

# Design And Fabrication of Automatic Ground Clearance Enhancement Technology For 4 – Wheeler

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**Abstract-** An air compressor is a device that increases the pressure of the air by compressing and pressurized air which is using in the Pneumatic jack. There are numerous methods of air compression, divided into positive-displacement and non-positive displacement types. These air compressors pressurize the air and are released through the pipes that are coupled with the cylinder.

Here a small air compressor based lift for vehicle ground clearance is described and shown for demonstration. A small air compressor is used to pressurize the air and is used to operate the frame of the vehicle that is controlled automatically by activating the relay when any obstacle is sensed. Here the air compressor is operated through a relay to pressurize the air that is released through a pipe and is coupled with the cylinder to control the frame of the vehicle for increasing the ground clearance when any obstacles like speed breakers, etc. are detected. For demo purpose a small miniature vehicle is designed with a metal frame to which an air compressor is connected through a cylinder. The obstacle is sensed using the optical sensors arranged in front of the vehicle. Depending on the air pressure present inside the cylinder, a small frame is coupled with the outlet of the cylinder will be lifted up slowly. And if the air is released from the cylinder, the platform will be lowered downwards automatically. The vehicle is driven through the DC motor by axial mechanism.

## I. INTRODUCTION

The functional description of the project work is explained in brief here. For better understanding, the total project work is divided into various blocks and each block explanation is provided here. The complete block diagram and circuit diagram of this project work is provided in the next chapter. The following is the description of overall function of the module. The air compressor based ground clearance of the vehicle system for the all type of roads is a logical development of the self-leveling system in the automobiles (cars). Designing a vehicle this perfect for on and off-road use

sounds like squaring the circle. Usually the strengths of an off-road vehicle are decided weaknesses when it comes to road use. A high ground clearance, crucial for rough terrain, gives the vehicle a correspondingly high center of gravity. When it comes to fast cornering, however, this is as disadvantageous as it is for driving stability at higher speeds. In addition, the air resistance is increased, which significantly affects fuel consumption as well. In contrast, the shorter spring travel and the firmer running gear matching of an on-road running gear offer inadequate driving comfort off-road.

## OBJECTIVE OF THE PROJECT WORK

- 1 The automatic in built pneumatic system is used to lift the chassis from the ground without human efforts and time.
- 2 Pneumatic lifting technique system is used to provide higher ground clearance at the time of rough roads and speed bumps.
- 3 To cope up the shortage of most commonly used fuel and go for compressed air or liquid fuel as a working medium.
- 4 While driving four wheelers, we faced a problem related to tyres. A hydraulic operated jack is placed in a supportable position where transitional motion to lift vehicle.
- 5 In several automobile garages, revealed the facts that mostly some difficult methods were adopted in lifting the vehicles for reconditioning.
- 6 Hence a suitable Design has been designed such that the vehicle can be lifted from the floor land without application of any impact force.
- 7 In order to avoid all such disadvantages, the automatic jack has been designed in such a way that it can be used to lift the vehicle very smoothly without any impact force.
- 8 In order to fulfill the needs of present car jack, some improvement must be made base on the problems statement:
  - To design and develop efficient jack system.

- To minimize human effort.

## II. LITERATURE REVIEW

Off-road vehicles have to face the rough terrain, where we need the high ground clearance of the vehicle; on the other hand we run the same vehicle on a road where high ground clearance is not necessary. Whereas a sedan car or hatchback has to run on smooth roads as well as on rough terrains sometime with its fixed lower ground clearance which tends to create dents on the bottom portion of the car. In both cases we need an adjustable ground clearance system in the vehicle to have optimum performance. Here this paper introduces the pneumatic lifting technique which is used to provide the higher ground clearance at the time of rough roads/breakers and lower the same to get proper ground clearance to maintain the stability at high speed on smooth roads.

Hrishikesh V Deo & Nam P Suh Et.al [1] introduced that how the comfort and handling are interrelated with centre of gravity of the vehicle. They designed the suspension system which varies its height and stiffness according to speed. The researchers used short long arm suspension system which is widely used in front wheel suspension. For controlling the height and stiffness, it can be achieved by making the lower spring pivot movable along the lower control arm. For moving the pivoted point and achieve desired position electric motor is used to actuate the actuator. But there are some limitation which we come across, that is about less quick response. In this paper they also described about active and semi-active suspensions limitations and how it can be overcome with adaptive control with variable height.

P.E. Uys, P.S. Els, M. Thoresson Et.al [2] presented the suspension settings for optimal ride comfort of off-road vehicles travelling on roads with different roughness and speeds. In this they vary the suspension settings for different roads roughness and vehicle speeds and results achieved for comfort level. Simulation is performed on a Land Rover Defender 110 model in MSC.ADAMS software for speeds ranging from 10 to 50 km/hr. Tests were performed on 100m Belgian paving and also ISO 2631-1, BS 6841 and VDI 2057 at different speeds. Correlation between measured and simulated results is very good, especially with respect to vertical acceleration. There are number of applications related to ground clearance and their consideration is designer need. DebojyotiMitra Et.al [3] presented design optimization of ground clearance of domestic cars. Stability and performance is also parameter of ground clearance. If we allow the vehicle for the low ground clearance then it helps to give less drag force simultaneously it consumes less fuel resulting less

pollution. The experiment is carried out in wind tunnel with the help of notch back car model. The result shows that the positive lift force reduces with increasing height of ground clearance. Hence the optimized value of h/b ratio has to be taken in to consideration of clearance design. With the help of spoiler the lift force problem can be solve. The active suspension system is very essential for handling and giving comfort. These days this system is used in different type of vehicles like hybrid vehicles.

Morteza and Mahdi Et.al [4] presented active suspension system in parallel hybrid electric vehicles. In this they compare the conventional and hybrid vehicle with active suspension. For conventional the power is taken from the IC engine hence gives little lag in actuation while in hybrid electric vehicle it is direct, resulting less fuel consumption and less emission.

## III. FUNCTIONAL DESCRIPTION

### PNEUMATIC JACK

The standard vehicle jacks require the operator to retrieve the jack from the trunk, place it under the vehicle in the proper location, and then manually rotate the screw thread in order to lift the vehicle. This process is time consuming, physically demanding and poses several safety hazards. Adverse weather conditions can exacerbate the process and make it a greater safety hazard. Those who are physically weaker (women, senior citizens, young drivers) may face great difficulties in jacking a vehicle in case of an emergency repair. The purpose of this senior design project is to counter the safety hazards and physical demands related to using manual jacks or aftermarket hydraulic jacks by designing a jack system that is permanently attached to the vehicle.



Fig. 3.1 Pneumatic cylinder

**AIR COMPRESSOR**

An air compressor works similarly like the internal combustion. A rotary engine moves a piston through a linear motion through connecting rod of a cylinder which is it fits tightly. Air is then drawn in through its open valve as the piston moves up, this allows for an adequate space for volume of air. When the valve closes the piston moves down, where it then compresses the air. This has kinetic energy which it has gained from the pressure on the restricted spaces. The valve then opens to release the energy. A compressor is a mechanical device that takes in a medium and compresses it to a smaller volume. Compressors can either increase or decrease a given mass to a lower or higher pressure. A mechanical or electrical drive is typically connected to a pump that is used to compress the medium. As a consequence, the pressure drops to a low setting, and the pressure switch is turned on, thus allowing atmospheric air to enter the unit.



Fig. 3.2 Air compressor

**ULTRA SONIC SENSOR**

An ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception.

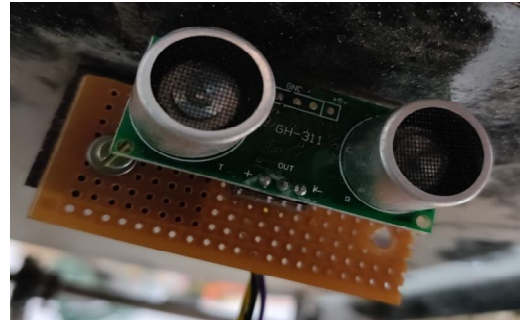


Fig. 3.3 Ultra sonic sensor

An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

**Table 3.1 Specifications of Ultrasound sensor**

SL/NO	SPECIFICATIONS	
1	Power Voltage	DC 6-12V
2	Quiescent current	Less than 2 m A
3	output Level	High 5V
4	output Level	Low 0V
5	Sensing Angle	no greater than 15°
6	Sensing distance	2mm-3m

**DC MOTOR**

An electric motor is a machine, which converts electrical energy into mechanical energy. DC motors are configured in many types and sizes, including brushless, servo, and gear motor types. A motor consists of a rotor and a permanent magnetic field stator. The magnetic field is maintained using either permanent magnets or electromagnetic windings. DC motors are most commonly used in variable speed and torque applications.

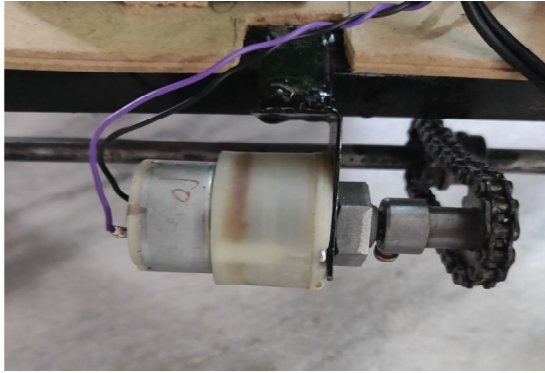


Fig. 3.4 DC Motor

**Principles of operation**

In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field.

**Table 3.2 Specification of DC Motor**

Parameter	Value
Operating Voltage	12 V DC
Operating Current	150 milli Amps
Speed	60 RPM

**Relay**

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts.

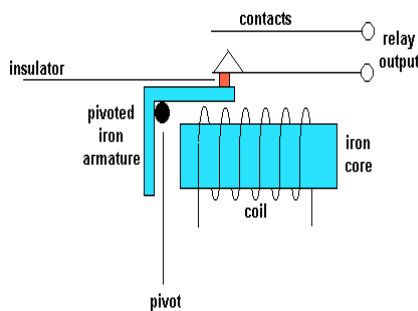


Fig. 3.5 Relay switch

An electric current through a conductor will produce a magnetic field at right angles to the direction of electron flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil. The greater the current and the greater the strength of the magnetic field, all other factors being equal, inductors react against changes in current because of the energy stored in this magnetic field. When we construct a transformer from two inductor coils around a common iron core, we use this field to transfer energy from one coil to the other.

**Power supply by Battery**

Battery is a device that converts chemical energy into electrical energy, consisting of a group of electric cells that are connected to act as a source of direct current. The term is also now commonly used for a single cell, such as the alkaline dry cell used in flashlights and portable tape players, but strictly speaking batteries are made up of connected cells encased in a container and fitted with terminals to provide a source of direct electric current at a given voltage. A cell consists of two dissimilar substances, a positive electrode and a negative electrode, that conduct electricity, and a third substance, an electrolyte, that acts chemically on the electrodes. The two electrodes are connected by an external circuit the electrolyte functions as an ionic conductor for the transfer of the electrons between the electrodes. The voltage, or electromotive force, depends on the chemical properties of the substances used, but is not affected by the size of the electrodes or the amount of electrolyte.



Fig. 3.6 DC Power supply Battery

Batteries are classed as either dry cell or wet cell. In a dry cell the electrolyte is absorbed in a porous medium, or is otherwise restrained from flowing. In a wet cell the electrolyte is in liquid form and free to flow and move. Batteries also can be generally divided into two main types-rechargeable and non-rechargeable, or disposable.

**IV. DESIGN AND FABRICATION METHODOLOGY**

**PROPOSED METHOD**

Pneumatic lift in a vehicle can be achieved by pneumatic cylinder employing a reciprocating compressor. Compressor compresses the gas to a high pressure. This high pressurized gas then send to pneumatic cylinders to exert force against the piston head inside it to have the piston movement to create a linear motion outwards. By lowering the pressure of gas the piston movement can be reversed. And with this mechanism ground clearance of the vehicle can be increased or decreased.

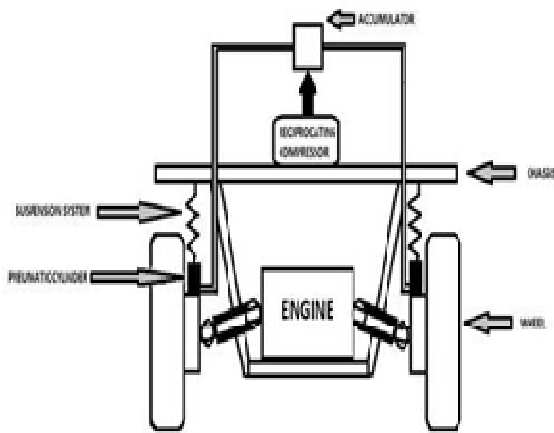


Fig. 4.1 Position after pneumatic lifting

There are two button systems on the dashboard, one to turn on the motor and one to open the outlet of pneumatic cylinders to release the high pressurized gas. A person driving a car on a smooth road when sees rough bumpy road or rough terrain in front of the vehicle, he can choose to increase the ground clearance just by pressing the button which is assigned to start the motor by connecting it with the battery. And as the rough terrain ends driver of vehicle can decrease the chassis height by pressing another button assigned to open the exhaust valve of the pneumatic cylinders to release the high pressurized air to the atmosphere which makes all the lifted pistons of pneumatic cylinders to get down to the position of inner dead centre. Releasing the pressed button ensures the closing of outlet valve of pneumatic cylinders. And again driver can have the standard ground clearance of the car to have a proper centre of gravity so to utilize the full potential of acceleration.

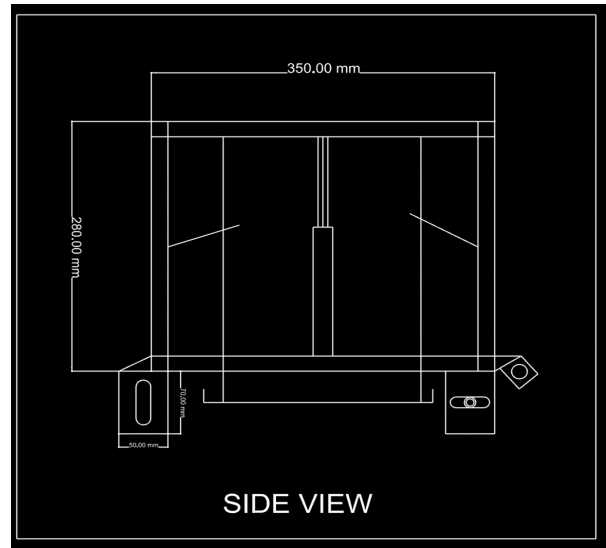


Fig. 4.1 Design of the proposed model

**FABRICATION:**

The fabrication process is done by using arc welding in which the metal used is **CARBON STEEL HALLOW RECTANGULAR BAR** is cut into required specifications.



Fig. 4.1 Fabricated prototype model

Prototype of this project consists of one chassis with four wheels with their axle shafts attached to it, one reciprocating compressor, four motors, a DPDT controller and rest of the design accessories. The prototype vehicle runs by the electric motors and compressor which runs on the battery power is employed to produce the pneumatic lift at each vehicle to increase the ground clearance of the vehicle. A controller is used to operate the compressor and motors to run the mechanism.



The pneumatic lift mechanism applied in prototype to increase the ground clearance works successfully. It is able to lift the weight of chassis up to 3-4kg with a compressor of capacity 350psi, which is good enough for a lower scale work. The mechanisms takes maximum 5 seconds to lift the chassis after providing input to the controller and then can have a fixed higher ground clearance up to required period of time to protect the chassis of prototype. And later can lower the chassis using controller to have fixed lower ground clearance within 5 second. And the performance can be optimized.

## V. EXPERIMENTAL RESULT

The pneumatic lift mechanism applied in prototype to increase the ground clearance works successfully. It is able to lift the weight of chassis up to 30-40kg with a compressor of capacity 5bar, which is good enough for a lower scale work. The mechanisms takes maximum 5 seconds to lift the chassis after providing input to the controller and then can have a fixed higher ground clearance up to required period of time to protect the chassis of prototype. And later can lower the chassis using controller to have fixed lower ground clearance within 5 second. And the performance can be optimized.

The results can be arranged as:

- ❖ The average time required by the system to vary the ground clearance of the vehicle is 5 seconds.
- ❖ The ground clearance of the vehicle is increased by 3cm along the obstacles. Car chassis is prevented from being damaged.
- ❖ The system can withstand a weight of 3 to 4 kg with the compressor of 350psi capacity.
- ❖ The project works well in case of prototype but there might be a chance that the result can vary with the real time application of the pneumatic system. But with proper design and mechanism with having accurate measurement in real time application the performance can be optimized.

As a result of this automatic braking system, the function of each part is working well and the whole system is successfully accomplished. The safety distance is determined then the vehicle system is activated when the obstacle is detected. The ranging accuracy of ultrasonic sensor in this prototype is about 2cm to 1m and works effectively within the prescribed limit.

Final Overview of Project In this project, we have checked the working of our project, we connected it with a batteries and whose braking system is controlled by a DC gear motor and servomotor. This technique is eco-friendly and this work is an attempt to reduce accidents while in critical driving

conditions. We have tested the working of the system by placing various objects ahead as obstacles. The system responded by reducing the speed of the vehicle when the obstacle is placed at various distances from it.

## VI. CONCLUSION

The project work “**Design and Fabrication of Automatic Ground Clearance Enhancement Technology for 4 - wheeler**” is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. While designing and developing this proto type module, we have consulted few experts those who are having knowledge in Mechatronics, and these professionals working at different organizations belongs to Hyderabad helped us while fabricating this project work. This innovation can help driver to choose the ground clearance with his comfort of driving according to terrain. Riding off-road becomes easier and vehicle can fuel efficient by lowering ground clearance while driving on-road. For the off-road tracks, one can have highest clearance and move along the course of the road with better handling.

This system helps in under steering of the vehicle. The system is very user friendly. This system will increase the economy of a vehicle. The system proves that the Adjustable Ground Clearance Mechanism is a good innovative system for better performance of off-road vehicles. Since the system is more users friendly and at the same time increase the performance, this will have good market potential. The ground clearance can be easily adjusted by the driver itself at any place. The system is very much reliable in operation. This system is cheaper in initial as well as running costs. It does not require an external energy to run the system and no moving parts in the system so maintenance is also very low.

This system allow to overcome uneven territory without damaging lower body and reduce unnecessary burden caused by such damage. The sole purpose is to protect vehicle from damage and at the same time increase fuel economy. To fulfill these purposes we need a system which is capable of lifting our vehicle and then coming back to its original position. Thus for the lifting purpose we can utilize different mechanism For example instead of using pneumatic cylinder we can utilize screw with square threading as square thread is best for lifting heavy loads.

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