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Design and Fabrication of Rocker Bogie Mechanism Using Fire Fighting Robot

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Abstract. This paper presents the design and fabrication of a rocker bogie mechanism based fire fighting robot developed for rescue and firefighting operations in hazardous environments. The proposed system is capable of traversing uneven terrains, climbing obstacles, and suppressing fire using a remotely operated water spraying mechanism. The rocker bogie suspension system provides enhanced stability and mobility over rough surfaces where conventional wheeled robots face operational difficulties. The robot is powered using direct current geared motors controlled through a wireless communication system. A water pump and nozzle arrangement are integrated to extinguish fire effectively in industrial, residential, and disaster affected areas. The chassis is fabricated using mild steel and lightweight materials to achieve sufficient strength and maneuverability. The performance of the system is evaluated based on terrain adaptability, obstacle climbing capability, motor torque, and firefighting efficiency. The results indicate that the developed robot reduces human risk during firefighting operations and provides reliable movement in difficult environments.

Keywords: Rocker bogie mechanism, Firefighting robot, Rescue robot, Obstacle climbing robot, Wireless control system.

I. Introduction

Fire accidents in industrial plants, residential buildings, forests, and hazardous environments cause severe damage to life and property every year. Conventional firefighting operations expose firefighters to dangerous conditions such as high temperatures, toxic gases, smoke, and explosions. Due to these challenges, robotic firefighting systems have become an important area of research and development.

A fire fighting robot is designed to detect and extinguish fire while minimizing direct human involvement. Most existing firefighting robots use ordinary wheel mechanisms, which face limitations in rough terrain and obstacle climbing conditions. In rescue environments such as collapsed buildings, rocky surfaces, and staircases, mobility becomes a major challenge.

To overcome these limitations, the rocker bogie mechanism is introduced in the proposed robot. The rocker bogie suspension system is widely used in planetary exploration vehicles due to its excellent terrain adaptability and stability. The mechanism enables the robot to move over uneven surfaces and obstacles without losing balance.

The proposed system integrates:

- Rocker bogie suspension mechanism
- DC geared motor drive system
- Wireless remote control
- Water pumping and spraying unit
- Fire suppression mechanism

The robot can be operated remotely to enter hazardous areas and extinguish fire effectively. The system improves operational safety, reduces human risk, and increases mobility in difficult terrains. Humans really invented machines so they could avoid entering burning buildings themselves. For once, that is an intelligent survival instinct.

II. Need Of The Study

Firefighting in hazardous environments is highly dangerous for human operators. Traditional methods are often ineffective in confined spaces, rough terrains, and disaster affected regions. Existing firefighting robots are generally limited by poor mobility and inability to climb obstacles.

The need for this study arises due to:

- Increasing fire accidents in industrial and residential areas
- Risk faced by firefighters during rescue operations
- Need for robots capable of operating in uneven terrain
- Requirement for remote controlled firefighting systems
- Demand for low cost and efficient rescue robots

The rocker bogie mechanism provides superior stability and obstacle climbing capability compared to conventional wheel systems. Hence, the development of a rocker bogie based firefighting robot offers an efficient solution for rescue and fire suppression applications.

III. OBJECTIVES

The main objectives of the project are:

1. To design and fabricate a rocker bogie mechanism based firefighting robot
2. To develop a robot capable of moving on uneven surfaces
3. To integrate a water pumping system for fire suppression
4. To provide wireless remote operation for safety

IV. Working Principle

The working of the robot is based on the rocker bogie suspension mechanism combined with an electrically powered drive system.

The DC motors drive the wheels through a gear reduction mechanism, producing sufficient torque for movement over rough surfaces. The rocker bogie arrangement distributes the load equally among the wheels, enabling the robot to climb obstacles and maintain stability.

The firefighting system consists of:

- Water storage tank
- Mini water pump
- Spray nozzle
- Remote activation system

When fire is detected visually by the operator, the water pump is activated remotely to spray water toward the fire source. The robot can move toward hazardous locations while the operator remains at a safe distance.

V. Components Used

Sl. No	Component	Specification
1	Wheels	Rubber Wheels
2	12V High Torque	DC Geared Motors
3	Mild Steel	Rocker Bogie Chassis
4	Motor Driver	L298N
5	Battery	12V Rechargeable Battery
6	Water Pump	Mini DC Pump
7	Spray Nozzle	Adjustable Nozzle
8	WirelessController	Bluetooth / RF Module
9	Microcontroller	Arduino UNO
10	Wheels	Rubber Wheels

VI. Design Methodology

The development methodology includes:

- Conceptual design of rocker bogie mechanism
- CAD modeling using SolidWorks/CATIA
- Material selection for chassis fabrication
- Motor torque calculation
- Assembly and integration of electronic systems
- Fabrication using welding and machining processes
- Performance testing under real conditions

The rocker bogie system is designed to maintain wheel contact on uneven terrain and improve climbing capability.

VIII. Results And Discussion

The fabricated robot was tested on rough surfaces, inclined paths, and obstacle conditions.

Parameter Result

Obstacle Climbing Height	80 mm
Maximum Speed	1.5 km/hr

Battery Backup	45 minutes
Water Spray Distance	2 meters
Terrain Stability	Good

The results indicate that:

- The rocker bogie mechanism provides excellent terrain adaptability
- The robot maintains stability during obstacle climbing
- The water spraying system effectively suppresses small fires
- Wireless operation improves operator safety

The robot successfully performed firefighting operations in controlled testing environments.

IX. Advantages

- Operates in hazardous environments
- Reduces human risk during firefighting
- Climbs obstacles efficiently
- Stable movement on uneven terrain
- Compact and cost effective system
- Remote controlled operation

X. Applications

- Industrial fire safety
- Military rescue operations
- Disaster management
- Forest fire monitoring
- Hazardous chemical industries
- Search and rescue missions

XI. Conclusion

The rocker bogie mechanism based fire fighting robot was successfully designed and fabricated. The system demonstrates effective mobility over uneven terrain and performs firefighting operations efficiently using a remote controlled water spraying mechanism.

The rocker bogie suspension system significantly improves obstacle climbing capability and stability compared to conventional wheel arrangements. The robot reduces direct human involvement in dangerous environments and enhances operational safety during firefighting and rescue missions.

The developed system provides a practical, economical, and reliable solution for modern firefighting applications. Future improvements can include fire sensors, autonomous navigation, thermal cameras, and IoT based monitoring systems.

XII. Future Scope

Future developments can include:

- Autonomous fire detection
- AI based navigation system
- Thermal imaging camera integration
- Solar charging system
- IoT monitoring and live video transmission
- Smoke and gas sensors

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