

Battery Powered Road Cleaner Car with Vacuum System

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Abstract- Cleaning of roads and public areas is essential for maintaining hygiene and environmental safety. Traditional manual cleaning methods are time-consuming, labor-intensive, and can cause health issues due to dust exposure. This research paper presents the design and development of a manually operated eco-friendly road cleaning machine. The proposed system integrates mechanical components such as brushes, chain drive, wheels, and collection unit to perform efficient cleaning. The machine is simple in construction, cost-effective, and does not require electricity or fuel. Experimental results show that the system reduces human effort, cleaning time, and operational cost while maintaining effective cleaning performance. This solution is suitable for small and medium-scale applications like roads, hospitals, and public areas.

I. INTRODUCTION

Cleaning plays a vital role in maintaining hygiene in public and private spaces such as hospitals, roads, bus stands, and industries. Conventional cleaning methods involve manual sweeping, which is inefficient and physically demanding. The developed machine aims to overcome these limitations by providing a mechanical solution that is easy to operate and economical. The system combines functions like sweeping, collecting waste, and partial cleaning in a single mechanism.

The machine is designed to:

- Reduce human effort
- Save time
- Minimize cost
- Provide eco-friendly operation

II. LITERATURE REVIEW

Various researchers have contributed to the development of cleaning machines:

- V. Mural et al. (2017) developed a motorized floor cleaning machine integrating vacuum,

water spray, and drying system. Their design improved cleaning efficiency but increased cost and complexity.

- S. Ramesh Kumar et al. (2018) performed stress analysis on a manually operated cleaning machine and concluded that such systems are safe and reliable when properly designed.
- Samarth Gaikwad et al. (2019) focused on multifunctional cleaning machines capable of cleaning different surfaces, emphasizing cost reduction and ergonomic design.
- Shubham Khade (2017) designed a semi-automatic cleaning machine with wet and dry-cleaning features, improving versatility.
- Sandeep J. Meshram (2016) introduced a tricycle-based road cleaning machine suitable for rural areas, but performance was limited on uneven surfaces.
- Liu (2013) studied robotic cleaning machines and highlighted the importance of automation but noted high cost and complexity.

Research Gap Identified:

- High cost of automated systems
- Complexity in design
- Lack of affordable solutions for small-scale users

III. PROBLEM DEFINITION

Manual road cleaning presents several issues:

- Dust spreads into air causing respiratory diseases
- Requires more manpower
- Time-consuming and inefficient
- Worker fatigue and health problems
- Poor cleaning quality

IV. OBJECTIVES

- To design a simple and effective cleaning machine
- To reduce human effort and fatigue
- To increase cleaning efficiency
- To minimize cost and maintenance
- To develop an eco-friendly system
- To ensure safety and ease of operation
- To make it suitable for rural and urban use

V. METHODOLOGY (DETAILED)

The project is carried out in the following stages:

5.1 Concept Development

Different design ideas were analysed and the best concept was selected based on simplicity and efficiency.

5.2 Design Phase

- CAD modelling using Solid Works
- Component layout planning
- Mechanism selection

5.3 Material Selection

- Mild steel selected due to strength, cost and availability

5.4 Fabrication Process

- Cutting
- Welding
- Drilling
- Assembly

5.5 Testing

- Performance testing on different surfaces
- Efficiency evaluation

VI. DESIGN AND COMPONENTS (DETAILED)

6.1 Frame

- Made of mild steel
- Supports all components
- Provides structural stability

6.2 Shaft

- Transmits power from wheels to brush
- Designed to withstand torque and bending

6.3 Chain Drive Mechanism

- Transfers motion without slipping
- Ensures efficient power transmission

6.4 Brush System

- Rotates to collect waste
- Pushes debris into collection tank

6.5 Wheels

- Provide mobility
- Convert manual force into rotational motion

6.6 Bearings

- Reduce friction
- Support rotating shafts

VII. WORKING PRINCIPLE

The machine operates on a mechanical transmission system:

1. Operator pushes the machine
2. Wheels rotate due to applied force
3. Shaft rotates along with wheels
4. Chain drive transfers motion to brush
5. Brush rotates at higher speed
6. Dust and waste are collected in tank
7. This system eliminates the need for electricity or fuel.

VIII. ENGINEERING CALCULATIONS

- Speed of wheel calculated based on human walking speed
- Torque calculated using power relation
- Brush speed increased using sprocket ratio
- Shaft designed for combined bending and torsion
- Chain tension analysed for safety
- All components are designed within safe limits.

IX. FABRICATION PROCESS (DETAILED) STEPS INVOLVED

- Cutting of mild steel sections

- Welding of frame
- Drilling for assembly
- Mounting of shaft and bearings
- Installation of chain and sprocket
- Fixing brush and wheels
- Finishing and painting

X. COST ANALYSIS (DETAILED)

Total Cost Breakdown:

- Material Cost = ₹6860
- Labour Cost = ₹5150
- Indirect Cost = ₹3100

Total Cost = ₹15110

XI. RESULTS AND PERFORMANCE ANALYSIS

- Cleaning efficiency improved
- Time reduced significantly
- Easy handling and operation
- Works best on smooth surfaces
- Less effective on rough terrain

XII. ADVANTAGES (EXPANDED)

- Low cost
- Eco-friendly
- No fuel or electricity required
- Easy maintenance
- Portable and lightweight
- Reduces health risks

XIII. LIMITATIONS (EXPANDED)

- Manual effort required
- Limited performance on uneven roads
- No automation
- Limited storage capacity

XIV. FUTURE SCOPE (DETAILED)

- Integration of electric motor
- Use of solar power
- Automatic dust collection system
- Improved brush mechanism
- Smart sensors for automation

XV. APPLICATIONS

- Roads and streets
- Hospitals
- Shopping malls
- Railway stations
- Industrial areas
- Colleges and campuses

XVI. CONCLUSION

The manually operated eco-friendly road cleaning machine is successfully designed, fabricated, and tested. The system provides a practical solution for cleaning applications where cost and simplicity are important factors. It reduces human effort, improves cleaning efficiency, and minimizes environmental impact.

The project proves that mechanical systems can effectively replace traditional cleaning methods while maintaining affordability. With further improvements, the machine can be upgraded into a semi-automatic or fully automatic system, making it more efficient and widely applicable.

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