Wayfinder
A Differential Drive Autonomous Mapping Robot

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Project Goal
Design and prototype a differential robot that can autonomously navigate and map a maze.

Requirements:
1. ROS-compatible autonomous mapping
2. Localization within ± 2.0 cm
3. PIDF velocity controller (steady-state error less than ± 0.5 cm/s with no overshoot)
4. Physical envelope: 15 cm x 15 cm x 15 cm
5. Total cost below $200

Applications
- Search & Rescue
- Autonomous exploration
- Mapping of indoor areas
- Indoor delivery
- Academic research

Framework
ROS runs on the Raspberry Pi 4B which use peripheral sensors to allow the robot to map and localize. The motors are both controlled via PWM signals and encoder counts are read back to the Pi. The homebase displays a live map of the surroundings.

Path Planning, Localization, and Navigation
Wayfinder uses motor encoders, an IMU, and data from the LiDAR for localization. Additionally, the data from the LiDAR is used to build a map of the explored regions. The explore_lite ROS node is then used to autonomously determine a new frontier and the move_base ROS node plans a path to avoid obstacles and reach the target location.

What’s Next?
- Integrating multiple robots to produce a shared global map
- Optimizing localization and path planning algorithms

Robot Design

LiDAR Sensor
3D Printed Plates
Standoffs
Raspberry Pi 4B
Battery
Step-up Converter
IMU
Ball Wheel

Motor Driver
Wheel & Motor w/ Encoder

LiDAR

Physical Maze
Partial Exploration
Completed Exploration