Forklift Mobile Robot Prototype

Description

This project presents a mobile forklift robot prototype designed to transport and lift up to four loads simultaneously. The robot addresses the problem of time-consuming material handling when moving items one by one using conventional forklifts or manual labor. This system is important because efficient material transportation is critical in warehouses, factories, and logistics environments. Automating this process can significantly reduce operation time, improve consistency, and minimize human workload.

Objectives

The main objective of this project is to reduce transportation time by automating the process of moving and lifting multiple loads simultaneously. From a technical perspective, the project focuses on: Autonomous navigation using line-following sensors, Coordinated lifting of multiple loads, Stable omnidirectional movement using mecanum wheels

Technologies Used

- 3D Mechanical Design
- Acrylic Sheet Fabrication
- V-Belt Mechanism
- Arduino Mega
- Arduino IDE
- Battery Power System
- Mecanum Wheels
- Sensors
- Measuring Tools

System Workflow

1. Robot Design and Body Fabrication The robot was designed using Autodesk Inventor following specific mechanical constraints. The final design consists of Four mecanum wheels for omnidirectional movement, Four forklift arms, Eight sensors for navigation and positioning, Mechanical com-

ponents were fabricated using 3D printing and laser-cut acrylic, based on the finalized design.

2. Component Assembly All mechanical components, actuators, V-belts, and structural parts were assembled according to the robot design. Electrical wiring and power distribution were configured carefully. Sensors and mecanum wheels were calibrated to ensure correct movement direction and responsiveness.

3. Programming The system program was divided into two main functionalities:

a. Navigation Control Line sensors placed behind each mecanum wheel serve as input, Sensor data determines robot movement direction (forward, sideways, or turning),Output controls the motion of the mecanum wheels

b. Load Detection and Lifting Line sensors positioned behind each forklift arm detect load alignment, When the correct position is detected, all forklift arms lift the loads simultaneously

4. System Testing The robot was tested on a predefined track using one to four loads to evaluate Lifting capability, Movement stability, Navigation accuracy

Key Features

- Ability to lift up to four loads simultaneously
- Omnidirectional movement, including sideways motion, enabled by mecanum wheels
- Automated navigation and lifting process

Challenges & Issues (Key Section)

- Limited development time
- Complex mechanical design
- Complicated wiring layout
- Use of low-cost components
- Insufficient lifting power for maximum load
- Forks unable to grip loads securely

Solutions & Technical Decisions

- Reprinted mechanical components to improve fit and strength
- Reduced sensor usage to only essential sensors to simplify logic and wiring
- Designed a custom PCB to improve wiring organization and reliability
- Reduced the number of active forklift arms
- Applied rubber material to the forks to increase friction and gripping performance

Results & Evaluation

The implemented solutions successfully resolved several critical issues, including navigation stability and partial lifting functionality. However, due to limited development time and component constraints, the robot was unable to lift the maximum load consistently. With additional time and improved components, the remaining issues could be fully resolved.

Lessons Learned

- Working efficiently under strict time constraints
- Fabricating and assembling acrylic components
- Configuring sensors and mecanum wheel control
- Managing system complexity with limited resources
- Maximizing system performance under tight budget conditions