

Four Wheel Drive Steering Mechanism with Rack and Pinion

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Abstract — This paper presents the design and development of a four-wheel drive (4WD) robotic vehicle integrated with a rack and pinion steering mechanism and Bluetooth-based control system. The system aims to improve traction, steering accuracy, and stability compared to conventional robotic platforms. Four DC motors are used to drive each wheel independently, ensuring uniform torque distribution. The steering mechanism converts rotational motion into linear displacement using a rack and pinion system for precise control. An Arduino Uno microcontroller processes wireless commands received via an HC-05 Bluetooth module to control movement. The proposed system demonstrates improved mobility, efficient control, and cost-effective design suitable for educational and research applications.

Keywords: Four Wheel Drive, Rack and Pinion, Arduino, Robotics, Steering Mechanism

I. INTRODUCTION

In modern engineering systems, mobility and steering mechanisms play a crucial role in determining vehicle performance. A four-wheel drive system distributes power to all wheels, improving traction and stability.

Rack and pinion steering is widely used due to its accuracy and simplicity. This project integrates both systems to develop a robotic vehicle with improved performance and control.

II. LITERATURE REVIEW

Previous studies show that traditional two-wheel steering systems have limitations such as larger turning radius and reduced maneuverability.

Researchers like R.K. Rajput and S.S. Rattan explained kinematics of machines, while J.Y. Wong discussed vehicle dynamics and stability.

Modern research highlights that four-wheel steering improves:

- Manoeuvrability
- Stability
- Turning efficiency

Thus, combining 4WD with rack and pinion provides an effective solution.

III. METHODOLOGY

A. System Design

The system consists of:

- Four DC motors (drive system)
- Rack and pinion (steering system)
- Arduino Uno (control system)
- Bluetooth module (HC-05)

B. Working Principle

- DC motors drive all four wheels

- Pinion rotation converts into linear rack motion
- Rack movement turns front wheels
- Arduino controls system via Bluetooth commands

C. System Integration

Mechanical, electrical, and embedded systems are integrated for smooth operation.

IV. CONSTRUCTION AND WORKING

A. Construction

- Chassis made from lightweight material
- Motors mounted using brackets
- Rack and pinion aligned properly
- Electronics placed securely

B. Components Used

- DC Motors
- DC Geared Motor
- Arduino Uno
- L298N Motor Driver
- HC-05 Bluetooth Module
- Battery

C. Working

User sends commands via mobile → Bluetooth → Arduino → Motor driver → Motors operate accordingly.

V. DESIGN AND CALCULATIONS

Torque Calculation

$$T = F \times r$$

$$T = 49 \times 0.05 = 2.45 \text{ Nm}$$

Motor Torque

Torque per motor $\approx 0.6 \text{ Nm}$

Power Calculation

Motor Speed = 150 RPM

Power $\approx 40 \text{ W}$

Gear Design Summary

- Teeth = 38
- Module = 3 mm
- Pitch Diameter = 114 mm

VI. RESULTS AND DISCUSSION

The developed system shows:

- Smooth movement
- Accurate steering
- Improved traction
- Stable performance

The rack and pinion mechanism provides better control compared to differential steering.

VII. ADVANTAGES

- Better traction (4WD)

- Accurate steering
- Low cost
- Easy maintenance
- Simple design

VIII. APPLICATIONS

- Robotic vehicles
- Agricultural robots
- Surveillance systems
- Educational projects
- Autonomous systems

IX. FUTURE SCOPE

- Obstacle detection sensors
- GPS tracking
- AI-based automation
- Camera integration
- IoT-based control

X. CONCLUSION

The project successfully demonstrates a four-wheel drive robotic vehicle with rack and pinion steering. The system provides improved traction, stability, and precise control. It is cost-effective and suitable for educational and research purposes.

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