Development of a Vision-Based Cruise Control System for Wheeled Mobile Robots

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Abstract

Wheeled mobile robots (WMRs) are increasingly used in various applications, such as surveillance, transportation, and autonomous delivery systems. One of the critical challenges in developing WMRs is implementing effective cruise control systems that allow the robot to maintain a desired speed and trajectory while navigating through dynamic environments. This project focuses on developing a cruise control system for a WMR using camera feedback, enabling the robot to autonomously adjust its speed and direction based on real-time visual information.

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1 Introduction

Wheeled mobile robots (WMRs) play a significant role in various fields, including industrial automation, logistics, and personal assistance. An effective cruise control system is essential for maintaining stability and precision in the robot's navigation. This project explores the use of camera feedback to develop a vision-based cruise control system, enhancing the robot's ability to navigate autonomously in complex environments.

1.1 Objectives

The primary objectives of this project are as follows:

1. To design and implement a vision-based cruise control system for a wheeled mobile robot.
2. To develop algorithms for processing camera feedback to detect obstacles, identify paths, and determine speed adjustments.
3. To evaluate the performance of the cruise control system in various simulated and real-world scenarios.

2 Literature Review

Recent research has focused on integrating computer vision into autonomous navigation for mobile robots. This integration provides enhanced perception and adaptability, enabling more efficient and reliable navigation.

2.1 Vision-Based Navigation

Vision-based navigation systems utilize cameras to perceive the environment and make navigation decisions. These systems often involve image processing techniques to detect features, identify obstacles, and track the robot's position relative to its surroundings.

2.2 Cruise Control Systems

Traditional cruise control systems focus on maintaining a constant speed by adjusting the throttle based on feedback from speed sensors. In the context of WMRs, cruise control systems must also consider the robot's trajectory, which requires additional sensory input.

2.3 Camera Feedback in Robotics

The use of cameras as a sensory input in robotics has gained popularity due to the rich information they provide. Camera feedback allows for the detection of obstacles, path planning, and real-time decision-making, making it suitable for dynamic environments.

3 Research Methodology

3.1 System Design

The proposed cruise control system will consist of the following components:

- **Camera Module:** A camera mounted on the robot to capture real-time visual data.
- **Image Processing Unit:** A module that processes the camera's visual data to extract relevant features such as obstacles and paths.
- **Control Algorithm:** An algorithm that determines speed and steering adjustments based on processed visual information.
- **Actuation System:** A system to implement control commands, adjusting the robot's speed and direction.

3.2 Algorithm Development

The algorithm development process will include the following steps:

- **Image Acquisition and Preprocessing:** Capturing images from the camera and preprocessing them to enhance features such as edges and contours.
- **Feature Detection and Extraction:** Identifying critical features such as obstacles, paths, and landmarks within the image.

- **Path Planning and Obstacle Avoidance:** Developing algorithms to plan the robot's path and avoid obstacles by analyzing detected features.
- **Speed and Steering Control:** Implementing control algorithms to adjust the robot's speed and direction based on path planning and obstacle detection.

3.3 Simulation and Testing

- **Simulation Environment:** Develop a simulation environment to test the cruise control system under various conditions, such as different terrains and obstacle configurations.
- **Real-World Testing:** Implement the system on a physical robot and conduct experiments in real-world scenarios to validate the system's performance.
- **Performance Evaluation:** Evaluate the system's performance using metrics such as speed regulation accuracy, obstacle avoidance efficiency, and computational efficiency.

4 Expected Outcomes

- **Efficient Vision-Based Cruise Control:** A functional cruise control system that effectively uses camera feedback to navigate a wheeled mobile robot.
- **Improved Obstacle Detection and Avoidance:** Enhanced ability of the robot to detect and avoid obstacles in real-time.
- **Adaptability to Dynamic Environments:** The ability of the system to adapt to changes in the environment, such as moving obstacles and varying lighting conditions.

5 Conclusion

The development of a vision-based cruise control system for wheeled mobile robots has the potential to significantly enhance autonomous navigation capabilities. By leveraging camera feedback, the system can achieve real-time

perception and decision-making, allowing the robot to navigate complex environments efficiently. This project aims to contribute to the field of autonomous robotics by providing an innovative solution for cruise control in WMRs.

6 References

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