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Design and Fabrication of Automatic Ground Clearance Adjustment Car

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Abstract: *Road infrastructure varies greatly across urban and rural environments, demanding flexibility from vehicle suspension systems. Fixed ground clearance leads to limitations in both comfort and vehicle safety. This research presents the design and fabrication of an automatic ground clearance adjustment mechanism for automobiles using a motorized pulley and crank system. The system is designed for budget-friendly implementation and improves the versatility of vehicles operating in diverse terrain conditions. This paper explores the theoretical background, system design, fabrication, performance evaluation, and future prospects of the proposed mechanism.*

Keywords: Ground Clearance Adjustment, Motorized Crank Mechanism, Pulley System, Adaptive Suspension, Vehicle Design Innovation

I. INTRODUCTION

In conventional automobiles, ground clearance is a fixed specification determined during manufacturing. However, a single height is not optimal for all driving conditions. Low ground clearance improves aerodynamics and high-speed stability but increases the risk of underbody damage on uneven roads. Conversely, higher ground clearance provides better terrain navigation but compromises vehicle handling and fuel efficiency.

Adaptive or active suspension systems do exist, but they rely on expensive components like sensors, ECUs, hydraulic pistons, or pneumatic actuators, making them unfeasible for most budget vehicles. Our project offers a cost-effective, mechanical solution using a pulley and crank mechanism driven by an electric motor to alter the ground clearance as needed.

This research is aimed at making vehicles more adaptable to terrain conditions without heavily relying on electronics or costly systems, thus enabling wider accessibility and simpler maintenance.

II. LITERATURE REVIEW

Several studies and industry applications highlight the importance of adjustable suspension: Hydropneumatics Systems were revolutionary but expensive and complex. Air Suspensions used in luxury SUVs like Range Rover offer excellent ride comfort but require high maintenance and have limited affordability. Electromagnetic Suspensions offer fast adjustments but involve advanced control systems and sensors. Prior academic work has explored linkages, lever-based mechanical systems, and even screw-type lifters for basic adjustments. However, most require manual intervention or operate very slowly. Our design attempts to strike a balance between mechanical simplicity and automatic actuation for everyday use.

III. SYSTEM DESIGN AND COMPONENTS

The proposed system consists of the following primary components:

1. DC Motor (12V, 300 RPM): Provides the rotational power required to drive the crank mechanism.
2. Crank Shaft and Linkage: Converts rotary motion into vertical movement.
3. Pulley Mechanism: Distributes the motion to each wheel area in a synchronized manner.

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4. Frame Mounts and Pivot Arms: Allow the body to raise or lower in response to linkage movement.
5. Control Switch: Enables manual activation by the driver (future scope includes sensor-based automation).
6. Power Supply (Battery): Portable or vehicle battery used to power the motor.

Design Objective: Achieve a ground clearance variation of approximately 20–50 mm while ensuring structural stability and safety of the chassis.

CAD Modeling: A SolidWorks model was created to simulate forces and validate the feasibility of the mechanism before fabrication.

IV. FABRICATION PROCESS

The fabrication involved the following steps:

1. Chassis Modification: A scaled vehicle frame was prepared with movable wheel mounts.
2. Motor Integration: The motor was mounted centrally with a crank connected via a coupler.
3. Pulley Setup: Cables routed through pulleys on each side to uniformly distribute movement.
4. Linkage Assembly: Connecting rods were installed from crank to vehicle body pivots.
5. Testing Bench: A static test rig was built to evaluate movement range and system durability.

All components were chosen for their availability and cost-efficiency. Lightweight metals and durable plastics were used where possible to keep the prototype agile.

V. WORKING PRINCIPLE

The motor receives power when the control switch is activated. As it rotates the crank, the attached cable pulls on a pivoted arm connected to the chassis. This causes a lifting motion. Reversing the motor rotation allows the chassis to return to its lower position.

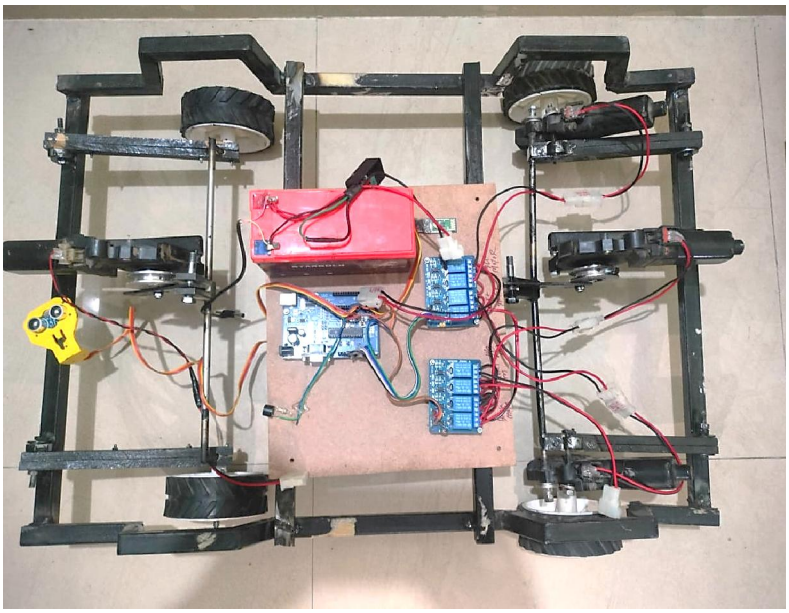
Features:

Real-time height adjustment

Simple mechanical linkages for easy servicing

Can be adapted for automation via sensors

VI. PROTOTYPE



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VII. APPLICATIONS

- Rural vehicles: Frequent encounters with uneven terrain and potholes
- City vehicles: Low clearance for efficiency, with occasional lift for speed bumps
- Emergency vehicles: For swift clearance adjustment in varied terrains
- Off-roaders: Supplemental height flexibility without compromising the core suspension

VIII. FUTURE SCOPE

The future of automatic ground clearance adjustment systems in cars is highly promising, with applications across various vehicle types. This technology enhances safety, comfort, and fuel efficiency by automatically adjusting the vehicle's height based on road conditions, speed, and load. It is especially useful for adapting to rough terrains or optimizing aerodynamics on highways. With advancements in AI, sensors, and smart suspension systems, such features are becoming more practical and affordable, paving the way for wider use in electric, autonomous, and even budget vehicles. This innovation represents a significant step toward smarter and more adaptive transportation.

IX. CONCLUSION

This paper has demonstrated the feasibility of a motorized mechanical system for adjusting the ground clearance of vehicles. Through our design and prototype testing, it is evident that such a solution can bridge the gap between affordability and functionality in adaptive suspension systems. It presents a viable option for developing nations and budget-oriented vehicles needing terrain adaptability without high-tech solutions.

X. ACKNOWLEDGMENT

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