ROS 2-Based LiDAR Robot for Autonomous Maze Navigation

Miles Masker, Juan Moncada, Lorenzo Martinez, Cris Gamez

RSEARCH QUESTION

How can ROS 2 and LiDAR sensing be used to develop an autonomous robot capable of perceiving, mapping, and navigating through a maze in both simulation and real-world environments?

BACKGROUND

- Autonomous navigation is a core robotics problem where a robot senses its environment and makes decisions without human input.
- LiDAR (Light Detection and Ranging) is commonly used because it provides accurate distance measurements using laser signals.
- ROS 2 is a robotics framework that enables communication between components (sensors, mapping, control) through a distributed system.
- ROS 2 supports simulation, real-time processing, and hardware integration, making it suitable for autonomous system development.

Maze navigation is a simplified but effective way to test key robotics concepts such as:

- Localization
- Mapping (SLAM)
- Path planning
- Obstacle avoidance

METHODS

The system was developed using ROS 2 and implemented in both simulation and physical environments.

Key components:

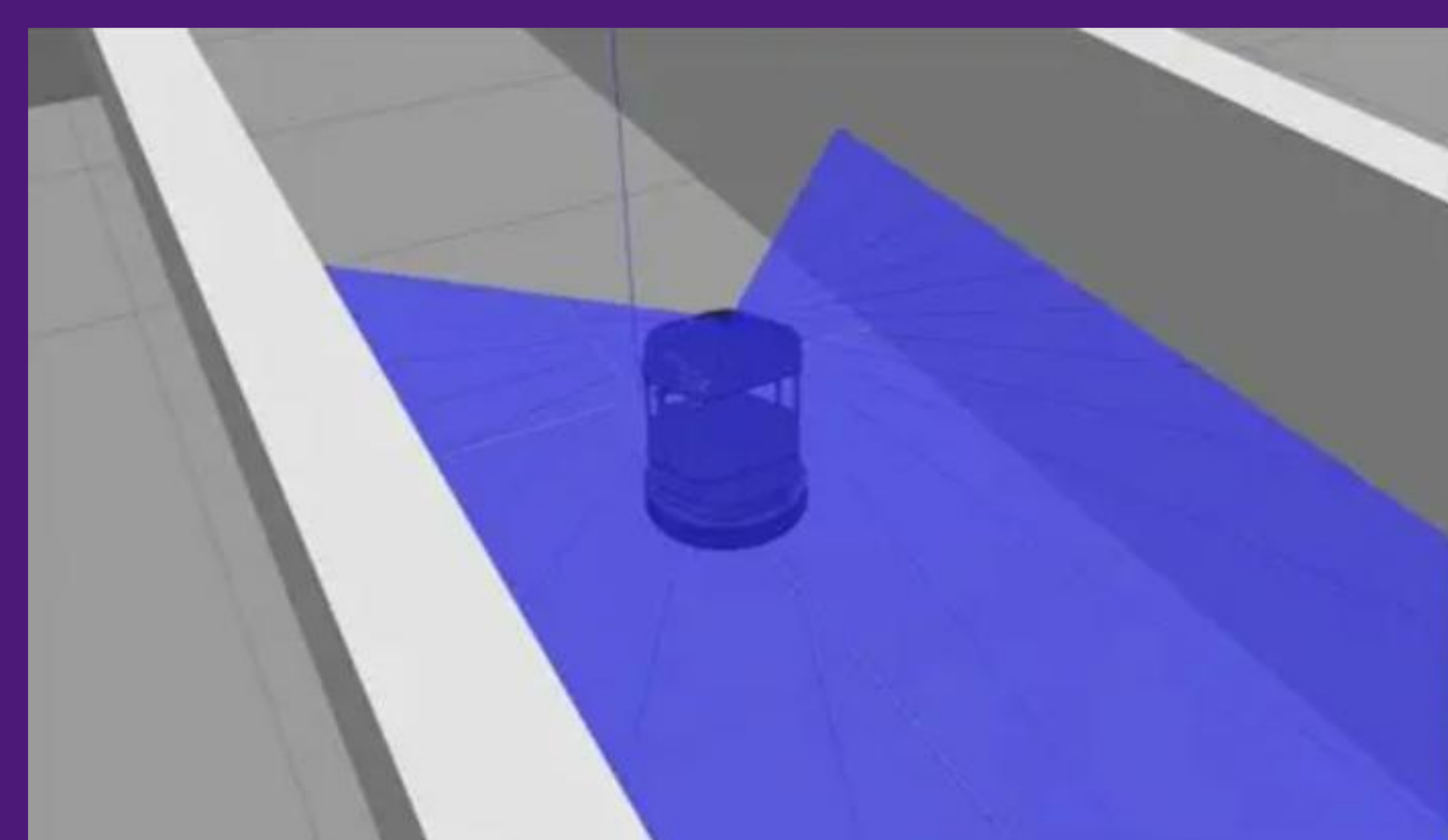
- LiDAR Sensor: Collects distance data from surroundings
- ROS 2 Nodes: Separate modules for sensing, mapping, and control
- Simulation (e.g., Gazebo): Used to test navigation algorithms
- Mapping Algorithm (SLAM): Builds a map of the maze
- Navigation Algorithm: Determines optimal path through maze

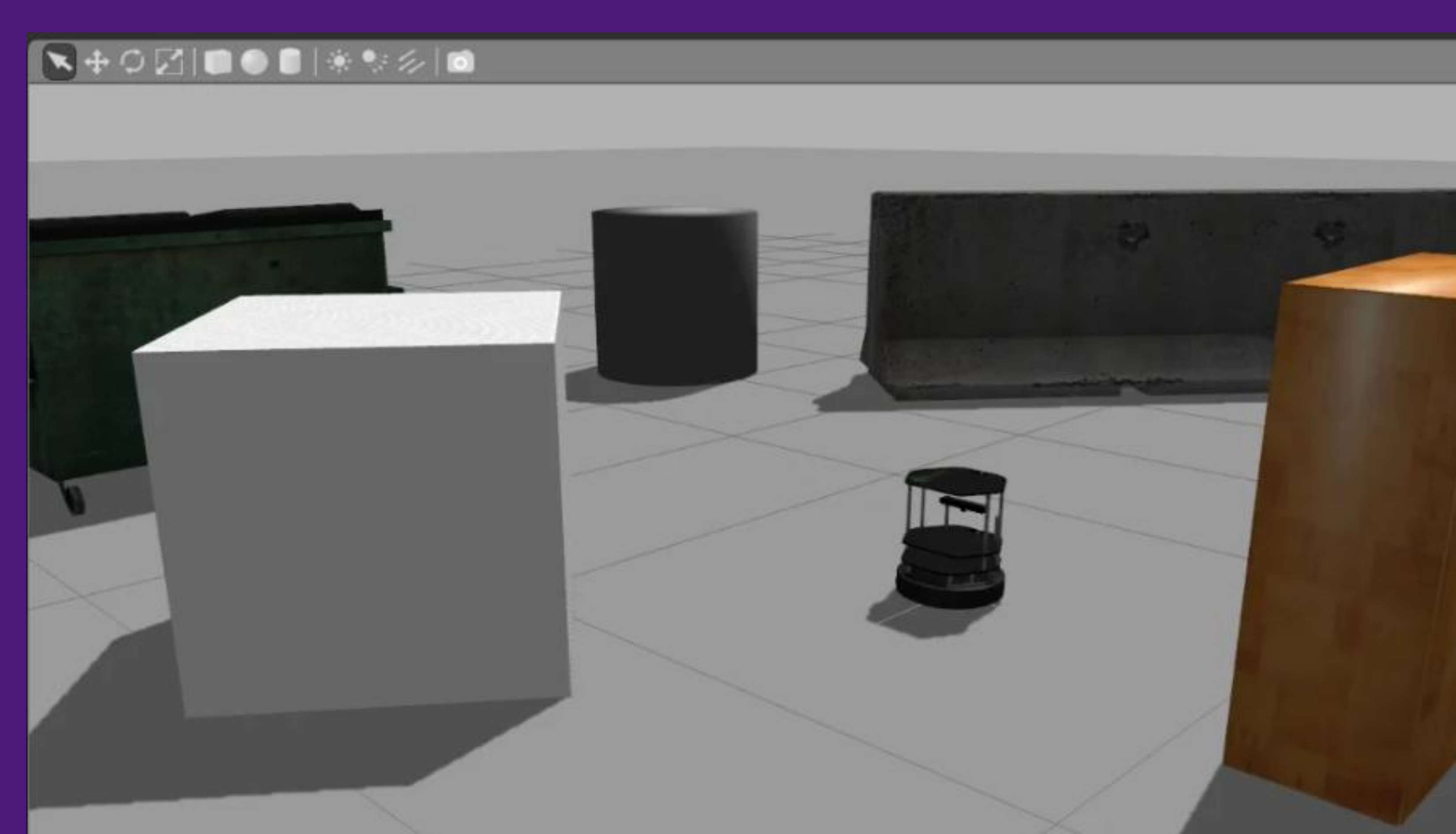
Process:

- Acquire LiDAR scan data
- Process data to detect obstacles
- Generate a map of the maze
- Plan a path to navigate through the maze
- Send control signals to robot motors

ABSTRACT

This project focuses on the development of an autonomous robotic system using ROS 2 and LiDAR sensing for maze navigation. The system integrates perception, mapping, and path planning algorithms to allow a robot to detect its surroundings and navigate efficiently. Simulation tools are used to test performance before deployment on a physical robot. The results demonstrate that ROS 2 enables modular and scalable development of robotic systems, while LiDAR provides reliable environmental sensing for navigation tasks.





RESULTS

The system successfully demonstrated autonomous navigation in a simulated maze environment. The robot was able to:

- Detect walls and obstacles using LiDAR
- Generate a map of the environment
- Navigate through the maze with minimal collisions
- Does not always solve the maze

Simulation results showed consistent performance, and initial implementation on a physical robot confirmed the feasibility of real-world deployment.

FUTURE DIRECTIONS

Future improvements to the system include:

- Improving navigation accuracy using advanced SLAM algorithms
- Enhancing obstacle avoidance with sensor fusion (camera + LiDAR)
- Optimizing path planning for faster navigation
- Improving hardware design for better stability and durability
- Testing in more complex and dynamic environments