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Princeton Soccer Robotics

RADIAN.

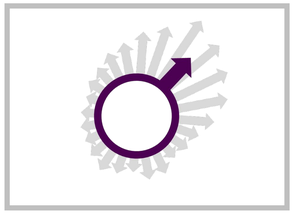
Robocup Junior Lightweight

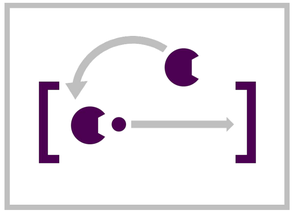
United States of America

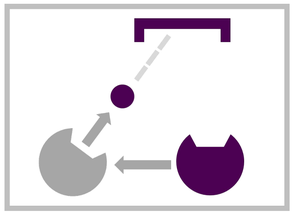
L'UNIVERSITÉ DE BORDEAUX PRÉSENTE
RoboCup23
BORDEAUX, NOUVELLE-AQUITAINE, FRANCE

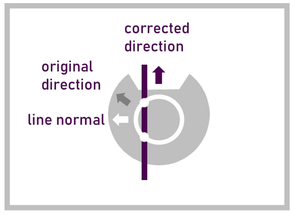
soccer-robotics.github.io

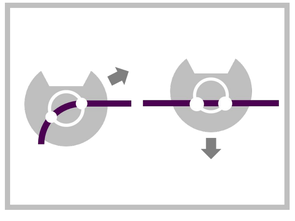
Software

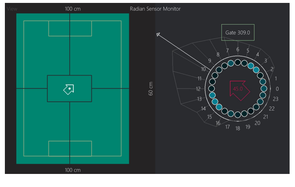












General

Infrared Ball Detection
- Intelligent sensor failure detection and adaptation
- Performance speedups with trigonometric precomputation

Role Switching
- HC-05 Bluetooth communication
- Ball proximity/angle and ultrasound readings used to assign Goalie/Striker

Striker

Goal Rotation
- Calculates expected position of robot and ball using ultrasound and infrared proximity readings
- Conducts sidestep and rotation maneuver so robot, ball, and goal are collinear before kicking ball

Line Avoidance
- Redirection algorithm moves robot along the field boundaries instead of directly backing off
- Corner cases (literally) — detect number of activated clusters to compute recovery motion

Goalie

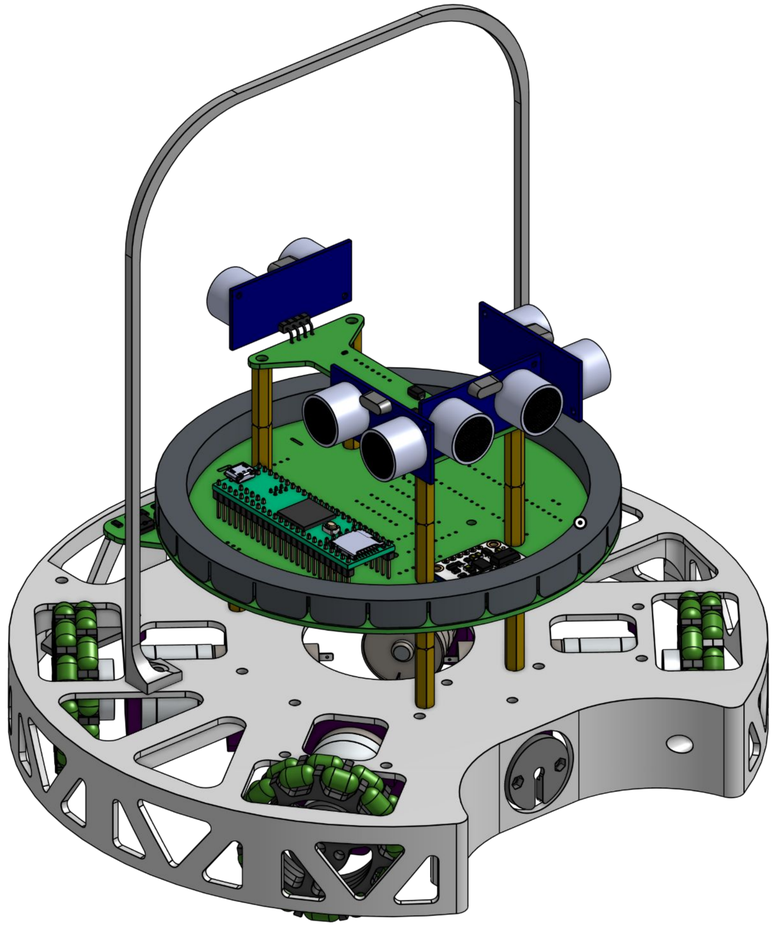
Line Straddling
- Goalie tracks line to maintain position, keeping itself centered on the line

Localization
- Uses ultrasound to position robot in front of goal if it leaves the line, or after role switching

Visualizer
- Graphical display of sensor readouts for debugging
  - Localization, ball detection, line detection, gyroscope
- Serial communication

Abstract

Hailing from Princeton, Radian's robots feature a solenoid kicker, role switching, and ultrasound-based localization. They are built from the ground up with reliability in mind: our software is written such that the robot can keep working with over half its sensors broken, our custom PCBs have a modular design to facilitate swapping, and our 3D-printed parts are deliberately simple to eliminate points of failure.



OpenMV
DigiKey
Pololu Robotics & Electronics
JLCPCB
MOUSER ELECTRONICS

Electrical Design

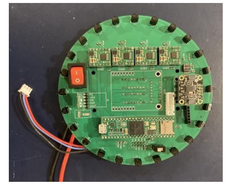
Main PCB
- 24 IR sensors with sensor shield to precisely detect ball from all directions
- Teensy 4.1 microprocessor, BNO055 IMU
- Components are easily swappable

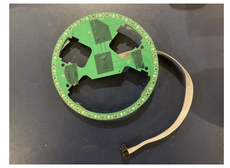
Line PCB
- Circular design with 24 phototransistors/LEDs
- 3 ADCs communicate with Teensy via SPI

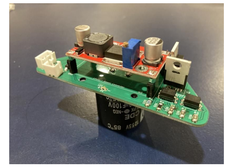
Solenoid PCB
- 2200uF capacitor driving solenoid at 48v
- Electrical isolation with optocouplers controlling mosfets to avoid voltage drops
- Separated from other PCBs to reduce EMF
- Indicator LED discharges capacitor to prevent dangerous residual charge

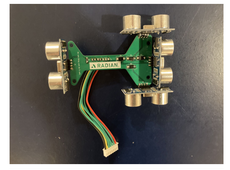
Ultrasound PCB
- 4x ultrasonic sensors used for localization
- Mounted high to see over goals

Drive System
- *What we considered:*
  - Pololu 25D 9.7:1: fast, but significantly reduced line reliability and had low torque
  - Maxon DCX16 was out of stock and would require higher-power motor drivers
- *What we chose:*
  - Pololu 25D 20.4:1 offers good balance between speed/torque at low price point









Mechanical Design

Materials
- FDM 3D printed pieces for rapid prototyping
- PETG and Carbon-fiber PLA
- Nylon standoffs and screws to reduce weight

Chassis
- Single piece to reduce complexity and points of failure (i.e. loose screws)
- Crash ring to protect hardware
- No bottom layer increases ground clearance

Omniwheels
- Dual-layered omniwheels, 18 rollers, 21g
- *What we tried:*
  - 3D printed adapters with captive nut
  - PETG deforms, Carbon-fiber shatters
- *What we chose:*
  - Metal adapters are more durable and less prone to deformation