AUTONOMOUS ROVER FOR MAPPING AND OBJECT DETECTION

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Introduction:

In this comprehensive project, we aim to enhance an obstacle avoidance system built on a 4-wheel chassis, leveraging a combination of Arduino, Raspberry Pi 3B, TensorFlow Lite, and RP LiDAR A1. The integration of these components creates a sophisticated robotic system capable of intelligent decision-making, object detection, and continuous two- dimensional mapping. The foundational obstacle avoidance system relies on Arduino, employing a servo motor-mounted ultrasonic sensor for real-time detection of obstacles in the robot's path, which was carried out earlier. This simple and cost-effective solution provides the initial layer of navigation, ensuring the robot can maneuver in dynamic environments by avoiding collisions. To elevate the system's capabilities, we introduce the Raspberry Pi 3B, serving as the brain of the operation. Connected to a USB camera, the Raspberry Pi utilizes the TensorFlow Lite library in Python for object detection and recognition. This addition enables the robot to identify and categorize objects in its surroundings, enhancing its ability to make informed decisions based on the visual input.

Objectives:

1. Enhance a 4-wheel chassis obstacle avoidance system by integrating advanced technologies.
2. Utilize Raspberry Pi for processing power to analyze complex data streams and execute intelligent responses in dynamic environments.
3. Integrate TensorFlow Lite to enable high-level object detection and recognition tasks for precise and accurate identification and categorization of objects in the robot's vicinity.
4. Incorporate RP LiDAR A1 to facilitate continuous spatial mapping, allowing the robot to build and update detailed maps of its surroundings in real-time.
5. Develop a sophisticated robotic system capable of real-time decision-making and advanced object detection.
6. Create a versatile robotic platform with applications in various fields, including autonomous navigation and advanced robotic operations.
7. Achieve seamless integration of Raspberry Pi, TensorFlow Lite, and RP

LiDAR A1 to enhance the overall functionality and performance of the robotic system.

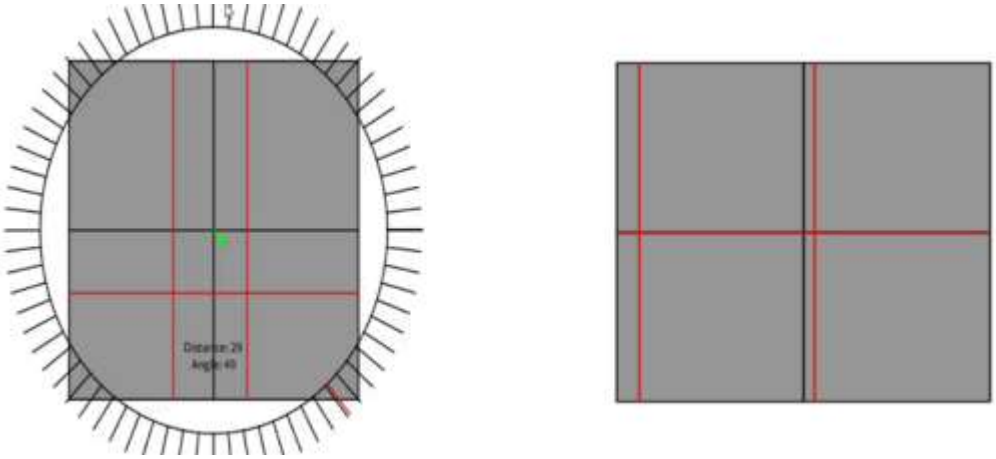
Methodology:

The proposed methodology involves initially setting up a 4-wheel chassis with Arduino for basic obstacle avoidance, incorporating a rotating ultrasonic sensor. The Raspberry Pi 3B is integrated, connecting to the Arduino for centralized processing, and a USB camera is added for visual input. Object detection using TensorFlow Lite on the Raspberry Pi is implemented, trained for common warehouse objects. Continuous mapping is achieved through RP LiDAR A1 integrated with ROS Noetic. A decision-making algorithm is designed to incorporate inputs from ultrasonic sensors, object detection, and LiDAR mapping. A comparative study assesses RP LiDAR against traditional ultrasonic sensors. Following integration and testing, optimization focuses on refining sensor fusion and system performance. Documentation encompasses the hardware setup, software architecture, and a comprehensive report detailing the methodology, experimental results, and insights. Future enhancements are discussed, including additional sensors or machine learning models for scalability and adaptability in diverse warehouse environments.

Conclusion:

The successful implementation of this project results in a fully functional Rover-Base Station system that is capable of autonomously navigating, mapping its environment, and securely transmitting data to a Base Station for further processing and visualization. The project demonstrates effective communication, testing, and iteration throughout its development, leading to the achievement of the desired objectives.

LiDar Output



UltraSonic Map Output

Scope for future work:

1. Design and 3D print a chassis specifically for the LiDAR system to ensure optimal placement and protection.
2. Develop more sophisticated mapping algorithms to improve both ultrasonic and LiDAR-based maps, enhancing the rover's spatial awareness and navigation accuracy.
3. Integrate advanced object detection capabilities using cutting-edge technologies to increase the precision and reliability of identifying and categorizing objects in the rover's environment.
4. These advancements will contribute to creating a more robust and efficient autonomous system capable of superior real-time decision-making and detailed environmental mapping.