ROS-Controlled Mobile Robot for Workstation Navigation

Degree programme: Master of Science in Engineering
Specialisation: Mechatronics and Automation
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This project carried out in collaboration with the Autonomous Robotics Laboratory (LARA) at HEIG-VD, aimed to develop an Autonomous Mobile Robot (AMR) for flat indoor environments. It contributes to LARA's initiative of advancing open-source robotic solutions and highlights the potential of autonomous systems in industrial and research settings. The robot was designed to autonomously navigate and interact with workstations, forming a foundation for future applications.

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Motivation

As robotics technology progresses, the need for modular and adaptable systems grows. This project addresses this need by developing an AMR capable of obstacle avoidance, waypoint navigation, and precise docking. These functionalities make it a valuable robotic solution in environments where automation of material transport or docking tasks is required, bridging theoretical knowledge with practical applications.

Objectives

The main objectives of the project were to:

1. – Finalize the design and development of a stable, differential-drive robotic base for operation on flat surfaces.
2. – Implement autonomous navigation using ROS2, including SLAM for mapping and localization.
3. – Enable obstacle avoidance, waypoint navigation, and docking functionalities through 2D Lidar integration.
4. – Develop a reliable system for recognizing and docking with a triangular workstation using Lidar-generated point clouds.

Methodology

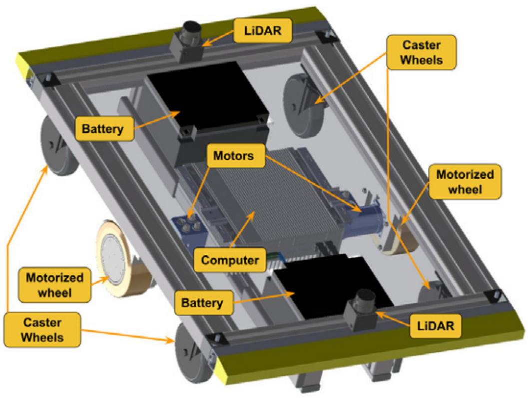
The project began with simulations in Gazebo to test SLAM, autonomous navigation, and manual joystick control. The robotic base was equipped with a Karbon-700 industrial computer and two smart motors controlled via the CANopen CiA402 protocol. A 2D Lidar sensor was used to scan the environment, allowing for obstacle detection and recognition of docking stations. Following successful simulations, the system was transitioned to hardware implementation, where it demonstrated its capabilities in a real-world setup.

Results

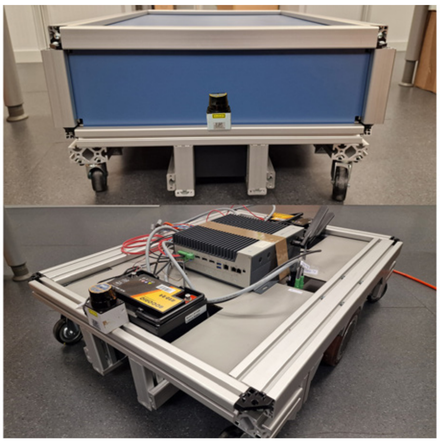
The AMR successfully navigated autonomously within a flat environment, avoiding obstacles and accurately docking with predefined workstations. Waypoint navigation was achieved using Rviz and a joystick interface. These results validated the system's robustness and flexibility, positioning it as a platform for future research and industrial applications.

Outlook

This project highlights the potential of open-source and modular robotics solutions in advancing autonomous systems. Future extensions could include enhancing the docking algorithm, integrating additional sensors for complex tasks, and exploring applications in industrial automation. The mobile robot can also be equipped with a robotic arm to perform versatile tasks, such as pick-and-place operations or assembly processes, expanding its functionality and applicability in both research and industrial environments.



Robot Components



Robot Hardware front (covered) and corner (uncovered) view