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computer science 12

Bachelor/Master Thesis

Automatic Exploration of Static Environments using SLAM for Autonomous Robots

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In this thesis, we aim to develop a method for the autonomous exploration of unknown environments using simultaneous localization and mapping (SLAM) and autonomous robots. Autonomous exploration of static environments is a crucial task in robotics that requires effective mapping and navigation techniques. Our proposed exploration method will rely on the Robot Operating System 2 (ROS2), Gazebo robot simulator, and the Nav2 navigation stack, which are powerful tools for developing complex robot systems.

ROS2 provides a range of features to support the development of robot applications and complex robot systems that consist of multiple components. It uses DDS (Data Distribution Service) middleware to provide real-time communication between different components of a robot system. Gazebo, on the other hand, is a widely used robot simulator that provides a realistic environment for testing and validating robot systems. It enables developers to create complex scenarios and test the behavior of robots in different environments. Finally, Nav2 is a navigation stack for ROS2 that provides a flexible and configurable set of algorithms and tools for robot navigation, including global and local planning, obstacle avoidance, and localization.

The goal of our exploration method is to use the available navigation, localization, and mapping algorithms to explore unexplored areas automatically. The final robot system should be able to autonomously navigate in unknown environments until all areas have been mapped completely. To achieve this, we will integrate and configure a SLAM algorithm that generates a map of the environment and localizes the robot. We will also integrate a path planning algorithm to generate an optimal path for the robot to follow during exploration. In addition, we will develop a method to detect unexplored areas and use it to guide the robot's exploration. The method will be integrated using ROS2, Gazebo, and the Nav2 navigation stack to ensure that the robot can autonomously explore unknown environments efficiently and robustly.

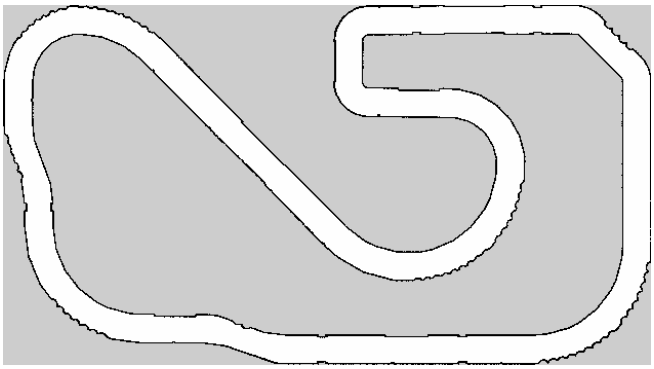

Figure 1: Occupancy grid map created using SLAM

Objectives: The main objective of this thesis proposal is to create a method for the autonomous exploration of static environments with SLAM and ROS2. To achieve this objective, the following sub-objectives will be pursued:

- Integrate a SLAM algorithm that will generate a map of the environment and localize the robot.
- Choose and configure a path planning algorithm to generate an optimal path for the robot to follow during exploration.
- Design a method to detect unexplored areas and use it to guide the robot's exploration.
- Integrate the method using ROS2, Gazebo, and the Nav2 navigation stack.

Requirements: The following skills and tools will be required to successfully complete this thesis proposal:

- Proficiency in C++ and Python programming languages
- Experience working with ROS2
- Familiarity with robot simulators, such as Gazebo
- Knowledge of robot navigation