Competitive Multi-Robot Parking Game: Vision-Based Localization and Gesture-Based Remote Control

MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

EECS 373: Introduction to Embedded System Design | Guanyu Xu, Haobo Fang, Varun Agrawal, and Xiang Jiang

{xuguanyu, fanghb, varunagr, xianger} @umich.edu

Introduction

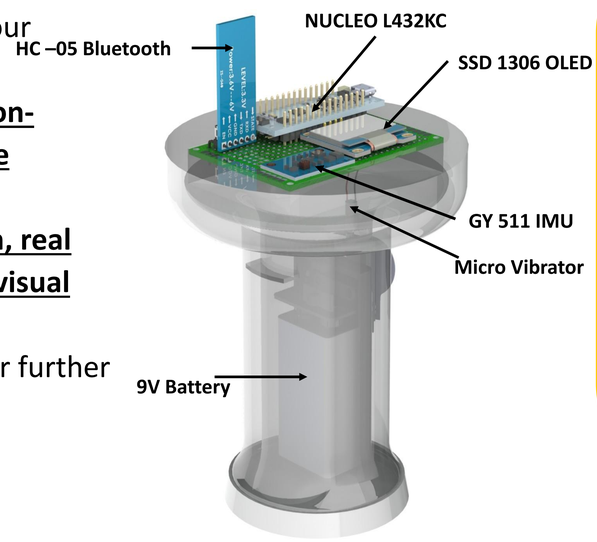
- A fast paced, interactive parking game using four Zumo robots on a 4x4 ft LED marked field.
- The system uses STM32 microcontrollers, **Vision-Based localization, and Gesture-Based remote control** to drive gameplay.
- The platform highlights **embedded integration, real time multi-agent coordination, and dynamic visual and haptic feedbacks**.
- Robust, modular system architecture allows for further expansion.

Methodology

Playground:

- **PixyCam** identifies each Zumo car's position via unique top-mounted color tags.
- Compare available spots position and Zumo's positions to check occupancy.
- Change **LED color** to represent occupancy.

Remote Controller Design



Remote Controller:

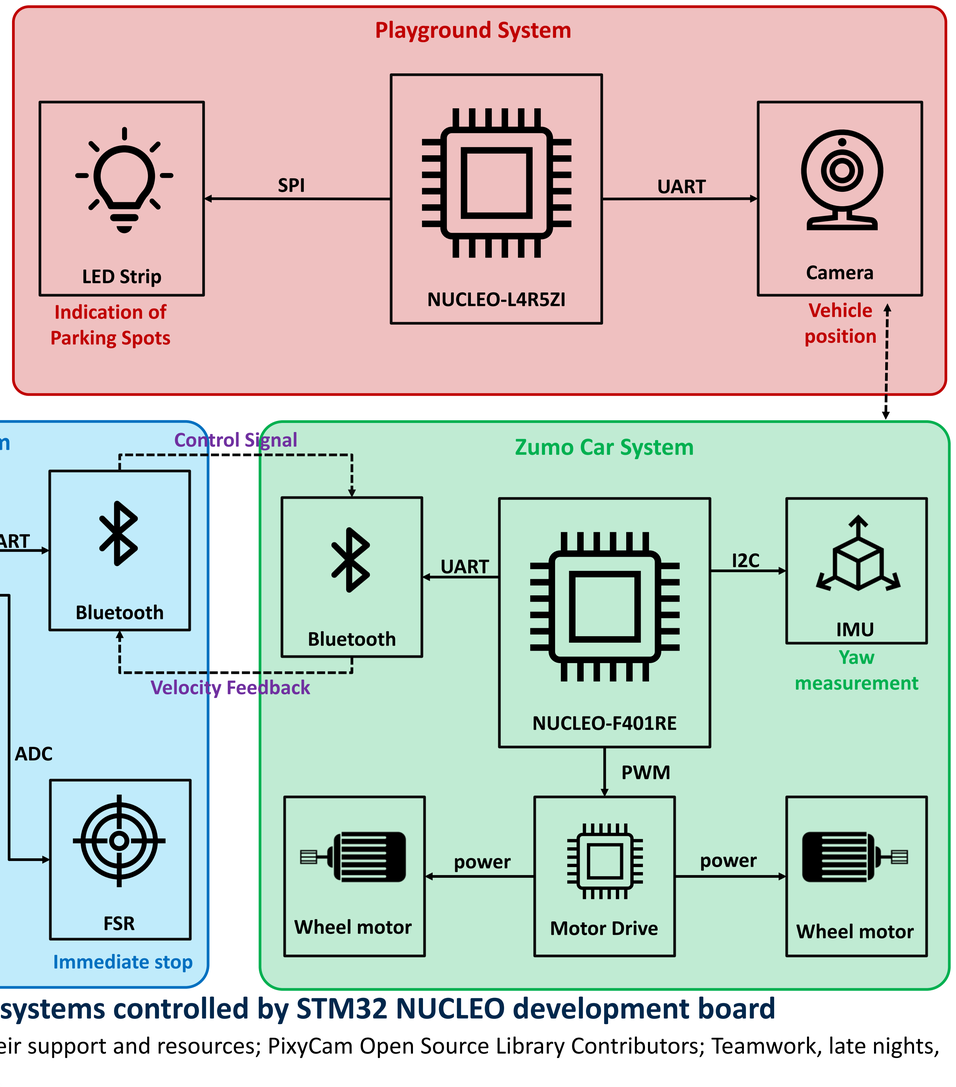
- Reads IMU pitch and roll.
- Compute target speed and direction.
- Sends control signals.
- **Force sensitive resistor (FSR)** triggers emergency stop.
- **Vibrator** generates haptic feedback.

Zumo Car:

- Reads IMU yaw.
- Receive speed and direction.
- Manipulate the Car using a **PID curve control**.
- Sends velocity **feedback.**

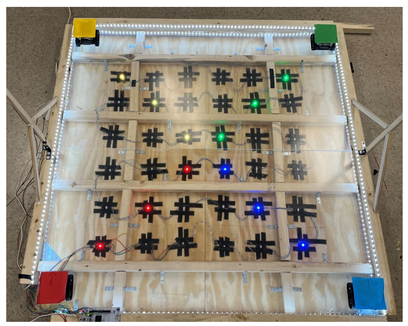
GAME ON!

- **Players:** 4 Zumo cars, 4 Colors, 4 Starting Positions
- **Rounds:** 5 Total rounds, Pick the highest total scores
- **Parking Spots**: 10 randomly generated per round, **available spots** will be indicated by **White LED** lights
- **Time Limit: 30 seconds** per round
- **Between Rounds:** Zumo robots are free to move across rounds
- **Scoring Rule:** A robot scores only if it parks in a spot that turns into its **assigned color** during the round
- **Warning**: Participants are strictly prohibited from touching the robots, the arena, or any game elements during the match

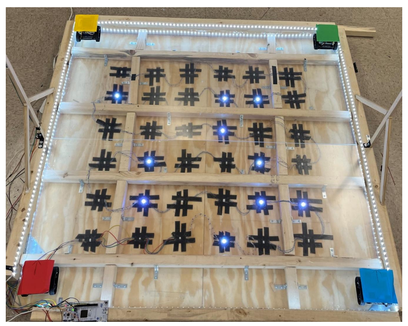


Three interconnected systems controlled by STM32 NUCLEO development board

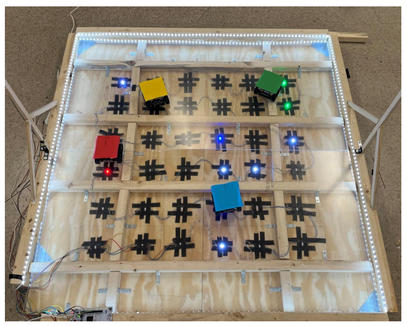
Results



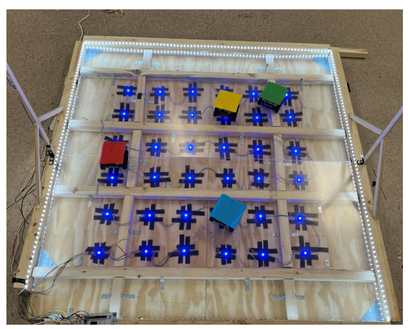
Initialization



Randomly light up 10 LEDs each round



Zumo Cars compete to occupy spots



Declare winner

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