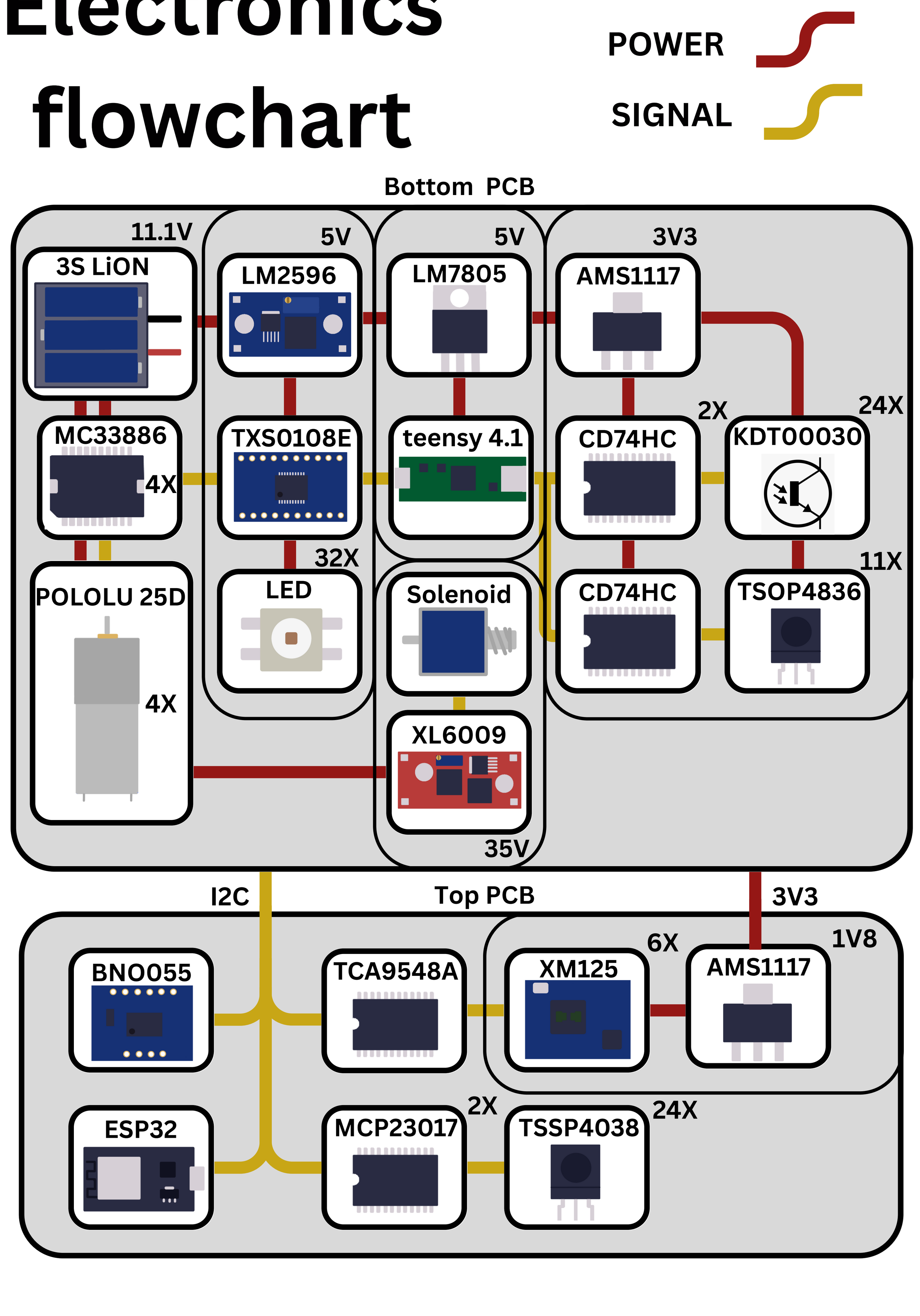
@_THE__SHROOMS_



Abstract

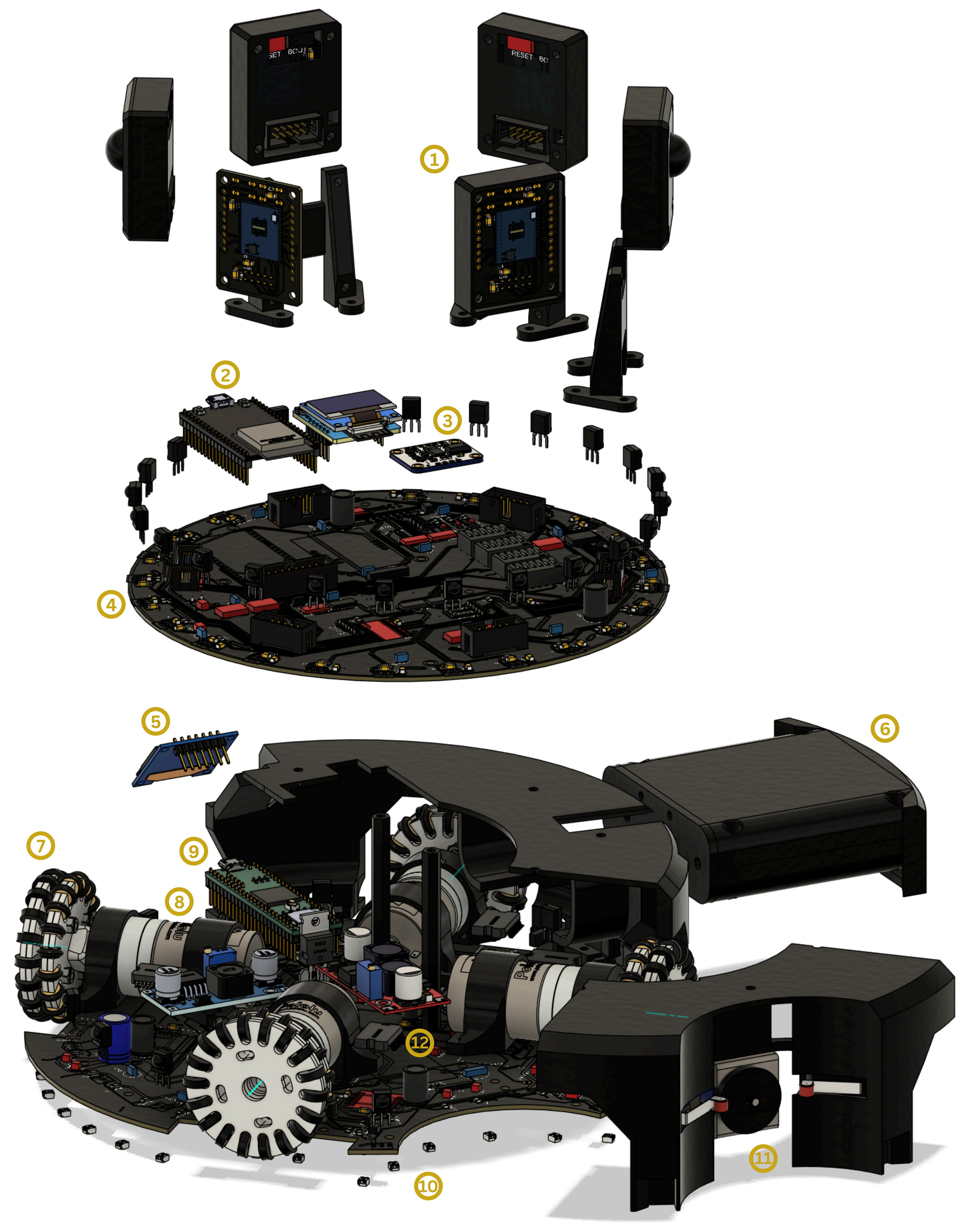
We are a team of high school students from Prešov, Slovakia, representing our country in RoboCup Junior Soccer Lightweight 2025. This is our latest generation robot, designed and built entirely from scratch with an emphasis on advanced sensor integration and modular electronics.
The robot features a fully custom electronic system distributed across two PCBs, supporting a wide array of infrared sensors for ball detection and line following, optimized for real-time response and precision. A BNO055 IMU provides orientation data.
What truly sets this robot apart is its integration of six mmWave radars. These sensors allow for environmental awareness, obstacle detection, and basic map orientation, giving the robot a strategic advantage in dynamic match conditions.

Electronics flowchart



Parts

1. XM125 radar
2. BNO055 gyroscope
3. ESP32 2nd microcontroller
4. Top PCB
5. Display
6. Battery pack
7. Omniwheel
8. Pololu 25D 12V 5A motor
9. Teensy 4.1 1st microcontroller
10. Line sensors
11. Kicker assembly
12. MC33886 motor driver



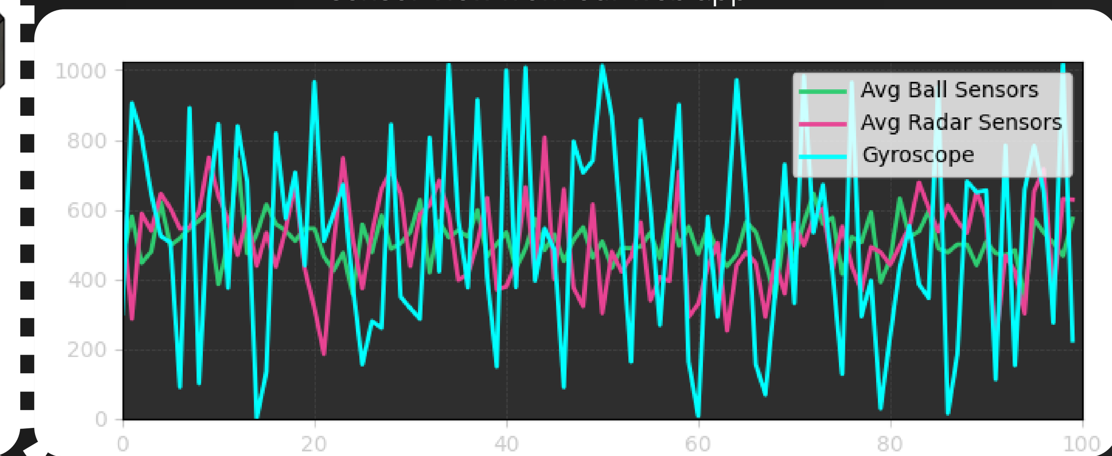
Software

Line Detection Software
The line detection module processes input to accurately recognize field boundaries and distinguish critical features such as inner and outer corners. It also calculates how much of the robot has crossed a line by measuring the percentage of its body over the boundary. This precise spatial awareness helps the robot navigate confidently and stay within the playing area.

Ball Detection Software
The ball detection system continuously tracks the ball's position and movement relative to the robot. By analyzing this data in real time, the robot can quickly approach, intercept, and control the ball during fast-paced gameplay.

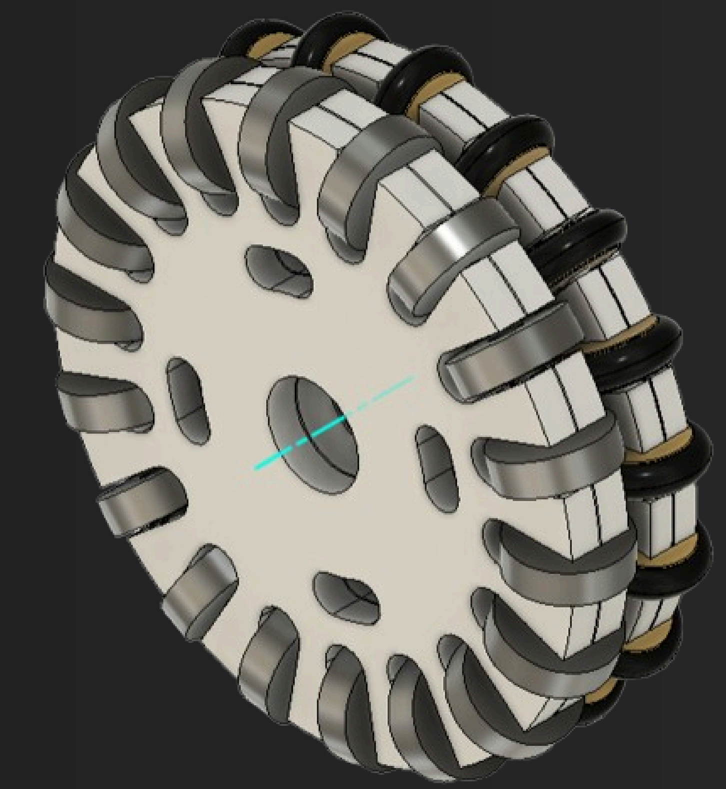
Strategy
The strategy relies heavily on data from the mmWave radars and gyroscope. The radars provide situational awareness of nearby obstacles and opponents, allowing the robot to anticipate and avoid collisions. The gyroscope supplies accurate orientation and heading information, helping the robot maintain balance and navigate the field effectively. Combining this information with ball and line detection, the strategy module dynamically decides when to attack, defend, or reposition—optimizing the robot's behavior throughout the match.

sensor view from our web app



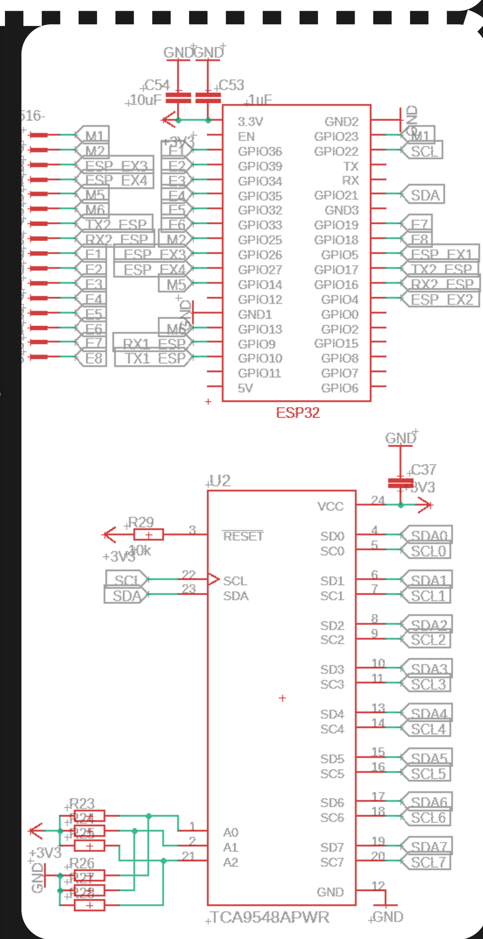
Wheel design

Our robot uses a dual omni-wheel setup that combines the advantages of 3D-printed and CNC-machined components.
The first version of our wheels was fully 3D-printed, which made them cheap and easy to modify, but they struggled with roller durability and axle strength. In 2024, we switched to CNC-machined aluminum omni-wheels for better stability, but they lacked sufficient traction, especially during rapid direction changes.
To solve this, we developed a hybrid design: we mounted a custom 3D-printed wheel directly onto each CNC wheel, forming a dual-layer omni-wheel. This approach combines the strength and precision of CNC parts with the grip and customizability of 3D-printed materials, resulting in more reliable movement and better control on the field.



Electronic design

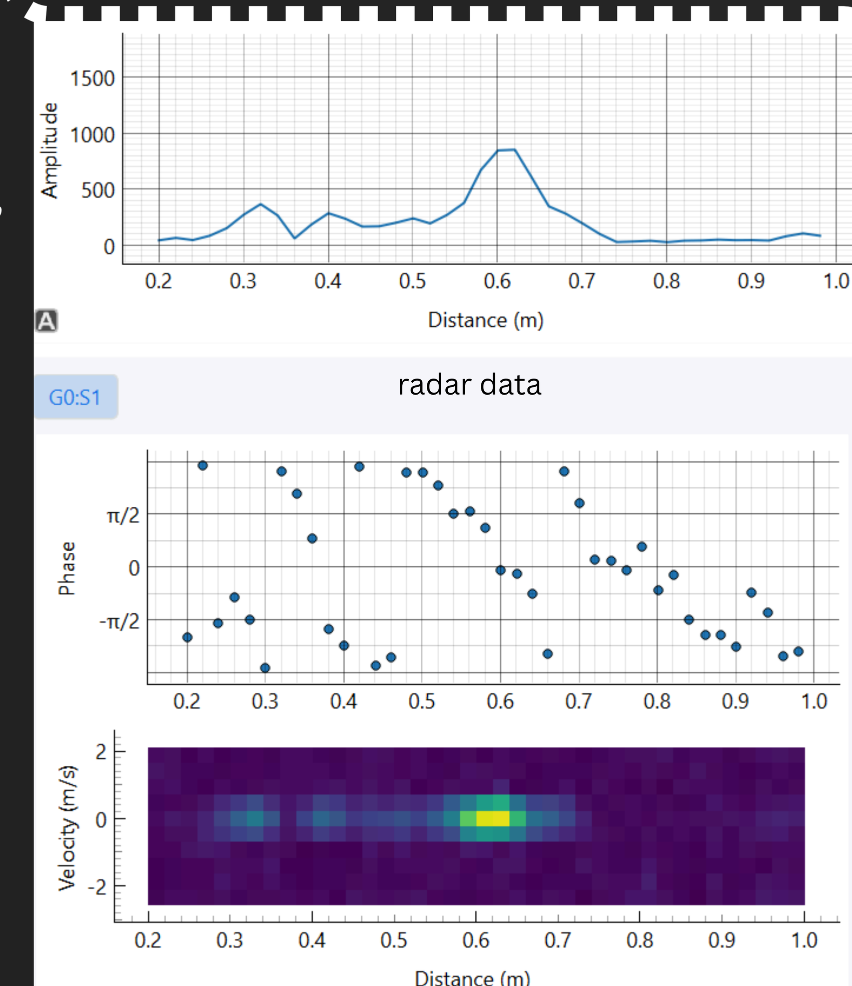
The robot's electronics are distributed across two custom-designed PCBs to ensure modularity, ease of repair, and clean signal routing.
The main PCB includes the Teensy microcontroller, all power regulation circuits, and motor drivers (MC33886). A TXS0108E logic level shifter bridges the 3.3V logic of the Teensy with the 5V logic required by the drivers. The board also integrates three CD74HC multiplexers: two handle input from 24 line-detection phototransistors, and one processes 11 IR ball sensors.
The secondary PCB connects via a single ribbon cable and includes two MCP23017 I/O expanders for an additional 24 IR ball sensors. It also houses the BNO055 IMU for orientation sensing and an ESP32 for wireless communication.
This board additionally supports six mmWave radars for object detection and includes optional mounting points for an OpenMV Cam and ultrasonic sensors, enabling future upgrades for vision and proximity sensing.



snippet from the top PCB's schematic

Radars

Our robot uses six Acconeer XM125 mmWave radars, connected to an ESP32 that handles communication and data preprocessing. These radars were chosen because ultrasonic sensors are too slow, and ToF sensors are not allowed under the RoboCup Junior Soccer rules.
mmWave radars offer a good balance of speed, compactness, and reliability, and they can detect nearby robots, players, or obstacles without relying on light or sound. Combined with orientation data from the BNO055 IMU, the radar system provides basic environmental awareness and supports future development of field mapping and collision avoidance.



"No mushrooms were harmed in the making of this robot." 🍄