Omniwheel Wall-Guided Mobile Robot

Description

This project presents an omniwheel-based mobile robot designed to navigate from one room to another using a wall-guided navigation system. The robot addresses the challenge of maneuvering in tight and constrained spaces, where conventional wheeled robots often struggle due to limited turning radius.

Objectives

The main objectives of this project are To develop a robot capable of wall-guided navigation, To enable stable omnidirectional movement in narrow spaces, To implement autonomous movement between rooms using sensor-based guidance. Technically, the project focuses on distance-based control using ultrasonic sensors and motion stabilization using control algorithms.

Technologies Used

- 3D Mechanical Design
- DC Motors
- Omniwheels
- Arduino Uno
- Battery Power System
- Ultrasonic Sensors
- Color Sensor
- Measuring Tools

System Workflow

1. Robot Design and Body Fabrication The robot was designed using Autodesk Inventor and consists of Three ultrasonic sensors, Three motors, Three omniwheels. Mechanical components were fabricated using 3D printing based on the finalized design.
2. Electronic Calibration All electronic components, especially the ultrasonic sensors and color sensor, were calibrated to achieve optimal sensitivity and measurement accuracy.
3. Component Assembly All mechanical and electronic components were as-

sembled according to the robot design. Electrical wiring and power distribution were carefully configured to ensure stable operation.

4. Program Development The control program was developed using Arduino IDE with the following functionalities Wall-guided navigation using distance thresholds from ultrasonic sensors, Direction control (left, right, forward, backward) based on sensor input, Start and stop behavior triggered by specific color detection using the color sensor. The control logic maps sensor inputs directly to motor commands.

5. Robot Operation and Testing The robot was tested in a fixed arena with varying start and end points. The total travel time was recorded to evaluate navigation efficiency and stability.

Key Features

- Omnidirectional movement using omniwheels
- Autonomous wall-guided navigation
- Automated start and stop using color detection

Challenges & Issues (Key Section)

- Omniwheels lacked sufficient grip on the arena surface
- Robot was unable to move in a straight line consistently
- Ultrasonic sensor signals were partially blocked by defects in the robot body

Solutions & Technical Decisions

- Applied rubber material around the omniwheels to increase surface friction
- Implemented PID control to stabilize and correct movement direction
- Smoothed body defects using sandpaper to prevent ultrasonic signal obstruction

Results & Evaluation

The implemented solutions successfully resolved most mechanical and sensor-related issues, enabling the robot to navigate effectively. However, the PID controller still requires further tuning to achieve more precise straight-line movement.

Lessons Learned

- Practical application and theory behind omniwheel motion
- Creative problem-solving using available materials
- Fundamentals and implementation of PID control